GL01167

[illegible]

CONFIDENTIALITY NOTICE

"Data contained in pages and figures listed below 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."

PAGE — 4-16a, 19, 20 inclusive
Optional Form 60 and attachments A-1, A-2

FIGURE — 1, 2,

FIGURES

APPENDICES

RFP NO. ET-78-R-08-003
GEOTHERMAL RESERVOIR CASE STUDY
NORTHERN BASIN AND RANGE PROVINCE

A. PROPOSER: CHEVRON RESOURCES CO.
320 Market Street
San Francisco, California 94111

B. TECHNICAL PROPOSAL

1. Investigation Area: BEOWAWE, NEVADA

a. Location

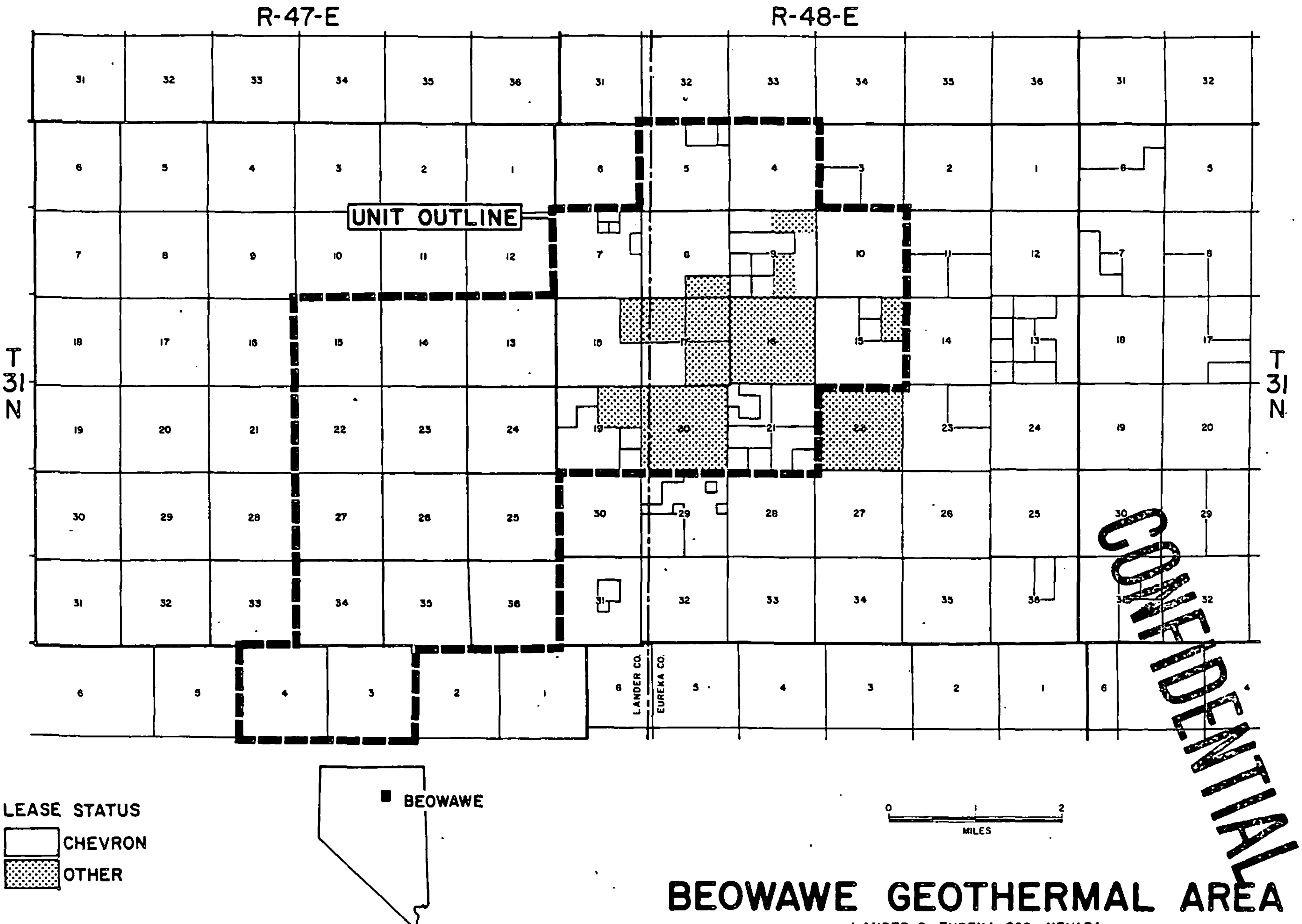
The geothermal resource area lies principally in T31N, R47 & 48E Lander and Eureka Counties, Nevada. An economic geothermal resource is known by virtue of wells drilled in the area.

b. Ownership

The attached map (Figure 1) shows the current geothermal leases. Federal lands administered by the BLM occupy a checkerboard of even-numbered sections through the area. The balance of the land is privately owned in tracts ranging in size from 10 acres to several thousand acres. Chevron is the principal lessee with approximately 24,865 acres.

Accessibility

The area is readily accessible by automotive vehicles over a dirt road from State Highway 21 south of the town of Beowawe. The topography is shown on the



BEOWAWE GEOTHERMAL AREA

LANDER & EUREKA COS., NEVADA

FIGURE 1

PROGRAM DATA INDEX map (Figure 2). The resource lies principally in Whirlwind Valley at an average elevation of 5000'. (Fig. 2 is folded map attached).

Unitization

Chevron is in the process of forming a Federal Geothermal Unit in the area. Designation of Area under 30CRF 271.3, as shown by Unit Outline on Figure 1, has been approved by the U.S.G.S. The Unit area comprises 8130 acres of Federal lands and 9118 acres of patented lands.

Chevron is contacting landowners for their consent to the Unit Agreement. It is anticipated that the 4000' well proposed under this program would be drilled as a Unit well.

c. Geology

Beowawe is a typical Basin & Range geothermal area (Figure 3). The major structural feature in the area is the Malpais fault, represented topographically by the Malpais escarpment which trends northeast - southwest through the area.

The Malpais fault is a Tertiary age normal fault with postulated slip displacement of about 4000 feet and possibly some oblique slip of unknown amount. The downthrown block is tilted southeasterly and is cut by numerous conjugate faults. The fault system has a

EXPLANATION

- Qa – ALLUVIUM
- Qls – LANDSLIDE
- Tba – TERTIARY BASALT & ANDESITE FLOWS
- Ovi – ORDOVICIAN VALMY – SHALE, CHERT & QUARTZITE

GEOLOGY – BEOWAWE AREA

FROM: GEOLOGIC MAP OF NORTH-CENTRAL NEVADA
STEWART & CARLSON – 1976
NEVADA BUREAU OF MINES & GEOLOGY

principal trend NE-SW, with a secondary trend NW-SE.

Results from drilling the Chevron Ginn #1-13 well demonstrate that the Malpais fault zone is the principal geothermal reservoir and a conduit which taps a deeper heat source. Intersecting faults and associated fracturing locally may provide additional reservoir capacity. The Malpais fault appears to dip between 65° and 70°.

Stratigraphy

The oldest rocks in the immediate area are the interbedded quartzites, siliceous shales, and cherts of the Ordovician Valmy Formation. Outcrops of the Valmy are found immediately northeast of the Geysers region along the Malpais escarpment and west of the Whirlwind Valley (Figure 3). Total thickness of the Valmy is unknown because of fault contacts. However, an estimate of 8000 feet for the total Valmy thickness is reasonably based on regional studies in the area. Young Tertiary basaltic andesite flows cap much of the area forming cuestas that dip at low angles to the southeast. Approximately 1000 feet of this unit crops out in the Beowawe Area, although 4000 feet of basalt, rhyolite, andesite, and tuff were encountered in the Chevron deep test. Whirlwind Valley is covered by a thin (0 to 550 feet) layer of alluvium, sinter deposits, talus, and landslide debris of Pleistocene to recent age.

Present day hot spring activity is found in Sections 17 & 18, T31N, R48E. Spring deposits, made up of opaline silica (siliceous sinter) cover nearly 0.6 sq. mi. and are about 6000 feet long and 2800 feet wide. The sinter covers the valley floor in part and forms a 300 feet high terrace along the Malpais escarpment.

In the early 1960's eleven shallow geothermal wells were drilled on and near the sinter terrace, four of which had fluid temperatures of 407 F to 414 F and high flow rates. At today's price for electricity they would be commercial.

Chevron drilled the Ginn #1-13 in 1974 to 9563' and in 1976 the Rossi 21-19 to 5680'. Both wells reached the fault and recovered high temperature fluids on drill stem test. The principal reservoir appears to be variable. More wells need to be drilled into the reservoir to locate the best productive area and the total productive capability of the reservoir.

Data from temperature holes located to the southwest along the Malpais fault in Sections 23, 27 & 35; T31N, R47E indicate a reservoir may lie at depth in this portion of the area. Such a reservoir may or may not be connected with the known reservoir.

d. <u>Technical Reasons for Site Selection</u>

Location of the proposed 4000' well (Figure 2) has been selected on the basis of analysis and interpretation of all the available geologic, geophysical and well data. Final location and depth of the well will depend on the results of a seismic program (proposed in Section 3) and on final total data interpretation.

2 PROGRAM DATA OFFERED - EXISTING DATA (See Figure 2)

a. Subsurface - Wells

CONFIDENTIAL

CHEVRON GINN 1-13

Spudded 1/23/74 Suspended 6/30/74

Total Depth: 9563'

Contractor: R B. Montgomery Drilling, Inc.
P.O. Box 2508
Bakersfield, CA 93303

1) Drilling history

2) Drilling fluids used

3) Casing and cementing record

4) Mud log 125' - 9551'

Contractor: Exploration Logging, Inc.
3325 Longview Drive
Sacramento, CA 95821

a) Bit data, hole size, penetration rate

b) Lithology

c) Continuous mud temperature (in and out)

d) H_2S gas

e) Hole deviation

5) Cuttings samples 125' - 9551'

approximately 30-50 gm. samples at 10' intervals will be furnished

6) Core Description

Cored interval 9551-63' (T.D.)

7) Electric Logs

Contractor: Schlumberger
517 Houston St.
Sacramento, CA

Log Run: 126 - 816' (1/24/74)

induction electrical log

Log Run: 8/0' - 8496' (5/22/74)

dual induction laterolog

compensated neutron

compensated formation density

gamma ray

caliper

four-arm high resolution dipmeter

8) Drill Stem Tests

Contractor: Haliburton Services
Rio Vista, CA

Intervals Tested:

2233-2491 (2/9/74)

8351-9426 (4/2/74)

9343-9551, 27 hour flow (6/28/74)

9) Fluid Chemistry

Contractor: Skyline Labs, Inc.
12090 West 50th Place
Wheat Ridge, CO 80033
Charles E. Thompson, Chief Chemist

Samples recovered from DST 2234-2491'

Samples recovered from DST 9343-9551'

10) Temperature Surveys

a) Surveys run by Chevron personnel with maximum reading thermometers:

CONFIDENTIAL

DATE	DEPTH
1/28/74	770'
2/8	2435'
2/24	4700'
2/26	5220'
3/15	6005'
4/05	8500'
5/22	8644'

CONFIDENTIAL

b) Surveys at 20' intervals, 0' - 9551

Contractor: Agnew & Sweet
3914 Gilmore Avenue
Bakersfield, CA 93308

8/22/74 — 43 days after well suspended

12/12/74 — 23 weeks after well suspended

11) Static Pressure Gradient Survey 0-9551 T.D.

Contractor: Agnew & Sweet
3914 Gilmore Avenue
Bakersfield, CA 93308

Dates Surveyed: 8/22/74, 12/12/74

CHEVRON ROSSI 21-19

Spudded 10/5/76 — Suspended 12/07/76

Total Depth: 5680'

Contractor: Big Chief Drilling Co.
P. O. Box 14837
Oklahoma City, OK 73114

1) Drilling history

2) Drilling fluids used

3) Casing and cementing record

4) Mud log 34' - 5680'
run by Chevron geologists at wellsite

a) Bit data, hole size, penetration rate

b) Lithology

c) Mud temperature (in and out) at 10' intervals

5) Cutting samples

Approximately 30-50 gm. samples at 10' intervals will be furnished

CONFIDENTIAL

6) Electric Logs

Contractor:	Welex (Halliburton) 1801 Oak Street Bakersfield, CA 93301
Log Run:	200' - 1998' (10/18/76)
	induction electric log
	compensated acoustic velocity log
	dip log
	caliper
Contractor:	Schlumberger 517 Houston Street Sacramento, CA
Log Run:	1998 - 4371 (11/20/76)
	dual induction laterolog
	compensated formation density
	gamma ray
	caliper
	four-arm high resolution continuous dipmeter
	borehole compensated sonic log
Log Run:	4374' - 5680' (12/3/76)
	dual induction laterolog
	compensated neutron
	compensated formation density
	gamma ray (operable 5590 - 5680' only)

caliper

four-arm high resolution continuous dipmeter

borehole compensated sonic log

CONFIDENTIAL

7) Directional Surveys taken by Chevron field foreman at various intervals

8) Drill Stem Test

Contractor: Johnston Testers
Bakersfield, CA

Interval Tested:

4369-5680 Date: 12/5/76

9) **Fluid Chemistry**

Contractor: Skyline Labs, Inc.
12090 West 50th Place
Wheat Ridge, CO 80033

Analysis of fluids recovered from DST:

4370' - 5680'

10) Subsurface Temperature Surveys

Contractor: Agnew & Sweet
3914 Gilmore Avenue
Bakersfield, CA 93308

Temperature logged at 20' intervals in 2 7/8" tubing

0' - 5580' on following dates:

12/8/76, 2/8/77, 3/7/77, 3/28/77, 4/15/7

11) Subsurface Pressure Surveys

Contractor: Agnew & Sweet
Bakersfield, CA

Pressure measured at 100' intervals

1800' to 5574' on 3/7/77

Pressure measured at 20' intervals

0' - 5574' on 4/15/77

b. SURFACE DATA

(See Figure 2, PROGRAM DATA INDEX MAP)

(1) GEOPHYSICAL SURVEYS

(a) ELECTRICAL - RESISTIVITY (Dipole - dipole)

Contractor: McPhar Geophysics Inc.
Tucson, AZ (Later became Phoenix Geophysics, Inc.)

Surveyed October, 1973

40 Miles

a = 2000'

n = 1 to 5

f = 0.125 H_2

Contractor: Phoenix Geophysics, Inc.
4690 Ironton Street
Denver, CO 80239

32 miles of line

Surveyed July 19 to August 11, 1976

a = 2000'

n = 1 to 6

f = 0.125H

ELECTRICAL - MAGNETO TELLURIC

Contractor: Geotronics Corp.
10317 McKalla Place
Austin, TX 78758

12 stations (8 on downthrown fault block, 4 on upthrown block) covering approximately 60 square miles

1) rotated apparent resistivities and impedance phase

2) impedance tensor rotation angle, dip axis angle, etc.

3) ellipticity, skew, etc.

4) continuous one dimensional inversion of both TE phase and amplitude curves to apparent resistivity.

ELECTRICAL - SELF POTENTIAL

Contractor: Terraphysics
815 So. 10th St.
Richmond, CA 94804

Robert Corwin, University of California, Berkeley, Consultant Aldo Mazzella, Terraphysics.

Field observations July 25 - August 22, 1977

10 north-south lines totaling 25 miles with one 5 mile tie line within area outlined in Figure 2. Electrode spacing predominately 100 meters, reduced to 25 meters where high reading observed. The "total" potential measurement was used for most of the survey, in which a base electrode is planted in the ground and measurements are made relative to this base with a moving electrode. "leap frog" measurements of successive potential differences were used only over difficult steep terrain.

Output: 1 contour map and profiles.

(b) AEROMAGNETICS

Contractor: Senturion Sciences, Inc.
P. O. Box 15447
Tulsa, OK 74112

80 line miles over 30 square miles, flown in January 1976

11 flight lines oriented NW-SE, 5 tie lines oriented NE-SW

Total field measurement, flown at constant altitude of 6500' (1500' terrain clearance average)

(c) SEISMIC - MICROSEISMIC

CONFIDENTIAL

Contractor: Seismic Exploration, Inc.
P. O. Box 9344
Salt Lake City, UT 84109

Lewis Katz, Principal investigator

Field operation: September 21 - October 5, 1977

5 stations measured, 4 utilized for analysis.

Data Acquisition

Five Sprengnether MEQ-800 microearthquake recording systems, together with Datamagnetics digital tape recorders, were used for field data acquisition. Hall Sears HS-1 (1 Hz) geophones with calibration coils were used as sensors. The digital tape recorders feature high dynamic range and low system noise recording. The MEQ-800 offers smoked paper records for field monitoring of the data. Geophones were spaced approximately 2000 feet apart. Individual recording systems were hard wired together so that absolute relative timing could be obtained by broadcasting time marks every hour. The crystal clocks supplied by the manufacturer in the MEQ-800's

are temperature dependent causing drifts greater than 20 msecs. These drifts are not linear and therefore cannot be scaled by a correction factor. Stations were occupied from one to two days, depending on the quality of data observed on the paper records.

Data Processing

Field data were first edited by picking quiet sections from the smoked paper records. These sections were stripped out and re-edited. Data from four stations (1,3,4,5) were chosen for processing. For each station, four depth arrays (20 x 20) of possible source locations were chosen at 1,050 foot intervals. That is, four 19,950 x 19,950 foot horizontal maps were generated at depths of 2000, 4,000, 6,000, and 8,000 feet. Ray tracing algorithms were used to determine delay times from each source location to the geophones at each station. Geophone arrays were focused on each location by shifting traces by appropriate delay times and then stochastically correlating traces. Five hours of array processing time per station was required (6800 correlations). A listing of individual delay times, correlation values, and graphic plots were produced.

Data Analysis

Data was processed using two velocity models, a half-space model of 16,000 fps and a layered model varying from 6,000 fps at the surface to 16,000 fps from 2,900 ft. and below. Both models appear to give the same results with no apparent differences in location of groundnoise sources. Also, two sets of independent data were processed in order to verify initial results and stationarity of source locations.

CONFIDENTIAL

SEISMIC - REFLECTION

Contractor: Charles B. Reynolds and Associates
11909 Allison Court NE
Albuquerque, NM 87112

Charles B. Reynolds, Principal Investigator

Grid of 4 NW - SE and 4 NE-SW lines

Total 17.5 miles

Field work conducted: May 13 - August 31, 1975

Method:

A 300 lb. steel weight dropped through a distance of 3-½ feet was the energy source on Lines BW-1 and BW-6. This was increased to a 700 lb. weight dropped 5-3/4 feet on the other survey lines. Receiver arrays along the lines consisted of twelve 10 Hz geophones placed at 12 foot intervals with a spacing of 165 feet between array centers. The source weight was dropped at two locations for each array position, being offset 8 feet from the line and at 24 feet in either direction from the array center. The weight was dropped one or two times at each of the drop locations. The drops at each array were summed in the field.

(d) GROUNDNOISE

Contractor: Charles B. Reynolds & Associates
11909 Allison Court NE
Albuquerque, NM 87112

Charles B. Reynolds, principal investigator

57 stations roughly 1 mile apart

Surveyed May, 1974

CONFIDENTIAL

Method

Data recorded at each station over a period of 9 to 12 minutes, with a specially designed geophone which has a peak response at 4Hz and filter cutoffs at 2 & 5 Hz. The data are processed by selecting three minutes (not necessarily continuous) of recorded data which appear to be free of extraneous noise. The mean of the maximum amplitudes occurring during each second of these three minutes is determined and the ground noise power in decibels is derived therefrom.

Contractor: Senturion Sciences, Inc.
1539 North 105th East Avenue
Tulsa, OK

John Bailey, R. G. Graf, Keith Westhusing, geophysicists conducting survey and analysis of field data

139 recording stations at 500 foot intervals along lines spaced 500' apart.

19 base stations

Area Covered: approximately 1½ square miles centered around Chevron Ginn #1-13

Dates of Survey: October 29 through November 20, 1974

Analysis of power spectra over three frequency bands (0.5-15Hz, 0.5-7.5Hz, 0.5-3.5Hz) via integrated power and mean frequency referenced to a base station.

(e) RESERVOIR ENGINEERING STUDIES

None made to date

3. PROGRAM DESCRIPTION

a. SUBSURFACE

(1) EXISTING WELL DATA

Chevron Ginn 1-13 and Chevron Rossi 21-19 as described in detail above (see 2. PROGRAM DATA OFFERED).

NEW WELL DATA

CONFIDENTIAL

A well located at Chevron's option in Section 17 or in Section 18, T31N, R48E is proposed to be drilled to a depth of 4000'*to penetrate the reservoir associated with the Malpais fault zone.

(2) DRILLING, TESTING, AND COMPLETION PROCEDURES

For existing wells, see details above under heading "2. PROGRAM DATA OFFERED".

For the proposed 4000'*production well the drilling, logging, and testing program is described in detail in Appendix I.

b. SURFACE INVESTIGATIONS - EXISTING

(1) All surface data offered have been completed and are described in detail above (see 2. PROGRAM DATA OFFERED).

(2) Type of Surveys: See Above

*More or less, depending on final surface location

SURFACE INVESTIGATIONS - NEW

Reflection Seismic - 8 line miles

The purpose of this survey is to provide detailed documentation of fractures in the area of the proposed exploratory wall. Because of scheduling constraints of the Chevron crew, the work wil be performed in July 1978. However, it is emphasized that the sole purpose of the work is to provide the best possible definition of location for our proposed well.

The coverage will be obtained by Chevron Geophysical Co. Party 8, (Chevron Geophysical Co. Box 36487, Houston, Texas (713) 781-3030; H. E. Stommel, President; S. R. Bridges, Party Chief). Dynamite charges at roughly 100 feet will be used as the source. For high resolution, a 10 meter group interval will be employed using six phones per flyer. Recording will be done using a 120 channel Texas Instrument DFS V. By shooting from both ends of the cable at a 120 meter shot interval, the ultimate processing product will be a 1000% CDP stock. Groundnoise will be cancelled by mixing many geophone groups via array simulation. A 60,000 total cost is estimated. (see attachment to Form 60)

(c) RESERVOIR ENGINEERING STUDIES

If drill stem test data indicates the well will produce, a flowing pit test of up to 24 hour duration will be made.

4. <u>SCHEDULE</u> (See also Figure 8 - Planning Schedule & Milestone Chart)

a. 1978 (3rd and 4th quarters): Obtain Secretary of the Interior's approval of Beowawe Unit.

(1) Obtain royalty owner's signatures to Unit Agreement.

(2) Obtain other lessee's signature to Unit Operating Agreement.

(3) Submit Unit Agreement and Unit Operating Agreement to U.S.G.S. Geothermal Supervisor.

(4) Submit to U.S.G.S. revised Plan of Operation for well location, section 17 or section 18 of T31N, R48E, (Exact location to be determined).

(5) Obtain environmental approval from U.S.G.S. for well site under revised Plan of Operation.

(6) Approval of Unit Agreement by U.S.G.S. Area Office.

b. 1979 (3rd quarter) Drill and test 4000'* production well. Estimated drilling and completion time: 35 days.

c. Availability of Data

(1) Existing data

After contract has been signed as soon as data can be reproduced and transmitted but not to exceed 60 days thereafter.

(2) New Data

Well data can be submitted to DOE within 15 days of completion and final report within 30 days of completion. Well data can be released to the public 6 months after completion.

*See Footnote p. 16

PLANNING SCHEDULE & MILESTONE CHART
4000' PRODUCTION WELL – BEOWAWE, NEVADA

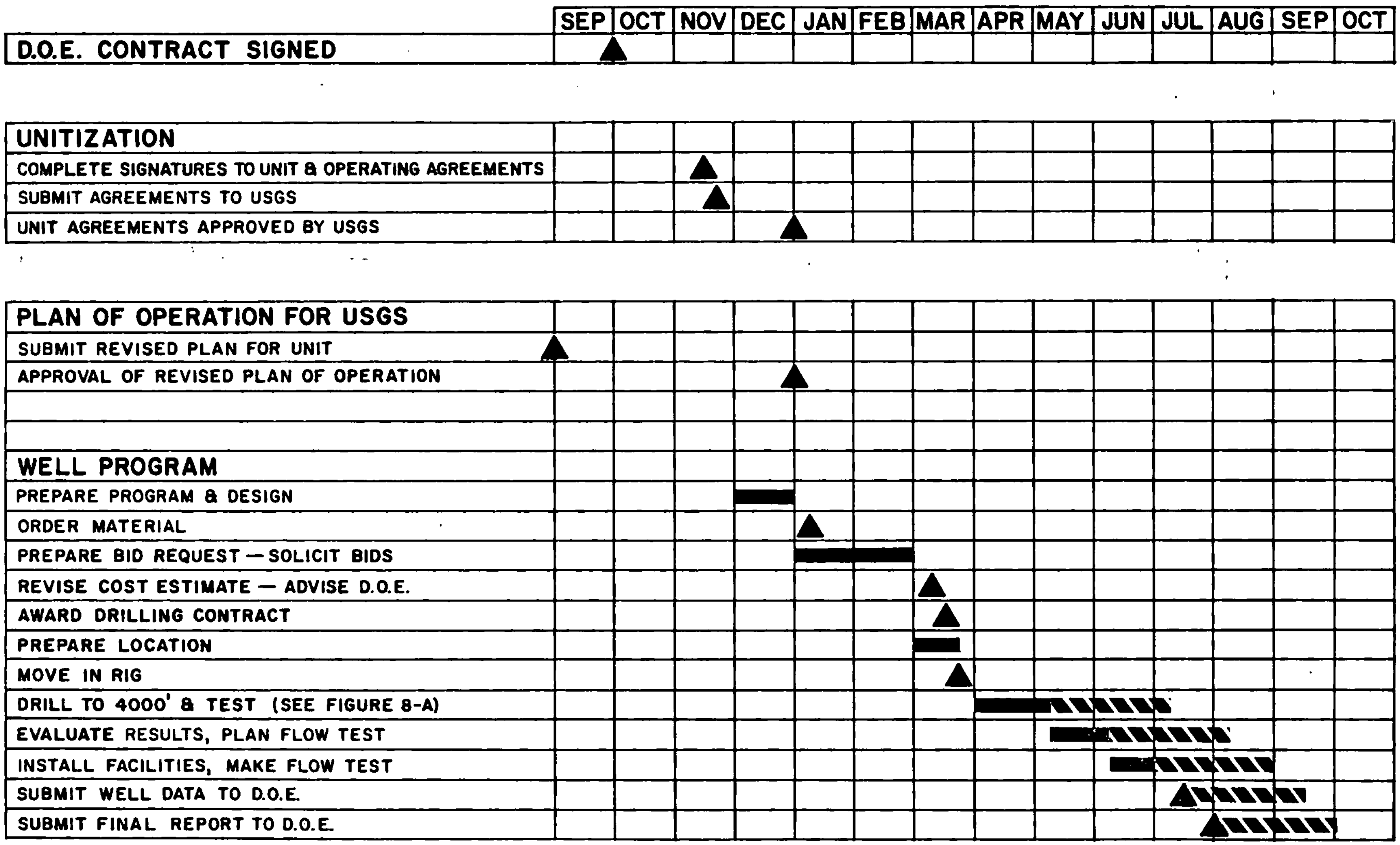
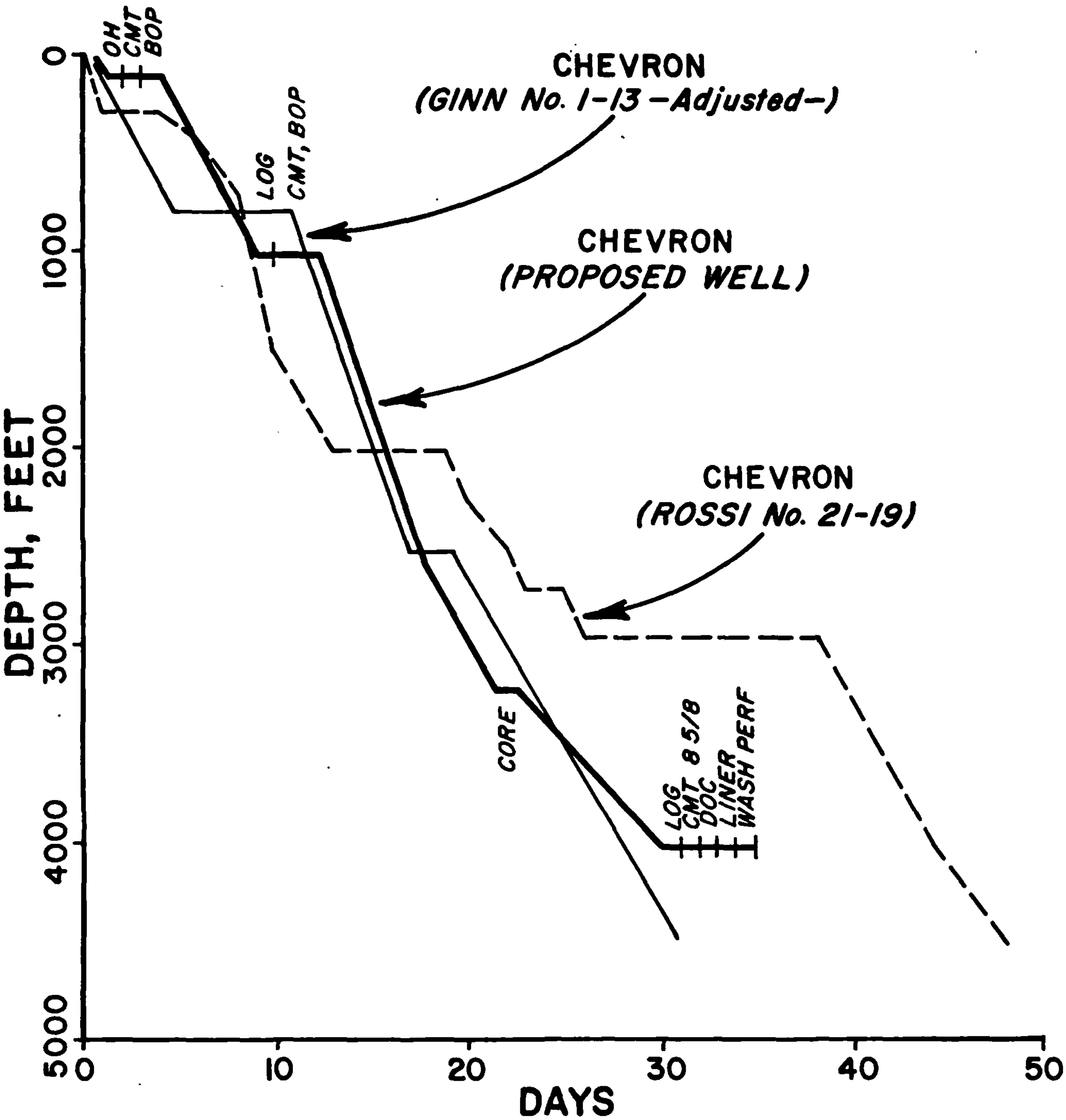


FIGURE 8



DRILLING TIME CURVE
BEOWAWE PRODUCING WELL

4/26/78 B.D. GARRETT

TO ACCOMPANY PRO-316-C

FIGURE 8-A

5. ENVIRONMENTAL EVALUATION

The Office of the Area Geothermal Supervisor, U.S.G.S., Menlo Park, has prepared EA#55 "Environmental Analysis" Beowawe Unit, dated June 10, 1977. This is a 155 page document including an Environmental Base Line report and the impact evaluation of seven proposed well sites, one of which is within 1500' of the location of the 4000' well proposed herein. One copy is attached and additional copies of the complete document may be obtained from the U.S.G.S. Geothermal office in Menlo Park.

a. Brief description of the environment affected.

Summary description is given on attached Figure 4, which is from "Site-Specific Analysis of Geothermal Development -- Data Files of Prospective Sites": Vol. III, February, 1958 HCP/T4014-01/3 UC-66. Prepared for Department of Energy under Contract No. EG-77-C-01-4014.

b. Analysis of the potential environmental impact.

Attached as APPENDIX III are copies of pages 23-29 of EA #55 in which the "Impact Evaluation and Mitigating Measures" are discussed.

c. Potential for conflicts with existing land use patterns and programs.

Page 29 of EA #55 is attached as Figure 5 in which impact on land uses is discussed.

SITE: **BEOWAWE, NV**

DESCRIPTION OF THE ENVIRONMENT

CLIMATE

Prevailing Winds
Precipitation (Annual): 23 cm (9.13 inches)
Average Temperature
Minimum: -5.5°C (22°F)
Maximum: 21°C (70°F)

Relative Humidity
(Seasonal Peaks)
Summer: 30 - 40%
Winter: 60 - 70%

AIR QUALITY (Including PPM, Type of Pollutant, Measuring Station)	WATER QUALITY (Quality, Supply, Ownership/Water Rights)	NOISE (Level, Source Measuring Station)	BIOLOGICAL ENVIRONMENT		
			DOMINANT FLORA	DOMINANT FAUNA	ENDANGERED SPECIES (Flora and Fauna)
ppm undetermined.(4) Principal pollutant is wind-borne dust, with some sulphur dioxide and hydrogen sulfide from hot springs.	Surface water is available from the Humbolt River. Shallow ground water of good quality is also available.(4) However, a water shortage exists.(1A)	Ambient noise level is low.	greasewood, shadscale, rabbit brush, big sage, winter fat, wild-rye, squirreltail, cheat grass. Aquatic plant life found in thermal springs. (4)	wild horse, fox, weasel, bat, coyote, bobcat, rabbit, mule deer, prong-horn antelope. Springwater heavily used by wildlife and livestock. (4)	Spotted Bat and a relict fish found in Carico Lake Valley.(4)

SITE-SPECIFIC ANALYSIS OF GEOTHERMAL DEVELOPMENT–DATA FILES OF PROSPECTIVE SITES
Vol. III, Feb., 1978

FIGURE 4

EA #55
ENVIRONMENTAL ANALYSIS
BEOWAWE UNIT
JUNE 10, 1977

Land Uses

Recreation - Impacts by the proposed action on recreational land uses of the unit area is expected to be low. Road improvement for the proposed action may benefit sight-seers, rockhounds and pass-through hunters of the area.

Aesthetics - Due to the relatively low profile of the area to be disturbed, the proposed activity is expected to do little to alter the appearance of the area. Drill pad preparation on this flat terrain requires only clearing of brush and very little movement of the flat desert soils. Scars in the landscape, therefore, will only be evident to those at the drill sites and access roads. The Mal Pais mountain range lies between most of Route 21 and the proposed area of activity, therefore, the drill rigs will not be noticeable from most of this route. Portions of the unit area that are visible from a small stretch of Route 21 and Interstate Highway 80 are of a distance that drilling activity would not be discernible by the naked eye.

Grazing - The grazing capacity of the sagebrush-shadscale lowlands is relatively low, generally requiring about 6.1-8.1 hectares to support one animal for one month. Revegetating the disturbed area with the seed mixture described (Special Condition #3) should enhance the forage value of these particular sites, although there would be a net loss in forageable acreage for that period of geothermal occupancy and period of vegetative restoration. In the long run, however, there should be a net increase in forage value.

Cultural Resources - Impacts on cultural resources by the proposed action are not expected. Eleven of the 15 aboriginal archaeological sites on drill pad locations 83-24, 2, 3, and 5 were recorded and collected. No Cultural resources were found at drill sight eight. The remaining four sites located on proposed drill pads 3, 4, 6, and 7 will require additional testing and/or salvaging prior to any surface disturbance. A proposal for the additional work has been accepted by Chevron (see Chevron comments, Appendix F, dated 7/26/76 and 12/6/76).

Socio-Economic Characteristics

Most of the drilling crews will stay at Battle Mountain, although in the past, some crews lived at Crescent Valley, Elko and Carlin. Because of the wide spread accommodations, these communities experienced no difficulties in accommodating these crews. Since the wells will be drilled one at a time, the drilling activities would not create significant impacts on the local socio-economic characteristics.

FIGURE 5

C. COST

1. ESTIMATED TOTAL PROGRAM COST

EXISTING DATA

See attached Optional Form 60 for detailed breakdown of cost elements.

Surface data (geophysical and temperature hole data)	$237,416
Subsurface data (wells)	$2,029,731

PROPOSED PROGRAM

Reflection Seismic Survey	$ 60,000
Drill 4000' production well	$ 816,500

(see attached Optional Form 60 and Chevron form PRO-316C)

ESTIMATED TOTAL PROGRAM COST	$3,143,647

The proposed 4000' well is estimated at this time to cost $816,500. Our PRO-316C shows breakdown into cost elements. This estimate is based upon our experience in drilling the two previous wells in Beowawe Area and the drilling of two 5000' + geothermal wells in the Battle Mountain High region in first quarter 1978. Because of continually changing prices of material and services, the estimate has not been developed by obtaining current price quotations for each of the multitude of items required to drill such a well.

If this proposal is selected within the Competitive Range and specific details of the cost estimate are required they can be developed and submitted at that time.

Chevron will make a revised well cost estimate in the first quarter of 1979 (see below under "Proposed Cost to the Government")

2. PROPOSED COST TO GOVERNMENT

CONFIDENTIAL

EXISTING DATA

20% of surface data	$ 47,483
33 1/3% of subsurface data	$ 676,577

PROPOSED PROGRAM

Chevron proposes that D.O.E. pay 50% of the actual cost of drilling the 4000' well, up to a maximum of 50% of the revised estimated cost of the well. The revised estimate will be based upon costs prevailing at the time the revision is made in first quarter 1979 and will reflect any changes in proposed depth.

Reflection Seismic Survey (50%)	$ 30,000
Drill 4000' production well	
50% of revised cost estimate as above	
50% of current cost estimate	$408,250

RECAP -PROPOSED COST TO GOVERNMENT

Existing surface data	$ 47,483
Existing subsurface data	676,577
New Surface data	30,000
Proposed 4000' well	408,250 *
Total Proposed Cost to Government	$1,162,310

*Subject to revision as above

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 CHEVRON RESOURCES COMPANY		SUPPLIES AND/OR SERVICES TO BE FURNISHED Existing geothermal well data Existing geophysical data Proposed drilling of 4,000' well Proposed Reflection Seismic			
HOME OFFICE ADDRESS 320 Market Street San Francisco, CA 94111					
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED BEOWAWE, NEVADA		TOTAL AMOUNT OF PROPOSAL COST TO GOVT.: $1,162,310.00		GOV'T SOLICITATION NO. ET-78-R-08-0003	

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS					
b. SUBCONTRACTED ITEMS					
c. OTHER—*(1)* RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL					
2. MATERIAL OVERHEAD[3] *(Rate %X$ 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)*				$3,143,647.00	
10. *TOTAL DIRECT COST AND OVERHEAD*					
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate % of cost element Nos.)*[3]					
12. ROYALTIES[4]					
13. *TOTAL* PROGRAM *COST*				$3,143,647.00	
14. FEE OR PROFIT					
15. PROPOSED COST TO GOVERNMENT				$1,162,310.00 *	

CONFIDENTIAL

* Subject to revision. See Proposal under C. Cost, p. 20.

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 NO. ET-78-R-08-0003 Geothermal Reservoir 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
C. DAHLSTROM
VICE PRESIDENT & GENERAL MANAGER

SIGNATURE
C Dahlstrom

NAME OF FIRM
CHEVRON RESOURCES COMPANY

DATE OF SUBMISSION
5/30/78

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*		EST COST *($)*
	EXISTING DATA		
	GINN #1-13 EXPLORATORY WELL		
	See Attachment A-1		$1,020,175
	ROSSI #21-19 EXPLORATORY WELL		
	See Attachment A-2		1,009,556
	SUBTOTAL, WELLS		$2,029,731
	GEOPHYSICAL COSTS		
	McPhar Geophysics	$ 12,850	
	Reynolds & Associates	33,097	
	Geonomics	4,357	
	Phoenix Geophysical	13,970	
	Geotronics	20,220	
	Senturion Geophysical	44,165	
	J. Fleiner	3,867	
	Eklund Drilling	67,293	
	Ensco	21,300	
	Terra Physics	16,297	$ 237,416
	SUBTOTAL, BEOWAWE COSTS EXPENDED TO 4/30/78		$2,267,147
	PROPOSED PROGRAM		
	Reflection Seismic Survey: 8 line mi. (See Att.)		60,000
	Drill 4,000' production well (See Att. PRO-316C)		816,500*
	TOTAL PROGRAM COST		$3,143,647
	PROPOSED COST TO GOVT. (See Proposal discussion p.)		$1,162,310

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 & belief)

CONFIDENTIAL

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

* Subject to revision. See Proposal discussion under C. Cost, p. 20.

Well Name GINN #1-13

Project # X 20800

Well Costs from inception to 4/30/78

CONFIDENTIAL

	Chevron Code No.	Amount
Company labor	001-059	6,878
Expense accounts	071-0723	9,438
Motor fuel, lubes and greases	080-081	22,171
Fuels and utilities	090-1091	19,254
Materials and supplies:		
Drilling fluids	201-203	121,425
Casing and Tubing	206	51,356
Drillpipe, bits, reamers, other tools	222-249	120,744
Other surface equipment	204	-
Artificial lift equipment - subsurface	205	379
Subsurface controllable equipment	207	566
Transportation equipment services	267-279	76,298
Rentals, charters and equipment usage	291-2991	84,762
Contract labor	310	11,598
Drilling - contract	381-382	304,041
Drilling - company drilling equipment	383	-
Coring	3831, 825	-
Cementing	385	18,195
Directional tool, survey, and service costs	386	5,276
Logging and sampling - wire line & drill stem	388	16,936
Logging - mud	389	24,104
Perforating	390	-
Testing	391	93,494
Coring	392	-
Other drilling costs	399	10,300
Shops, mechanical services	406-419	1,192
Technical services	463-4799	6,469
Permits and fees	486-493	80
Telecommunications	505-509	579
Maps, surveys, logs, etc.	712	-
Loaned employee services	735	8,144
Other miscellaneous services & fees	736	-
Services from other operating companies	7387-739	6,496
General and administrative costs	754-748	-

TOTAL WELL COSTS 1,020,175

ATTACHMENT A-2

Well Name ROSSI #21-19

Project # V 20301

Well Costs from inception to 4/30/78

	Chevron Code No.	Amount
Company labor	001-050	10,253
Expense accounts	071-0723	50
Motor fuel, lubes and greases	080-081	16,317
Fuels and utilities	090-1091	40,416
Materials and supplies:		
Drilling fluids	201-203	137,487
Casing and Tubing	206	106,575
Drillpipe, bits, reamers, other tools	222-249	148,898
Other surface equipment	204	-
Artificial lift equipment - subsurface	205	422
Subsurface controllable equipment	207	24
Transportation equipment services	267-279	32,863
Rentals, charters and equipment usage	291-2991	35,465
Contract labor	310	1,360
Drilling - contract	381-382	267,584
Drilling - company drilling equipment	383	350
Coring	3831, 825	-
Cementing	385	44,933
Directional tool, survey, and service costs	386	-
Logging and sampling - wire line & drill stem	388	44,444
Logging - mud	389	-
Perforating	390	102,473
Testing	391	1,834
Coring	392	2,331
Other drilling costs	399	-
Shops, mechanical services	406-419	1,172
Technical services	463-4799	10,140
Permits and fees	486-493	-
Telecommunications	505-509	60
Maps, surveys, logs, etc.	712	1,803
Loaned employee services	735	-
Other miscellaneous services & fees	736	-
Services from other operating companies	7387-739	2,302
General and administrative costs	745-748	-
TOTAL WELL COSTS		1,009,556

CONFIDENTIAL

COST ESTIMATE

Reflection Seismic Survey, Beowawe, Nevada

Mobilization 2 days @ $4,000	$ 8,000
Drilling 8 line miles (120 meter short interval) at 8 holes/day for drill @ $600/day	16,000
Recording 6 days @ $4,000	24,000
Processing $1500/mile - eight line miles	12,000
	$60,000

By: Charles M. Swift Jr.
Geophysical Supervisor
Geothermal Exploration Division

May 26, 1978

WELL COST ESTIMATE WORKSHEET Pro-316-C

PROPERTY AND WELL NO. BEOWAWE WELL AREA 4/26/78

FIELD ______ SEC. ______ T ______ R ______

ESTIMATED TOTAL DEPTH 4000' ESTIMATED DRILLING DAYS OR TOURS 35 DAYS

C-946-2 ITEM NO.	DESCRIPTION	EXPLORATORY DRY HOLE	EXPLORATORY PRODUCER	DEVELOPMENT PRODUCER
1	CONTRACT DRILLING DAY RATE 35 DAYS @ $ ___ PER DAY 332			192,000
	___ DAYS @ $ ___ PER DAY			-
2	CONTRACT DRILLING FOOTAGE ___ FT. @ $ ___ PER FT.			-
	___ DAYS @ $ ___ PER DAY			-
3	COMPANY DRILLING LABOR ___ DAYS @ $ ___ PER DAY			-
4	COMPANY DRILLING SUPERVISION 40 DAYS @ $ 350 PER DAY 37			14,000
5	COMPANY EQUIPMENT USAGE			-
	DEU ___ DAYS @ $ ___ PER DAY			-
	DERS ___ DAYS @ $ ___ PER DAY			-
6	FUEL AND UTILITIES ___ DAYS @ $ ___ PER DAY			-
7	SUB TOTAL (1 THROUGH 6)	$	$	$ 206,000
8	RIG UP AND TEAR OUT/MOVE IN AND OUT			120,000
9	DRILLING FLUIDS			30,000
10	WELL SUPPLIES AND NON-SALVABLE MATERIALS (CEMENT BASKETS,			12,000
	FLOAT EQUIPMENT, CENTRALIZERS-SCRATCHERS).			-
11	TRANSPORTATION			15,000
	CONTRACT SERVICES AND RENTALS			-
12	DIRECTIONAL, TOOLS, SURVEYS & SERVICES			5,000
	(MONEL COLLAR, MULTI-SHOT INST., SERVICEMAN, SURVEYS, ETC.)			-
13	DRILL PIPE, BITS, REAMERS & OTHER TOOLS			55,000
	(HOLE OPENERS, STABILIZERS, REAMERS, DRILL PIPE & DRILL			-
	COLLAR RENTAL, ETC.)			-
14	OTHER SUB SURFACE CONTRACT RENTALS & SERVICES			10,000
	(WIRELINE PERFORATING, FORM, STIMULATION, CASED HOLE LOGS, ETC.)			-
15	OTHER SUB SURFACE COSTS			5,000
	(SWABBING, WASHING PERFORATIONS, CHANGE OVERS, ETC.)			-
16	SUB TOTAL (1 THROUGH 15)	$	$	$ 458,000
20	FORMATION EVALUATION CONTRACT SERVICES			-
	CORING 30 FT. @ $ 100 PER FT.			3,000
	SIDEWALL SAMPLES ___ @ $ ___ PER SAMPLE			-
	CORE ANALYSIS ___			2,000
21	TESTING DST TESTS @ $ 10000 PER TEST			10,000
	FLOW TEST WIRELINE TESTS @ $ 28000 PER TEST			28,000
22	LOGGING WIRE LINE ___ RUNS @ $ ___ PER RUN			35,000
23	LOGGING MUD 30 DAYS @ $ 500 PER DAY			15,000
24	TOTAL FORMATION EVALUATION SERVICES (20 THROUGH 23)	$	$	$ 93,000
30	CASING, TUBING AND RODS			
	CONDUCTOR 60'-20" 100# @ $ 50 PER FT.			3,000
	SURFACE 1000'-13 3/8 FT 54.5# 25 PER FT.			25,000
	PROTECTIVE ___ FT. @ $ 2300'@$17 PER FT.			59,000
	LINER 3300' 8 5/8 FT 36# $ 1000'@$20 PER FT.			87,000
	OILSTRING ___ FT. @ $ ___ PER FT.			
	TUBING 4000' 2 3/8 FT. @ $ 3 PER FT.			
	TUBING ___ FT. @ $ ___ PER FT.			
	RODS ___ FT. @ $ ___ PER FT.			
	RODS ___ FT. @ $ ___ PER FT.			
	TOTAL ___			

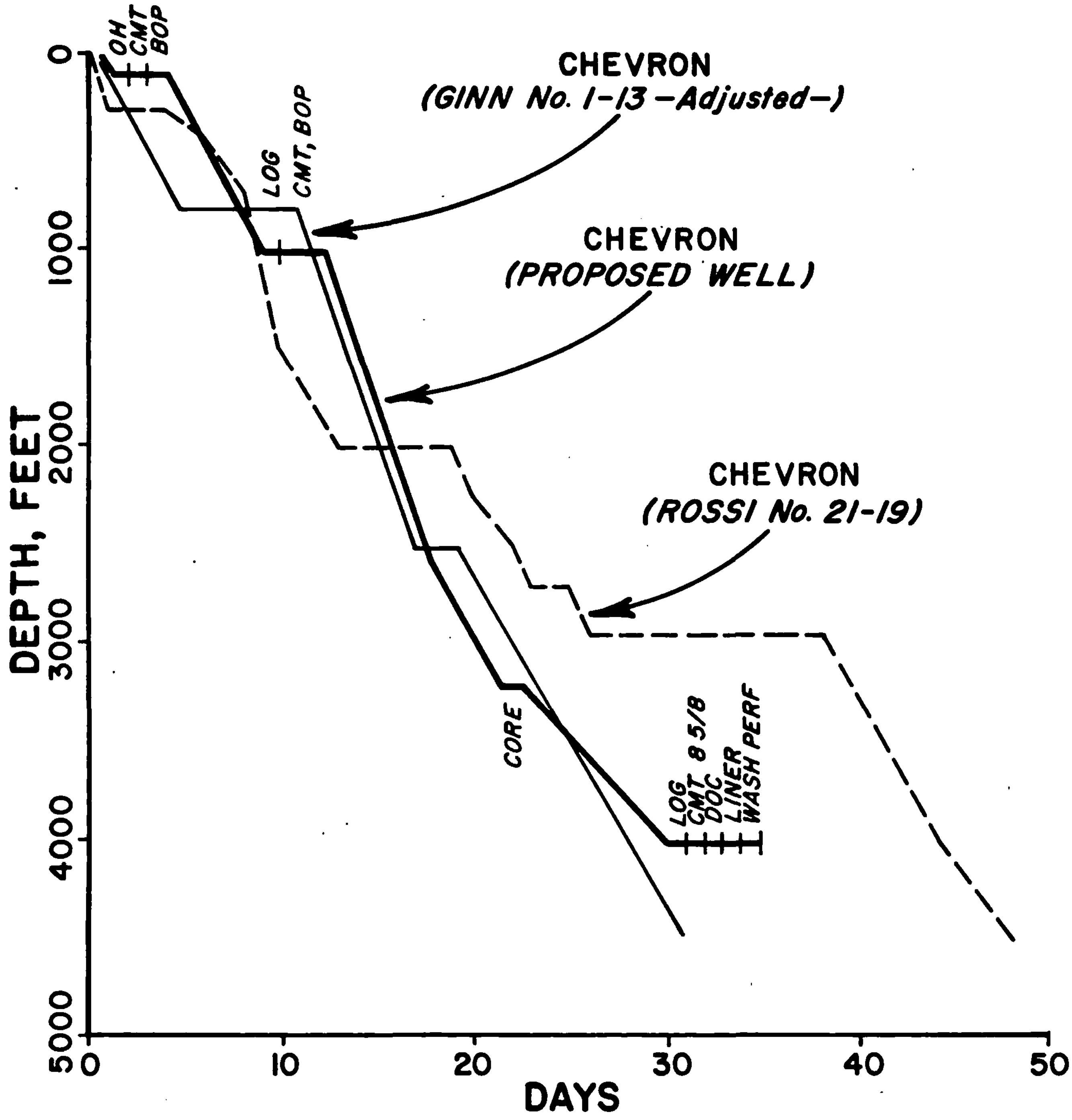
WELL COST ESTIMATE WORKSHEET Pro-316-C

C-946-2 ITEM NO.	DESCRIPTION	EXPLORATORY DRY HOLE	EXPLORATORY PRODUCER	DEVELOPMENT PRODUCER
31	SUBSURFACE PRODUCING EQUIPMENT CASING HEAD 5000 . TUBING HEAD - CASING SPOOL ___ . XMAS TREE 1-12" WKM 400#=7000 PACKERS ___ . WELL PUMP Misc 3000 SLIDING SLEEVES, SIDE DOOR CHOKES, ETC. ___			15,000
32	CONTRACT CEMENTING SERVICES CONDUCTOR 200ft³ YDS. @ $ 2000 PER YD. 1500 SURFACE 1000ft³ SACKS $ 11000 PUMP TRUCK $ 2000 PROTECTIVE 1200 SACKS $ 13000 PUMP TRUCK $ 2000 OIL STRING ___ SACKS $ ___ PUMP TRUCK $ ___ LINER ___ SACKS $ ___ PUMP TRUCK $ ___ SQUEEZE JOBS ___ SACKS $ ___ PUMP TRUCK $ ___ OTHER ___ SACKS $ ___ PUMP TRUCK $ ___ CEMENT BOND LOG ___ RUNS @ $ ___ PER RUN WATER SHUT OFF TESTS ___ TST. @ $ ___ PER TEST TEMPERATURE SURVEY			32,000
40	FISHING			
41	TOTAL SUBSURFACE WELL COSTS	$	$	$ 685,000
	SURFACE WELL COSTS			
51	SITE PREPARATION - LAND			25,000
52	SITE PREPARATION - WATER			-
53	ARTIFICIAL LIFT EQUIPMENT PUMPING UNIT $ ___ PRIME MOVER $ ___			-
54	TANKS, TRAPS, CAISSONS & OTHER SURFACE EQUIPMENT TANKS ___ @ $ ___ EACH SEPARATORS ___ @ $ ___ EACH FLOW LINES ___ FT. @ $ ___ FT. ELECTRIC LINES ___ FT. @ $ ___ FT. GAS LINES ___ FT. @ $ ___ FT. WATER LINES ___ FT. @ $ ___ FT. MISCELLANEOUS ___			-
55	TOTAL SURFACE WELL COSTS	$	$	$ 25,000
56	TOTAL DIRECT WELL COSTS	$	$	$ 710,000
61	Contingency for Fishing - 15%			$ 106,500
62	GENERAL AND ADMINISTRATIVE EXPENSE			
63	WELL CONTRIBUTION CREDITS			
64	TOTAL WELL COST			$ 816,500
	TOTAL TANGIBLE (TOTAL OF LINES 30, 31, 53 & 54)	$	$	$
	TOTAL INTANGIBLE (LINE 64 LESS TOTAL TANGIBLE)	$	$	$

Prepared by B. D. GARRETT 4/26/78 Senior Drilling Engineer ___

Approved ___ Date ___

Division Drilling Superintendent



DRILLING TIME CURVE
BEOWAWE PRODUCING WELL

4/26/78 B.D. GARRETT

TO ACCOMPANY PRO-316-C

D. BUSINESS AND MANAGEMENT

1. Chevron Resources Company is a division of Chevron Industries, Inc. which is a wholly owned subsidiary of Standard Oil Company of California, domiciled in San Francisco, California.

   Chevron initiated exploration for geothermal resources in the western states in 1971 and has actively continued exploration and drilling for geothermal resources to the present. We have identified some 45 prospects in which we hold Federal, State or private geothermal leases or first priority applications for Federal geothermal leases. Chevron holds approximately 210,000 acres under lease.

   Chevron has drilled 18 geothermal wells in seven areas, is operator in developing the Heber geothermal field in the Imperial Valley of California and is involved in drilling wells in the promising Brawley field nearby. Chevron conducts exploration and drilling with its staff of professional geologists, geophysicists and engineers. Geophysical surveys and drilling of wells are performed by contractors with consultation from Chevron professional personnel.

   Organizations having cognizance over our geothermal activities would be certain other companies active in geothermal exploration and drilling, i.e., our competitors. We have made trades of certain data with Phillips Petroleum Co., Union Oil Company of California, and

The Source Evaluation Panel may contact the following personnel regarding Chevron's professional qualifications in the geothermal field with the explicit understanding, however, that it will be inappropriate to discuss with them any portion of Chevron's proposal.

Mr. C. W. Berge
Energy Minerals Division
Phillips Petroleum Company
P. O. Box 752
Del Mar, CA 92014

Mr. Carel Otte
Union Geothermal Co.
Union Oil Company of California
P. O. Box 7600
Los Angeles, CA 90017

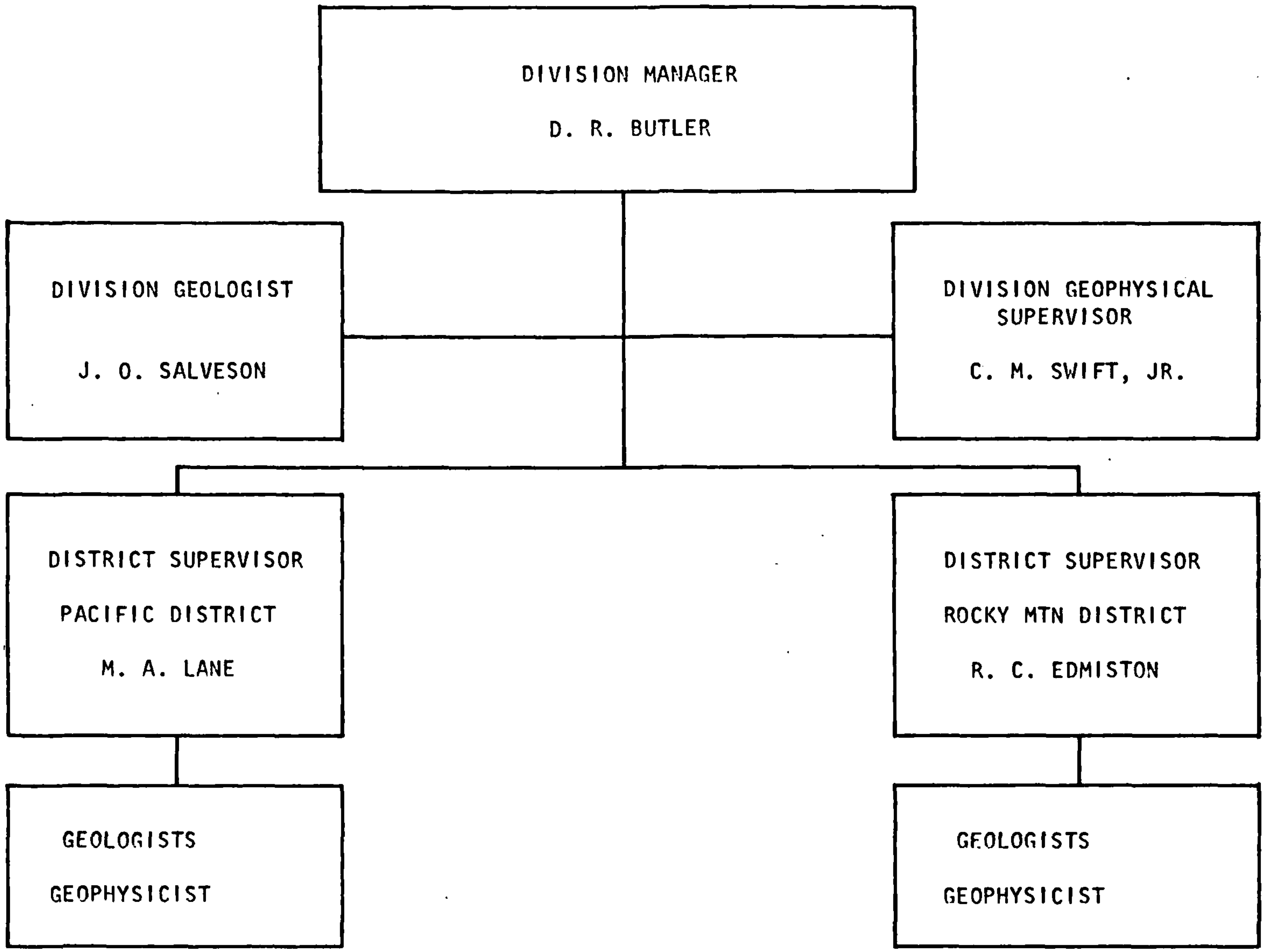
Mr. Glen Campbell
Gulf Energy & Minerals Co.
1780 So. Bellaire Street
Denver, CO 80222

2. PRINCIPAL PROGRAM PERSONNEL

The following personnel were responsible for acquisition of existing surface and well data and resumes for each follow: (See Appendix IV)

Exploration Personnel (See Figure 6 - Organization Chart)

D. R. BUTLER	Division Manager
J. O. SALVESON	Division Geologist
C. M. SWIFT, JR.	Division Geophysical Supervisor
M. A. LANE	District Supervisor
R. C. EDMISTON	District Supervisor
R. W. BUTLER	Geologist
R. J. ALMENDINGER	Geologist



CHEVRON RESOURCES CO.

EXPLORATION DEPARTMENT

GEOTHERMAL DIVISION

FIGURE 6

E. H. HAYNES	Formerly District Supervisor
W. E. MERO	Formerly Senior Geologist

DRILLING PROJECT PERSONNEL

A. M. COOPER	Senior Project Manager
B. D. GARRETT	Operations Supervisor-Geothermal

Certain of the above personnel plus those shown below(see Figure 7 - Project Organization Chart) will be responsible for the drilling of the proposed well and their resumes follow: (See Appendix IV)

R. H. HAND	Drilling Superintendent
E. E. GOMAA	Reservoir Engineer

3. MANAGEMENT PLAN

Proposed 4000' production well

a. Objective: to drill into Malpais fault zone reservoir, test productivity and complete with production casing, if test result data warrants, make short term flow test.

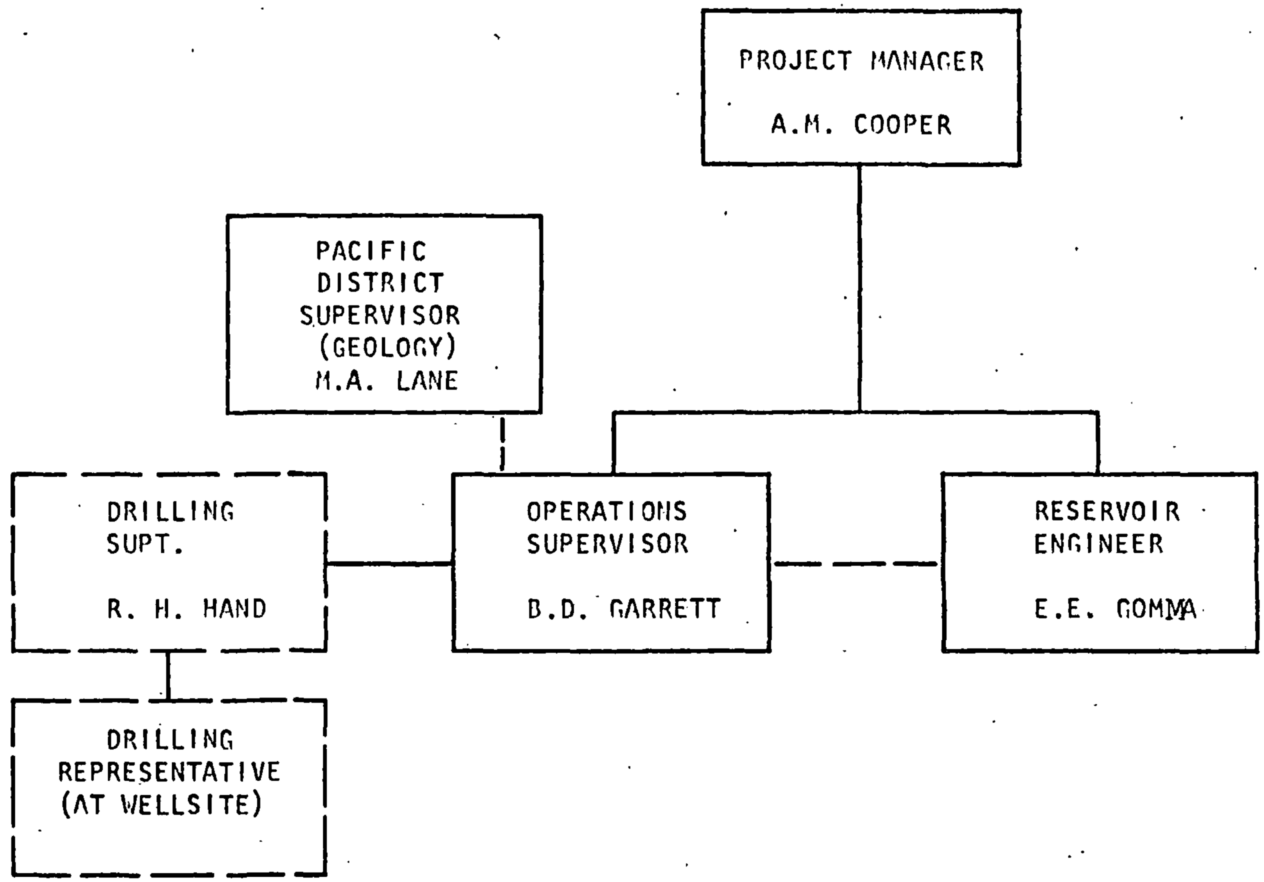
b. Drilling Operations - Responsibilities and Control Procedures:

The Project Organization Chart for the drilling of the 4000' well at Beowawe is shown in Figure 7.

Overall responsibility for drilling the well and accomplishing the objectives of the project lies with the Project Manager working through the Operations Supervisor.

The Operations Supervisor is responsible for preparation of the specific program and its implementation

The Drilling Superintendent is responsible for the



PROJECT ORGANIZATION
DRILLING OPERATIONS
BEOWAWE WELL

FIGURE 7

drilling operations including procurement of materials and services required to accomplish the objectives.

The Drilling Representative, located at the well-site, is responsible for all field work including supervision of the actual drilling operations, logistics of material and services, daily cost control and preparation of daily progress reports.

The Reservoir Engineer and the Pacific District Supervisor, who is a geologist, are responsible for analysis of data obtained while drilling, logging, and testing to determine that the objectives are being met and to recommend to the Operations Supervisor program changes which may be required to meet those objectives.

Well progress, cumulative costs, lithology, etc. are reported by phone each morning by the Drilling Representative to the Drilling Superintendent and the Operations Supervisor. Based upon these data, the Operations Supervisor determines that everything reasonable is being done to maintain schedules, cost control, and project objectives. The Pacific District Supervisor is advised daily of the lithology, well conditions, etc. so he may determine the stratigraphic and structural position of the well in relation to the projected geologic objectives and recommend changes in program as required.

c) Cost Controls -

1) After funds for the well have been approved and appropriated by Management, sealed bids are solicited from reputable drilling contractors who are or have been active in geothermal drilling.

2) The Drilling Superintendent studies the bids and normally awards the contract to the lowest bidder, other considerations being equal.

3) Service Orders, containing short form contractual language, are issued to service companies and local contractors by personnel with appropriate authority.

4) At the wellsite, the Drilling Representative directly monitors the various contractors and suppliers.

5) Invoices submitted by contractors and suppliers are processed in the following manner:

   (a) Drilling Representative checks invoices to be certain that work charged has been performed. Signs invoices except any which may require changes.

   (b) Invoices signed by Drilling Representative approved by Drilling Superintendent.

   (c) Clerk in Drilling Superintendent's office determines that appropriate project number is coded on invoice.

(d) Invoice clerk under supervision of Accounting Supervisor (San Francisco) compares invoice with contract terms for:

1. accuracy of rates
2. accuracy of invoice calculations
3. approvals have been made by personnel with proper authority

invoice clerk forwards accurate invoices to Accounting Supervisor for payment approval

(e) Invoice forwarded to Corporation Computer Services where:

1. pertinent data is keypunched into storage
2. payment check is printed by computer
3. a monthly tabulation of accumulated costs by project number are printed.

(f) Monthly project cost tabulation forwarded to Accounting Supervisor and appropriate Chevron Resources management for purpose of checking accumulated costs vs. appropriated costs.

4. PRIMARY BUSINESS AND TECHNICAL CONTACTS WHOM DOE MAY CONTACT

In as much as our entire proposal is proprietary except for evaluation purposes, we request that if our proposal is to be discussed with any of the contractors that the following procedure be followed:

a. Advise Mr. D. R. Butler
Chevron Resources Company
320 Market Street
San Francisco, CA 94111
Phone: (415) 894-3590

b. Mr. Butler will advise the contractor that he may discuss any of the equipment specifications, field procedures, and data quality relating to his work for Chevron in the Beowawe Area with appropriate D.O.E. personnel.

Following is the list of contractors (see also under Program Data Offered), principal supervisory personnel, phone numbers and addresses:

Geotronics Corp.
George Hopkins, President
(512) 837-7564
10317 McKalla Place
Austin, TX 78758

Phoenix Geophysics
Bruce Bell, Vice-President
(303) 373-0332
4690 Ironton Street
Denver, CO 80239

Senturion Sciences, Inc.
John Bailey, President
(918) 836-6746
P. O. Box 15447
Tulsa, OK 74112

Seismic Exploration Inc.
c/o Lewis Katz
(801) 272-1289
P. O. Box 9344
Salt Lake City, UT 84109

United Geophysical Corp.
Gunter Fercho, Regional Manager
(303) 572-8727
1645 Court Place, Suite 300
Denver, CO 80202

Terraphysics
Aldo Maggella, President
(415) 234-8961
815 South 10th Street, Suite 11A
Richmond, CA 94804

Photogravity Co. Inc.
William Scott, President
(713) 780-4911
7000 Regency Sq. Blvd.
Houston, TX 77036

Western Geophysical Co.
C. W. Dick, Vice President
(303) 770-8660
P. O. Box 1638
Denver, CO 80150

Charles B. Reynolds & Associates
Charles B. Reynolds
(505) 294-6971
11909 Allison Court N.E.
Albuquerque, NM 87112

R. B. Montgomery Drilling Co.
R. B. Montgomery

P. O. Box 2508
Bakersfield, CA 93303

Big Chief Drilling Co.
W. A. Glass

P. O. Box 14837
Oklahoma City, OK 73114

5. ACCEPTABILITY OF DRAFT CONTRACT PROVISIONS

The draft contract is generally acceptable as a basis for contract negotiations although we reserve the right to negotiate modifications of some of its provisions. Based on a preliminary review of Appendix B (General Provisions) to the draft contract, a number of provisions appear to be inapplicable to the proposal being made by Chevron Resource Company. Specifically these are:

Clauses	2.1	4.1.2	7.3
	2.4	4.4	7.16
	2.5	4.7	7.18
	2.6	4.8	7.19
	2.9	4.9	7.20
	2.10	4.10	
	3.3	6.6	

Other clauses in Appendix B may be inapplicable if the contract sum fails to exceed specified threshold amounts.

6. The "Program Technical Scope" has been reviewed and any such data offered by Chevron Resources in this proposal which D.O.E. accepts and contracts for may be published by D.O.E.

7. Six copies of the 1977 Annual Report of Standard Oil Company of California are attached (one for each member of the Source Evaluation Panel, per Joseph Fiore, personal communication May 18, 1978.

8. The specific terms and conditions contained in this proposal will remain in effect for 120 days from May 30, 1978; however, should D.O.E. propose any changes in such offered terms or conditions then Chevron shall have the right to reject such modified terms or conditions if they are unacceptable to Chevron.

9. Mr. C. Dahlstrom, Vice-President and General Manager, Chevron Resources Company, has the authority to commit Chevron Resources to the provisions of this proposal per the "Resolution of the Board of Directors of Chevron Industries, Inc. dated April 13, 1977", a certified copy of which is attached as Appendix V.

10. GSA Form 19B "Representations and Certifications "has been completed and is attached to the letter transmitting this proposal."

- END -

Field: BEOWAWE

Well: To be named

Surface Location: To be determined

Bottom Hole Location: Straight hole.

Objective: Geothermal production well.

DRILLING PROGRAM

1. Move in rig, cement 30" conductor at 20', drill 17-1/2" hole to 100', open hole to 26" and cement 20" conductor.

2. Install Totco eight-pen recorder to log mud temp. in and out, mud pit level with audio alarm, bit weight, pump press, pump speed, rotary speed and drilling rate.

3. Install 20" Class IIA BOP on conductor and test to 200 psi.

4. Using mud, drill 17-1/2" hole to 1,000'.

   a. Record mud in and out temperature at every connection.

   b. If, prior to cementing casing, abnormally high temperatures are recorded in the mud return line, Company Drilling Foreman is to be notified before continuing drilling.

   c. Use high temperature drill pipe float valve while drilling surface hole and during subsequent drilling operations.

d. Using sample catcher, take sample of cuttings from flowline at each connection.

e. Install mud logger prior to drilling out shoe of conductor pipe at 100'. (See Mud Logging Instructions Appendix II)

5. Run Schlumberger DIL, SONIC, logs.

6. Cement 13-3/8" casing from 1,000' to surface.

7. Install Class III BOP and test per Operating Instruction D-17.

8. Install mud cooling tower before drilling out 13-3/8".

9. Drill out shoe of 13-3/8" casing and drill 11" hole to 4,000' ±, as determined by well site geologist.

   a. Record fluid in and out temperature at every connection.

   b. Using sample catcher, take sample of cuttings from flowline at every connection.

   c. Take 30' core of intervals selected by well site geologist.

   d. Take directional surveys at least every 500'.

10. Run Schlumberger open hole logs. (DIL, CNL-FOC-GAMMA-CALIPER, DIP, SONIC)

11. Make open hole drill stem test if warranted.

12. Run 8-5/8 casing to 3,000 ± (top @ 800' ±) and cement from shoe to top of lap.

13. Drill out cement, clean out to T.D. and run 6-5/8 slotted liner to 4,000' (top @ 2,800').

14. Change over to weighted salt water and wash perforation.

15. Remove BOPE, install Xmas tree, release rig.

16. Run temperature surveys.

17. Install necessary facilities and make short term (12-24 hr.) flow test if warranted.

PROGRAM DETAILS

Blowout Considerations and Classification

1. This well is a geothermal evaluation well and bottom hole temperature over 400°F may be encountered.

2. Formation pressure will probably be near normal (cold water) hydrostatic, but due to the elevated temperature the fluid can flash to steam and the well may be capable of flow.

3. Class II A BOPE will be installed on the 20" conductor and Class III BOPE on the 13-3/8" casing. Test to 200 and 2,000 psi respectively as outlined in Operating Instruction D-17.

4. Hole to be kept full of drilling fluid at all times if practical.

Loss Circulation Consideration

Minor losses occurred at nearby Ginn 1-13 while drilling at 500', 800', 7,090', 8,421' and 8,491. Complete loss of returns occurred while cementing casing at 812'.

Major losses occurred at 8,885 and at 9,523 where a 6' cavity was encountered.

At Rossi 21-19 minor losses occurred in the intervals 320-620 and 1,940-1,953. It was necessary to use LCM to maintain full circulation.

These minor losses can be expected at any time and a major loss may occur below 3,000' if the objective fault is penetrated.

An adequate supply of drilling fluid and lost circulation material (asbestos fiber or equivalent high temperature material) must be kept on hand at all times. However, unless there is an emergency, do not add lost circulation material without first clearing with the Company Drilling Foreman.

Well Correlations

M.D.	V.D.	Estimated Formation Press. (PSI)	Drilling Fluid Pressure (69#) (PSI)	Overbalance (PSI)
1000	1000	433	480	47
2000	2000	866	958	92
3000	3000	1299	1437	138
4000	4000	1732	1920	188

Drilling Fluid Program

Interval	Type	Weight	Vis.	API Water Loss
0-1000	Clay Base	68-70	-	To Suit
1000-T.D.	Sepiolite	68-70	40-50	15-20

a. The mud specifications shown here are intended as a guide only. The Company Toolpusher, Contract Toolpusher, and Mud Service Representative must all understand this and work closely together to keep mud costs at a minimum without causing hole problems.

b. Maintain 40-50 sec viscosity. Maintain reasonably low gels, low yield point, and plastic to yield ratio of approximately 2:1.

c. Maintain sand content at 1% or less.

d. Take API high-temperature, high pressure filter loss at least once per day below 1,000'.

e. Have driller record mud-in, mud-out temperature every 30' drilled.

f. Attempt to maintain drilling fluid temperature below 165°F.

Casing and Cementing Program

1. Surface	Size	Wt. and Grade	Depth
1000'	13-3/8"	54.5#, K-55, Buttress	0-1000'

a. Equip casing with guide shoe and float collar on top of first joint.

b. Equip casing with two 13-3/8" x 17-1/2" dual KK-6 turbine centralizers on bottom three joints and one every third joint to surface.

c. Use sufficient Class "G" cement with 50-50 Poxmix D or equivalent and 33# silica flour per sack cement (slurry weight - 105 Pcf) followed by 200 sacks Class "G" with 33# silica flour per sack cement to fill to surface.

d. Precede cement with 100 cu. ft. water.

e. If cement does not reach surface, run 1" pipe to 100' and cement 17-1/2" x 13-3/8" annulus to surface with Class "G" cement with 33# silica flour per sack cement.

2. Intermediate String

Depth	Size	Wt. and Grade	Joint	Length
800-3000	8-5/8"	36# K-55	Butt.	2200'

a. Equip bottom of 8-5/8" with ported formation packer and float collar on top of first joint.

b. Equip each of the three joints above the packer with two 8-5/8" x 11" dual KK-6 turbine centralizers. Equip every third joint of 8-5/8" with one centralizer of same type.

c. Use 8-5/8" x 13-3/8" Burns liner hanger with latch-on connection for future tie back string.

d. Use sufficient Class "G" cement with 50-50 Poxmix D or equivalent, 2% gel, 37.5# (40%) silica flour per sack cement, with .2% HR7 retarder and .2% CFR friction reducer to fill to surface. Confirm amount of retarder to use based on temperature data at time of drilling.

e. Precede cement with 200 cu. ft. water.

3. Production liner

Depth	Size	Wt. and Grade	Joint	Length
2800-4000	6-5/8"	20# K-55	Butt.	1200'

a. Equip bottom joint with closed shoe.

b. Liner to be combination blank and slotted. Location of slots to be determined.

c. Use 6-5/8" 20# x 8-5/8" 36# lead seal liner hanger for 500°F temperature.

Special Operating Instructions

1. Install mud cooling tower. Have large volume centrifugal pump (1,000 gpm with 80' head) for circulation through cooling tower and mud-mixing purposes.

2. Install two mud pumps, stand-by pump not to be used for mud-mixing purposes. Use stand-by pump when repairs are required on hole pump and have stand-by pump hooked up to mud cooling tower.

3. Install Totco eight-pen recorder with continuous flow-line temperature recorder. Also install visual thermometers of flow-line and circulating pit at driller's station, record temperatures every 30' drilled.

4. Install lower Kelly cock.

5. Install high-temperature rubbers in pipe rams and complete shut-off (if available).

6. Run high temperature drill pipe float valve and maintain in good operating condition. Use Float valve in string while using air or aerated fluid.

7. Break circulation on trips while running in hole.

8. Start circulating pumps slowly and gradually increase pump speed in an effort to prevent breaking down formation, particularly after trips or long periods of no circulation.

9. If possible, dry pipe prior to pulling out of hole. Pull drill pipe very slowly.

10. Run cold water on drill pipe while pulling.

11. Do not jump drill pipe out of tool joint box on trips.

FORMATION EVALUATION PROGRAM

I. Temperature build-up survey may be run using maximum recording thermometers or temperature recorder in drill collars before each wireline log or drillstem test.

II. WIRELINE LOGGING

A. Surface Log (programmed for approximately 1,000')

1. Schlumberger Dual Induction Laterolog. Use resistivity scales of 0-100 ohm-meter and 10 millivolts per division S.P. scale unless formation characteristics are such that other scales are more appropriate.

2. Run sonic log.

B. At T.D. run:

1. Schlumberger Dual Induction Laterolog

Scales: (May be modified based on formation characteristics)

Self potential - 10 millivolts per division

Laterolog 8, medium and deep induction 0.2-2000 ohm-meters with 2" linear correlation log using scales as on run at surface pipe depth unless another scale appears better suited to formations.

2. Schlumberger CNL-FDC, gamma caliper. Density scale of 2.0-3.0, and CNL sandstone porosity scale of 0-60% are recommended unless otherwise indicated.

3. Schlumberger four arm High Resolution Taped Dipmeter.

4. Run Schlumberger or Fracture location log, if warranted.

5. Run Schlumberger sonic log.

6. Run Schlumberger continuous temperature profile.

C. <u>General Logging Instructions</u>

1. One-half gallon sample of circulated drilling fluid is to be obtained immediately prior to pulling drill pipe for logging operations. Sample is to be measured for Rm, Rmf, and Rmc.

2. Maximum recording thermometers are to be used on all logging sondes run.

3. All calibrations are to be recorded and printed on the 5" = 100' scale logs.

4. A back-up sonde is to be at location for all DIL runs.

5. Logging Engineer to fill out Log Quality Control checklist after completion of logging operations and give it to Well Site Geologist.

III. CORING

A. Cut 30' core at 3,500' ± in fault zone, per well site geologist's instructions. A 30' core possibly may be taken at T.D. depending upon formation encountered at that point.

B. Arrange with Petroleum Testing Service (213-696-3802 or 213-291-6529) to package and transport cores as they are removed from the core barrel.

IV. DRILL STEM TESTING

A. A test may be run as determined by the well site geologist.

B. Use caliper and E-logs to select packer setting depth.

C. Flow period 6-8 hour. Final shut in 2 hour.

D. Use three pressure recorders (2-outside, 1-inside) with pressure range of approx. 2500-3000 psi.

E. Use one temperature recorder (100-600°F).

F. Install 3 maximum reading thermometers (100-600°F ±).

G. Use nitrogen lift to cause well to flow.

V. FLOW TEST

A. Install surface test facilities.

B. Use nitrogen lift to start well flowing to pit.

C. Run bottom hole pressure-temp. recorder on wire line.

D. Measure flow rate and produce well until adequate data is obtained. This may be limited by pit capacity.

E. Obtain 2 set fluid samples (1 gallon sample for D.O.E.).

MUD LOGGING INSTRUCTIONS

A. Install Mud Logging Unit prior to drilling out shoe of conductor pipe. Continuously record from shoe of conductor pipe to total depth. H_2S & CO_2 to be monitored from conductor pipe to T.D.

B. Mud temperature at suction and flowline to be continuously recorded. If air drilling record air out temperature.

C. Two sets washed and two sets * unwashed ditch samples to be collected at 10' intervals unless drilling rates made such frequency impractical. * One unwashed set to be at least 2 lbs. in weight (for D.O.E.)

D. Special effort is to be made to detect unusual mineralization such as sulfur, mercury, siliceous material, also report indications of alteration or of fault or fracture zones.

E. Inform Well-Site Geologist or Company Drilling Foreman immediately of sudden increases in temperature, hydrocarbon shows, H_2S, steam, unusual mineralization or other possibly significant changes.

F. Report at once to the Drilling Foreman, Driller and Geologist any conditions that might affect safe, efficient drilling operations. This includes increasing gas readings, increasing trip and connection gas, unusual mud properties, unusually large amounts of slough, etc.

G. Daily log. Please note the following points:

1. Mud log form should follow API recommended practice plus Geysers special lithology (USGS nomenclature).
2. Include a weight on bit curve, record bit footage and hours, all hole surveys, and briefly note any significant mechanical delays, all on the left-hand track. Make careful lithologic descriptions and note any variations or exotic minerals.
3. Include a note on log to explain any unusual shows, anomalous conditions, or mud changes.
4. Record on log a full mud check at least once each tour or once per day if less than 100' drilled per day. Include mud and mud filtrate resistivities, corrected to 77° F, and salinities (ppm NaCl). Record time and date of mud check on mud log. Notify tool pusher and development geologist of any significant deviation from mud program. Record mud type on log heading and any change in mud type at depth of change.
5. Record and Log. CO_2 & H_2S continuously.

6. Record lag time once each day. Note depth, lag, and pump strokes per minute.

7. Include well name and location on reverse side of all copies of daily log.

H. Points to be stressed in circulating show or drilling break.

1. Run Ph checks on mud whenever objective zones are penetrated, and after any drilling break.

2. Circulate bottom sample before coming out of hole for any reason.

3. Whenever circulating is required, record length of time circulated.

I. Special instructions and comments.

1. Overall lithology is important and should be accurately described. However, we are more interested in what has happened to the rock and what is associated with it. Specifically:

a. Fault or fracture evidence - note presence or suggestions, if fractures are open or filled and, if filled, what is the filling material. In some instances, grain surfaces may be fracture planes and the coatings on grain surfaces may represent fracture fillings, so coating determination is important.

b. Alteration or alteration products - evidence of hydrothermal alteration or low-temperature metamorphism. Particularly, presence of kaolinite, clay minerals, zeolites, or any indicators of degree of hydrothermal metamorphism.

c. Accessories (extremely important) - note percent and type of distribution within sample of any sulfides and, if possible, determine what they are, i.e., pyrite, chalcopyrite, stibnite, cinnabar, or any other metallic mineral sulfides.

d. Hydrothermal deposits - note occurrence and percent of opal, chalcedony, sulfur, gypsum/anhydrite, carbonates. Note particularly presence and degree of silicification and mode of occurrence, i.e., pervasive, fracture controlled, orthoquartzites, etc.

Socio-Economic Characteristics

The subject area straddles Lander and Eureka Counties. The actual sites of the proposed operations are in Lander County. In the immediate vicinity of the subject area, there is negligible population. The town of Beowawe is the closest population concentration, located approximately 6.5 miles northeast of the subject area, in Eureka County. Other small communities in the area include Crescent Valley (Est. 50-100 pop.), Harney, Dumphy and Carlin. These communities are indicated as having populations of less than 500 people, likely considerably less. The population density of the area is less than 5 people per square mile. The largest communities in the area are Elko (10,000 pop.) and Battle Mountain (2,000 pop.).

As of the last survey (1974) there was little or no unemployment in the area. The only specialized skills available are those associated with the surface mining and agriculture. Housing is in short supply and community services are limited. The median family income in 1969 was $8,691 to $8,768 (Table 7). It is believed, however, (BLM, 1974) that the median income figure does not accurately reflect the current economic situation, because of the recent local growth of the mineral industries.

IMPACT EVALUATION AND MITIGATING MEASURES

Physical Characteristics

Geologic Hazards - Seismicity is evidently the only geologic hazard which poses itself to the proposed development. The only indication of seismic activity in the area is the event of 1945. Although the epicenter has been placed along a projection of the fault trace, there is no evidence of a direct relationship between the faults thought to constitute part of the geothermal reservoir and the recent seismic activity of the area. At such time, GRO Order No. 4, section 8 may be implemented. The lessee may then be required by the Supervisor to install seismic monitoring devices.

No information is available at the present time to form a basis for evaluating the likelihood that subsidence will result from the production of geothermal fluids in the subject area. If the geothermal reservoir exists in unconsolidated alluvium then subsidence may occur. On the other hand, the reservoir likely exists in consolidated rock at depth and little or no subsidence should be expected.

Local networks of horizontal and vertical control must be established by the lessee prior to prolonged production of the reservoir to monitor for possible subsidence and lateral surface deformation (GRO Order No. 4, Sec. 8). To minimize the risk of subsidence, injection programs may be initiated to maintain formation pressures in the reservoir. If subsidence is determined by the Supervisor to represent a significant hazard to operations or adjoining land use, then the Supervisor may require remedial action including, but not limited to, reduced production rates, increased injection of waste or other fluids, or a suspension of production (GRO Order No. 4, Sec.8).

Table 7 Economic Data

County	Total Personal Income	Per Capita Personal Income	Family Median Income
Eureka	$2,388,012	$2,519	$8,768
Lander	$7,088,894	$2,659	$8,641

Based on 1970 census

It is very likely that the bore holes will intersect the fault planes. Blowouts have occurred where improperly equipped drilling operations have encountered faults at depth. Full compliance with the provisions of GRO Order No. 2, Sec. 2, the review of the Application for Permit to Drill, and on-site blowout prevention equipment inspections should prevent blowouts.

Air Quality - Local air quality could be impaired by:

1. Increased suspended particulates due to earth moving operations and traffic to and from the drill sites.

2. Increased hydrocarbons, NO_x, CO and other pollutants associated with exhaust emissions from cars, trucks, generators and air compressor engines.

3. Increased H_2S and other noncondensible gases (CO_2, CH_4, NH_3, for example) which are sometimes associated with geothermal effluents.

The National and State Ambient Air Quality Standards presented as Appendix D are not exceeded in the subject area at this time with the exception of particulates during wind storms. There are several geothermal wells flowing in The Geysers area due to vandalism over 4 years ago. One well is flowing at a high rate and expells steam and hot water and other gaseous effluents many feet into the air. Due to the apparent lack of environmental damage caused by the effluent from these wells, it is assumed that the gases dissipate or oxidize rapidly from the source and do not adversely affect the air quality. Therefore, it is not expected that the State and National Standards will be exceeded by the proposed drilling and testing activities.

Surveillance of ambient air to ensure compliance with Federal, State and local regulations can be imposed by the Supervisor when deemed necessary (30 CFR 270.34, 41). The lessee has proposed to use drilling mud as a circulating medium to lubricate and transport cuttings to the surface (P.o.O.). If compressed air were substituted for mud, then an approved separator shall be used to adequately control particulate emissions.

Noise - Noise would be generated by the following activities:

1. Construction of drill pads and access roads.

2. Well drilling.

3. Well testing.

4. Vehicular traffic.

In accordance with GRO Order No. 4, Sec. 11.C noise emissions must be attenuated to a maximum of 65 dBA measured at the lease boundary line, or 0.8 km from the source, whichever is greater. The lessee is required

(GRO Order No. 4, Sec. 11.D) to monitor and measure noise levels as deemed necessary by the Supervisor using an octave band noise analyzer with an A-weighted frequency response. The noise level at drill site must be maintained within the allowable limits set by OSHA regulations.

If it becomes necessary to drill with air as a circulating medium an appropriate muffler may be required by the Supervisor to attenuate the noise from this operation.

At the present time the flowing steam wells at The Geysers area are the dominant noise emitters in the area. It is not expected that the proposed activities will exceed 65 dBA at the unit boundaries.

Water - The ground water may be contaminated by interzonal communication of aquifers. The well casing requirements imposed by GRO Order No. 2, however, should prevent such contamination. If waste fluids held in the sump are of lesser quality than the ground water, then seepage through the sump may result in ground water contamination. In such a case, an impermeable liner may be required. A minimum of 0.6 m freeboard will be required of the sump.

Water to be used for the drilling is of good quality and the drill mud is nontoxic. However, the operator may conduct a short-term well test prior to the completion of the wells. Therefore, sump lining is required unless the test fluid is contained in a separate tank and appropriately disposed of based on a chemical analysis of the fluid as proposed in the P.o.O.

The lessee proposed, as part of this plan, to conduct a long term (1-2 mo.) production test immediately following completion of the wells. Unless the geothermal fluid is of good quality suitable for surface discharge, the fluid will be injected into well Ginn No. 1-13. Although the proposed production test involves no additional surface disturbance, the Supervisor will review the injection proposal prior to approval to ensure safe injection and protection of ground water.

Soils - The potential impacts on soils include direct loss due to erosion, adverse physical changes due to compaction, adverse chemical alterations from possible drill waste spills, and alteration of the soil biota. Access road and pad construction have the most serious impact on the soil mantle. When the soil mantle is disturbed, erosion rates accelerate. The proposed drill sites, in terms of surface disturbance, will be approximately 1 hectare per site (Exhibit B, P.o.O.). Access to the drill sites will follow existing County and BLM roads for the most part, so new construction is required only at the sites (P.o.O.). One exception to this will be construction of approximately 0.4 km of new access to proposed drill site eight. Therefore total surface disturbance for the proposal will be minimal. The areas subject to vegetative removal are relatively flat, runoff is medium and erosion hazards are moderate. Except for occasional seasonal flash floods, erosion from surface runoff should be of minor consequence. Revegetation of the disturbed area, would also serve to minimize erosion after operations are completed. The revegetated areas will, however, be subject to wind erosion for a short period of time until pad revegetation is established.

All drilling waste will be contained in a sump, therefore alteration of the surrounding soil should not be a problem.

Vegetation - Potential impact of the proposed geothermal activity on plant life in the Beowawe Unit will come mainly from the physical removal of vegetation for drill site and road construction. All proposed sites, other than site 8, are immediately adjacent to the main access road and will require little vegetative removal. Site 8 will require approximately 0.4 km of vegetative cover removed for road access. Drill pad and road construction, would necessitate removal of approximately 10 hectare of the sagebrush-shadscale plant type if all seven of the proposed sites are drilled. This figure assumes that the area cleared of vegetation for each drill site would be approximately 1 hectare, and access roads would be constructed or widened to (4.6 - 6.1 m), over an area of approximately 0.8 km. The approximated 10 hectare subject to vegetative removal amounts to less than 0.5% of the total acreage covered by the Beowawe Unit.

Impacts from vegetative removal will be primarily to livestock grazing and wildlife habitat. These impacts, however, are considered to be of little consequence because of the small acreage affected.

Surface disturbance will be kept to a minimum and strictly confined to access roads and drill sites which are minimal and necessary. The BLM Elko and Battle Mountain districts have recommended that all sites and roads following completion of use, shall be restored as closely to the original contour as possible and back filled with top soil. Disturbed areas will be reseeded with a mixture of grasses or forbes determined by the surface management agency following the use of the drill sites. Application would be by drill and prior to the rainy season, allowing for maximum success of the plants. Fencing of the revegetated pads will also be required, to prevent overgrazing by cattle. This recommendation will be included as a Special Condition for the approval of the proposed plan.

The success of these revegetation measures will be monitored periodically by the staff of the Geothermal Supervisor and BLM personnel. If the reseeded areas fail to germinate or if for any other reason revegetation was not successful, the Supervisor would take whatever action necessary to promote successful revegetation of the disturbed areas.

Wildlife - Removal of vegetation during improvement and construction of access roads and construction of the drill sites will result in the loss of several acres of sagebrush-shadscale habitat. Wildlife will suffer losses of their habitat as land surface is occupied by geothermal activity. Small numbers of animals, primarily the smaller more sedentary mammals, rodents, and reptiles, and the ground nesting birds will be eliminated or displaced in the areas of the drill sites. The majority of these species should be able to escape and be absorbed by surrounding areas of low animal density.

Impacts on the larger mammalian predators in the area should be minor. These animals are very mobile and able to avoid geothermal activity. Impacts on mammalian predators and raptors (birds of prey) resulting from habitat reduction of the animals prey base should also be minor. This is believed to be the case because impacts on the prey species and associated habitat is expected to be minor.

Impacts on game species (i.e. mule deer and chuckar partridge) in the area are expected to be of little consequence. Both species are very mobile and able to elude man's activities. Little habitat will be lost in terms of food and cover for either species because both primarily occupy areas of high elevation. Because of their mobility and low density, impacts on wild horses is also expected to be minor.

Impacts from noise generated by geothermal activity could have adverse effects on raptors nesting in the immediate area. Drill site eight is situated in a small canyon near volcanic cliffs where a pair of golden eagles were observed nesting. Prairie falcons and other raptors are believed, by the U.S. Fish and Wildlife Service, to have utilized the cliff area. However, none other than the pair of eagles were observed this spring during a raptor survey by Paul Lucas, Nevada Fish and Game.

Raptors in general are particularly sensitive to noise and human activity during nesting, especially at the onset, within one-quarter mile of the nest site. This was evident during the Geothermal Environmental Advisory Panel (GEAP) field inspection (4/19/77) of the drill sites and unit area. The presence of the inspection party at drill site eight managed to flush the pair of eagles nesting on the cliff. Construction and drilling in the small canyon where proposed drill site eight is located would amplify the noise creating a far greater disturbance factor to nesting raptors in the area. Consequently, adverse effects on raptor nesting success is very likely. Therefore, to mitigate probable impacts on nesting raptors, a Special Condition in the form of seasonal restriction of site eight will be included for the approval of the proposed plan. Noise levels around all drill sites will be maintained within guidelines specified by Federal OSHA regulations (P.O.O.) and GRO Order #4 Sec. 11. These measures will help mitigate impact from geothermal noise on wildlife in the area.

Land Uses

Recreation - Impacts by the proposed action on recreational land uses of the unit area is expected to be low. Road improvement for the proposed action may benefit sight-seers, rockhounds and pass-through hunters of the area.

Aesthetics - Due to the relatively low profile of the area to be disturbed, the proposed activity is expected to do little to alter the appearance of the area. Drill pad preparation on this flat terrain requires only clearing of brush and very little movement of the flat desert soils. Scars in the landscape, therefore, will only be evident to those at the drill sites and access roads. The Mal Pais mountain range lies between most of Route 21 and the proposed area of activity, therefore, the drill rigs will not be noticeable from most of this route. Portions of the unit area that are visible from a small stretch of Route 21 and Interstate Highway 80 are of a distance that drilling activity would not be discernible by the naked eye.

Grazing - The grazing capacity of the sagebrush-shadscale lowlands is relatively low, generally requiring about 6.1-8.1 hectares to support one animal for one month. Revegetating the disturbed area with the seed mixture described (Special Condition #3) should enhance the forage value of these particular sites, although there would be a net loss in forageable acreage for that period of geothermal occupancy and period of vegetative restoration. In the long run, however, there should be a net increase in forage value.

Cultural Resources - Impacts on cultural resources by the proposed action are not expected. Eleven of the 15 aboriginal archaeological sites on drill pad locations 83-24, 2, 3, and 5 were recorded and collected. No Cultural resources were found at drill sight eight. The remaining four sites located on proposed drill pads 3, 4, 6, and 7 will require additional testing and/or salvaging prior to any surface disturbance. A proposal for the additional work has been accepted by Chevron (see Chevron comments, Appendix F, dated 7/26/76 and 12/6/76).

Socio-Economic Characteristics

Most of the drilling crews will stay at Battle Mountain, although in the past, some crews lived at Crescent Valley, Elko and Carlin. Because of the wide spread accommodations, these communities experienced no difficulties in accommodating these crews. Since the wells will be drilled one at a time, the drilling activities would not create significant impacts on the local socio-economic characteristics.

APPENDIX IV

R E S U M E S

DAVID R. BUTLER

EDUCATION:

B.S. Geology (honors) - University of Texas, 1955.
M.S. Geology - University of Oklahoma, 1957.
Group I Intercompany Management Development Program, 1977.

OUTSIDE ACTIVITIES:

Member, AAPG, SEG, Sigma Xi.
Registered Geologist, State of California.

PROFESSIONAL EXPERIENCE:

1956-1973 STANDARD OIL CO. OF CALIFORNIA
Area Geologist, Texas and New Mexico (1956-1968)

Prepared and maintained subsurface maps and prospect generation, well log analyses and photogeologic analyses; integrated existing and new seismic data; supervised seismic crew; generated and supervised subsurface geological plays.

Geophysicist/Area Geologist, La Habra, California (1968-1973)

Reviewed, integrated and interpreted California offshore seismic data; generated and supervised subsurface geological plays.

1973-1977 CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION
Senior Exploration Geologist (1973-1975)

Generated and supervised programs for geothermal exploration.

Staff Geologist (1975-1977)

Responsibility for recommending plans, execution and staffing of geological, geophysical, land and base programs for geothermal exploration.

1977-Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
Division Manager, Geothermal Exploration

Plan, review and recommend exploration programs for and direct exploration operations for the purpose of acquiring geothermal reserves which can be developed profitably. Supervise execution of geological, geophysical, land and base programs.

J. O. SALVESON

EDUCATION:

U.S. Naval Electronics Material School, 1947.
B.S. Geology - Massachusetts Institute of Technology, 1951.
Business Administration courses - University of California Extension, 1958-1961.
Management Development program, 1963.
Formation Evaluation seminar, 1966.
Corporation Structural seminar, 1967.
ACE courses:
  Principles of Metallic Ore Deposits, 1972.
  Global Tectonics, 1972.
  Modern Sedimentation, 1973.
  Potential Methods in Exploration, 1973.
  Evolution of Sedimentary Basins, 1974.
  Corporation Stratigraphic Seminar, 1976.

OUTSIDE ACTIVITIES:

Member, Pacific Coast Section, AAPG.
Member, M.I.T. Club of Southern California.
Member, San Joaquin Geological Society.

PROFESSIONAL EXPERIENCE:

1951-1971 STANDARD OIL COMPANY OF CALIFORNIA - WESTERN OPERATIONS - EXPLORATION
Geologist (1951-1960)

Reconnaissance and detail field mapping of Tertiary, Mesozoic and Paleozoic sediments in eastern and southern Nevada. (1951-1952).
Detailed field mapping and subsurface geology; incorporation of available gravity, magnetic and seismic information into analysis of specific projects. (1952-1956).
Training in theory and method of seismic exploration and application to specific problems in San Joaquin Valley. Reanalysis of seismic data Four Corners area. Geologic analysis offshore Santa Barbara Channel area, including reanalysis of seismic data and coordinating with onshore geology. (1956-1960).

Exploration Geologist (1960-1962)

Responsibility for systematic evaluation of Santa Barbara area. Planned and recommended programs. Directed projects to carry out approved programs. Followed activities of competitors in assigned areas and made recommendations for action.

Senior Exploration Geologist (1962-1964)

Responsibility for Washington-Oregon district involving exploratory evaluation of critical areas. Directed or took part in evaluations or special studies involving integration of exploratory tools and techniques. Assured that all available information and concepts were used in the best manner and developed or stimulated others to develop additional useful evaluation techniques.

District Geologist (1964-1967)

Conducted and supervised exhaustive systematic study of geological conditions, Pacific Northwest, and initiated new exploratory programs in assigned district with purpose of locating new reserves of oil and/or gas.

Division Geologist, Northern California (1967-1971)

Provided creative leadership to technical staff in division to assure effective geological exploration. Took part in training and developing efficient, enthusiastic technical force through constructive, critical analysis of results and insistence on sound imaginative thinking and on use of best technical adviser to Superintendent of the division's operations.

1971-1977 CHEVRON OVERSEAS PETROLEUM, INC.
Senior Staff Geologist

Performed independent geological studies to develop a worldwide framework of regional geology, utilizing principles of plate tectonics, to provide a basis for recognizing favorable basins and trends, and coordinated similar studies being carried on by COFRC and Socal operating companies.

1977-Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
Division Geologist

Primary responsibility for proposing that new geological programs and techniques be employed to more effectively explore for geothermal energy. Once approved, monitor implementation of these new programs and techniques. Responsibility for functional supervision of geologists working in division and for quality of geological output. Coordinate with District Supervisors and advise Division Manager on status and needs of geological programs and quality. Responsibility for geothermal activities outside boundaries of designated operating districts, including foreign.

CHARLES M. SWIFT, JR.

EDUCATION:

A.B. Geology (Magna cum laude) - Princeton University, 1962.
Ph.D. Geophysics (5 years) - Massachusetts Institute of Technology, 1967.
Digital Signal Processing - ACE, 1976.

OUTSIDE ACTIVITIES:

Adjunct Associate Professor, Department of Geology and Geophysics, University of Utah.
Lecturer, Engineering Geoscience Group, Department of Materials Science and Engineering, University of California, Berkeley.
Member, GSA, AGU, Society of Exploration Geophysicists (Chairman, Geothermal Exploration Committee).

PROFESSIONAL EXPERIENCE:

1967-1976 KENNECOTT COPPER CO.
Geophysicist (1967-1969) and Senior Geophysicist (1969-1976)

Responsibility for conceiving, conducting, supervising, contracting and/or interpreting geophysical surveys in conjunction with geologists of Bear Creek Mining Company (the domestic exploration group of Kennecott) in the following mineral exploration programs:

porphyry copper exploration in Washington, Nevada, Colorado, Arizona, New Mexico, Idaho, Montana and Utah;

volcanogenic massive sulfide exploration in Alaska, Wisconsin and Minnesota;

stockwork molybdenum exploration in Colorado, Washington and British Columbia;

copper skarn exploration in Alaska, Arizona, New Mexico, Idaho and Montana; and

ultramafic nickel exploration in Minnesota.

As Northwest District Geophysicist, became intimately acquainted with application of electrical (IP), electromagnetic (Turam and magnetotellurics), gravity and aeromagnetic techniques. Conducted applied theoretical research in aspects of IP, Turam and audio-frequency magnetotellurics. (This research was primarily in (1) computer modeling of the forward electromagnetic boundary value problem, and (2) interpretive techniques.) Instituted a research project on the relationship of porphyry copper mineralization to related plate tectonics and presented an in-house workshop which included both Prof. Jason Morgan of Princeton and Prof. Peter Coney of the University of Arizona. Made numerous oral presentations and wrote numerous publications.

1976-1977 CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION
Senior Geophysicist

1977-Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
Geophysical Supervisor

Supervise planning, contracting, execution and interpretation of wide range of geophysical surveys in support of domestic exploration program, e.g., resistivity, magnetotelluric, Curie point analysis of aeromagnetic data, gravity, telluric, reflection seismic, SP and passive microseismicity. Presented paper at November 1977 Intercompany Geophysical Conference (ICGC) "Geophysical Techniques in Geothermal Exploration."

MICHAEL A. LANE

EDUCATION:

A.B. Geology - Hamilton College, 1965.
M.A. Geology - Indiana University, 1967.
Ph.D. Structural Geology (minors: Petrology, Geochemistry) - Indiana University, 1970.
Supervisory Skills and Knowledge Program, 1976.

OUTSIDE ACTIVITIES:

Member, Pacific Section AAPG, GSA, GRC, AIME, Sierra Club.
Fluent in Spanish, French and German.

PROFESSIONAL EXPERIENCE:

1969-1973 STANDARD OIL OF CALIFORNIA
Geologist, La Habra, California (1969-1971)

Subsurface structural and stratigraphic geology, Hollywood Shelf area, involving E-log interpretation, SCAT interpretation, construction of serial cross-sections and structure contour maps; worked with COFRC in developmental phases of computer programs evaluation for cross-section construction and graphic analysis of three-dimensional data; recommended exploratory drilling.

Geologist (Summer 1971)

Geologic reconnaissance in Western Alaska.

Geologist (1971-1973)

Integrated current plate tectonics ideas with Los Angeles Basin geology.

1973-1977 CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION
Geologist (1973-1975)

Delineated prospective geothermal areas in western U.S.; compiled appropriate geological and geophysical data relating to geothermal anomalies; conducted and interpreted temperature surveys; collected and interpreted data on 32 geothermal localities; compiled and studied ERTS photographs. Did geochemical sampling of selected localities in British Columbia. Proposed two-year field exploration program for Indonesia. Assisted in preparation for federal land sales.

Senior Geologist (1975-1977)

Supervised development drilling and sampling program at Panna Maria uranium prospect to determine quality and size of deposit. Responsibility for establishing Karnes City office, hiring and supervising necessary field personnel. Coordinated field aspects of mine, mill, environmental and metallurgical engineering studies leading to project start-ups. Responsibility for community and landowner public relations.

1977- Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
Senior Geologist and Project Coordinator (1977)

Established and managed San Antonio exploration office. Set up and carried out regional exploration program for south Texas uranium deposits, conducted drilling program and related and contract geological and geophysical studies. Prepared geological and land budgets.

District Supervisor, Pacific District (1978-Present)

Responsibility for generating new geothermal prospects, evaluating current ones and training personnel for all programs in Washington, Oregon, California and Nevada. Involves budget, program planning and execution.

R. C. EDMISTON

EDUCATION:

B.S. Geological Engineering - University of Arizona, 1967.
M.S. Geological Engineering - University of Arizona, 1971.
Graduate study in Geophysics and related engineering and mathematics - University of Utah, 1971-1973.

OUTSIDE ACTIVITIES:

Registered Geophysicist, State of California (No. GP858).
Associate member, AIME and Society of Exploration Geophysicists.
Member, Geothermal Resources Council.

PROFESSIONAL EXPERIENCE:

1967-1969 AMERICAN SMELTING AND REFINING CO.
Silver Bell, Arizona
Resident Mine Geologist

Responsible for development drilling and geologic mapping for two open-pit copper mines.

1973-1975 GEOPHYSICAL SERVICE, INC.
Calgary, Alberta, Canada
Geophysicist

Responsible for interpretation of marine gravity and magnetics data. Formed and supervised marine gravity processing and interpretation crew in Calgary during 1974 and 1975.

1975-1977 CHEVRON OIL COMPANY - MINERALS STAFF - GEOTHERMAL DIVISION
Geophysicist and Senior Geophysicist

As geophysical supervisor of geothermal group, planned geophysical program that was integrated with remainder of exploration program; recommended necessary staffing; supervised execution of approved geophysical program; recommended action based on geophysical results. Did geophysical interpretation and integrated geological and geochemical data into geophysical interpretation. Advised of changes or new developments/ideas and recommended appropriate program modification. Trained new members of geophysical group and maintained geothermal and geophysical expertise.

1977-Present CHEVRON RESOURCES COMPANY - GEOTHERMAL DIVISION
District Supervisor, Rocky Mountain District

Responsible for exploration for geothermal resources in Utah, Arizona, New Mexico, Colorado, Idaho, Montana and Wyoming. Plan and recommend geological and geophysical exploration programs. Supervise area staff. Recommend land acquisition, surrender and rental payment. Responsibility for well recommendations and supervision of geological wellsite staff. Responsibility and authority for budget control of exploration programs carried out in district. Responsibility for recommending personnel for continuing programs and meetings. Prepare preliminary yearly budget for submittal to Division Manager each year. Functional areas of expertise include heat flow and electrical geophysical methods.

ROBERT W. BUTLER

EDUCATION:

B.A. Geology/Physical Geography - University of Santa Barbara, 1972.
M.S. Geology - Colorado School of Mines, 1976.

PROFESSIONAL EXPERIENCE:

1974-1977	CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION Geologist
1977- Present	CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION Geologist

Collect, evaluate and summarize geological and geochemical data on geothermal prospects by reconnaissance field studies and computer modeling and reduction of data. Supervise field, wellsite work, collect data for analysis and evaluation. Write final and summary reports of geothermal prospects. Recommend further action on leased land and new exploration programs.

ROGER J. ALLMENDINGER

EDUCATION:

B.S. Geology - State University of New York, College at New Paltz, 1969.
M.S. Geology (Geohydrology) - New Mexico Institute of Mining & Technology, 1971.
Ph.D. Geochemistry (Aqueous Geochemistry) - New Mexico Institute of Mining & Technology, 1976.
Research Interests: Fluid inclusion, Stable isotopes, Hydrothermal mineralization, Regional groundwater dynamics.

OUTSIDE ACTIVITIES:

All Saints Lutheran Church Council.
Amateur Photographer.

PROFESSIONAL EXPERIENCE:

1974-1976 CHEVRON OIL COMPANY - MINERALS STAFF - GEOTHERMAL DIVISION
Geologist

General geologic, geochemical and geophysical interpretation of geothermal prospects in the western U.S.

1977-Present CHEVRON RESOURCES COMPANY - GEOTHERMAL DIVISION
Geologist

Act as Lead Geologist for Rocky Mountain District, Geothermal Exploration. Geographic area of responsibility of New Mexico and Colorado. Assist District Supervisor in planning and executing programs to evaluate leased areas and find new prospects. Analyze data on pending lease sales in area of responsibility and make appropriate recommendations. Responsibility for quality control of geochemical sampling and interpretation of geochemical data within district.

EDWARD H. HAYNES (Retired)

EDUCATION:

B.S. Geology - University of Kansas, 1951.
M.S. Geology - University of Kansas, 1952.

OUTSIDE ACTIVITIES:

Member, AAPG, Sigma Gamma Epsilon, Sigma Xi, Pacific Coast AAPG
Registered Geologist, State of California.

PROFESSIONAL EXPERIENCE:

1952-1971 STANDARD OIL CO. OF CALIFORNIA
Development Geologist, Venezuela (1952-1959)

Worked with wildcat wells, surface mapping and geophysical prospects.

Geologist, Denver, Colorado (1959-1962)

Independently performed surface and subsurface mapping in areas of complex geology; supervised less experienced geologists.

Staff Assistant to Manager, Exploration
Denver, Colorado (1962-1963)

Assisted Manager in administration of exploration activities, reviewed proposals, analyzed budget and forecast status of long-range proposals. (This was a training program.)

District Geologist, Plains District
Denver, Colorado (1963-1967)

Performed, participated in and supervised geological/geophysical work and land and lease acquisition in search for new oil and gas reserves. Provided leadership to technical personnel.

Senior Exploration Geologist
Bakersfield, California (1967-1971)

Initiated and recommended geological work programs in California coastal and offshore basins. Appointed to Professional Specialist in recognition of fully demonstrated professional ability.

1971-1977 CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION
Senior Geologist (1971-1975)

Generated and supervised exploratory program for coal in western U.S.; generated steam coal evaluation studies and programs for world excluding U.S. Assigned to geothermal group: generated, supervised and coordinated programs for geothermal exploration.

Staff Geologist (1975-1977)

Responsibility for developing plans for geological and well programs for geothermal exploration. Responsibility for overseas coal project evaluation, including Venezuela, Colombia and Indonesia.

1977 CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
District Supervisor, Pacific District

Responsibility for exploration for geothermal resources in Washington, Oregon, Nevada and California. Planned geologic and geophysical programs and supervised staff for area. Recommended land acquisition, surrender and rental payment. Responsibility for well recommendations and supervision of geological wellsite staff. Responsibility and authority for budget control in district.

WILLIAM E. MERO (Transferred)

EDUCATION:

B.A. Geology - University of California, Santa Barbara, 1960.
M.A. Geology - University of California, Berkeley, 1962.

OUTSIDE ACTIVITIES:

President, North Orange County Young Republicans, 1966.
Area Precinct Chairman, La Habra, 1966.
Co-campaign Manager, City Council, 1968.
Co-campaign Manager, Elementary School Board, 1969.
Legislative Chairman, North Orange County Young Republicans, 1967-1968.
Orange County Deputy Registrar, 1968.

PROFESSIONAL EXPERIENCE:

1962-1972 STANDARD OIL COMPANY OF CALIFORNIA - WESTERN OPERATIONS - EXPLORATION - SOUTHERN CALIFORNIA DIVISION
Geologist

Surface and subsurface structural and stratigraphic studies, both regional and prospect oriented. Economic evaluations of prospects and bid acreage. Geophysical and geological subsurface interpretation, offshore Santa Barbara Channel. Stratigraphic and structural studies leading to drilling recommendations.

Geophysicist

Assigned to geophysics group for experience in all phases of geophysical work. Attended "Basic Chevron Geophysical School."

1972-1977 CHEVRON OIL COMPANY - MINERALS STAFF - GEOTHERMAL DIVISION
Geologist (1972-1976)

Supervised geophysical programs and evaluated geothermal projects. Evaluated data and made recommendations on land acquisition.

Senior Geologist (1977)

Executed assigned geological and/or geophysical projects in geothermal exploration. Initiated or recommended new projects.

1977 CHEVRON RESOURCES COMPANY - GEOTHERMAL DIVISION
Senior Geologist

As Lead Geologist, responsible for new prospect exploration and leased area exploration in Nevada. Aided District Supervisor in planning and carrying out programs in state. Aided and advised other geologists in district on geological evaluation of prospects in Washington, Oregon and California. Analyzed KGRA sales in Nevada and recommended appropriate action.

9/1/77 - Present CHEVRON, U.S.A. - WESTERN REGION
Senior Geophysicist

ALBERT M. COOPER

EDUCATION:

B.S. Engineering/Mechanical Specialization (minor: Thermodynamics) - University of Southern California, 1947.
Interdepartmental Management Development Program, 1962.
Computer School - San Francisco Computer Center, 1962.
Northern Division Geologic Training Course for Engineers, 1966.
Corporation Formation Evaluation Seminar, 1967.
"The Effective Executive Series," 1973.
Management Systems Program, 1977.

OUTSIDE ACTIVITIES:

Past Chairman, Pacific Coast District, API Drilling Practices Committee.
Past Chairman, Pacific Coast District, API Drilling Sessions.
Past Chairman, Pacific Coast District, API Blowout Prevention Committee.
Member, Pacific Coast District, API Advisory Committee.
Vice-Chairman, API Steering Committee on Drilling and Production Practices, 1967 and 1968.
Chairman, API Steering Committee on Drilling and Production Practices, 1969 and 1970.
Chairman, API Committee on Environmental Protection, Drilling and Production, 1971-1973.
Vice-Chairman, API Executive Committee on Drilling and Production Practices, 1971-1973.

PROFESSIONAL EXPERIENCE:

1947-1971 STANDARD OIL COMPANY OF CALIFORNIA
WESTERN OPERATIONS - PRODUCING DEPARTMENT
Junior Engineer, Professional Training Program (1947-1949)

Roustabout, pumper, well-puller, engineer, rotary helper, maintenance engineer.

Maintenance Engineer (1949-1954)

Made specific recommendations as to design, selection, layout, planning and construction of surface production facilities. Inspected sites regarding proposed alterations of existing facilities, plant modernization and waste water disposal plants. Assisted in development of cost estimates, general layout and scheduling of surface construction for new well locations.

Lead Engineer (1954-1956)

Planned, supervised and conducted engineering design or solution of engineering problems requiring a high degree of technical competence to achieve effective results, to drill wells, to produce and handle oil and gas, and to maintain surface facilities and equipment.

Job Engineer (1956-1962)

Directed engineering required in developing broad, overall plans for systems, processes, methods and practices necessary to efficient operations concerning well producing, oil gathering, gauging, cleaning and shipping.

Senior Engineer (1962-1967)

Applied sound engineering principles in selection, installation, use, care, operation, alteration and repair of materials and equipment; provided advice on complex mechanical, structural and electrical engineering problems. Provided engineering advice on technical problems such as oil cleaning, waste water handling and corrosion treatment.

Division Organization and Cost Control Supervisor (1967-1969)

Supervised division organization and cost control; furnished functional guidance to management on development, maintenance and improvements of organization structures, staff requirements, functions and obligations of management, position and job evaluation, application of wage and salary structures.

Supervisor, Administrative Staff (1969-1970)

Planned, supervised and coordinated division-wide activities in fields of capital expenditures, profit analysis, training and administration.

Field Superintendent, Northern Division, Elk Hills, USNPR #1 (1970-1971)

Conducted departmental activities, i.e., maintenance, construction, development, production of oil and gas, and conservation considerations, natural gasoline operations, surface and subsurface engineering.

1971-1972 STANDARD OIL COMPANY OF CALIFORNIA
WESTERN OPERATIONS - CORPORATION ENGINEERING DEPARTMENT
Senior Supervising Engineer

As a member of Project Management Team, directed Engineering

Department designs; served as department design representative in contractor's office. Responsibility for designs of plant costing $5-$20 million. Design and construction project manager for $100+ million Kaybob No. 3 gas plant in Canada.

1972-1977 CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION
Senior Project Manager

1977-Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
Senior Project Manager

Plan, supervise and coordinate engineering and operations activities associated with geothermal exploration and development including, but not limited to: drilling and test evaluation, facility design and construction, reservoir analysis, feasibility and process studies of geothermal energy conversion, commercialization planning, generation of project schedules, engineering requirements, operation plan, cost and economics. Responsibility for overall project management, including implementation, staff utilization, costs, contract awards, agency permits and negotiations. Provide technical guidance in engineering and operating aspects of geothermal exploration and development.

BASIL D. GARRETT

EDUCATION:

B.S. Mechanical Engineering/Spec. Hydraulics/Heat Power - University of California, 1944.
Management Development Program, 1962.
Reservoir Engineering Course - Texas A&M, 1960-1961.
Formation Evaluation Seminar, 1959.
Training courses in Electrical, G&NG, Prod. Operator, M&C Operator and Supervisor.

OUTSIDE ACTIVITIES:

Past President, Ventura Toastmasters.

PROFESSIONAL EXPERIENCE:

1945-1973 STANDARD OIL COMPANY OF CALIFORNIA
WESTERN OPERATIONS - PRODUCING DEPARTMENT
Pool-Shop Engineer (1945-1949)

Contacted production superintendents and foremen concerning specific problems. Followed up on job to compare cost with estimate and determine reason for overexpenditures, if any. Analyzed larger shop jobs, prepared cost estimates, handled technical phases of job. Made recommendations for shop procedures; analyzed shop costs; followed up on tests of material and equipment and made recommendations for standards.

Production Equipment and Methods Engineer (1949-1952)

Assisted job engineer on engineering problems arising in connection with selection, installation, use, replacement, repair and maintenance of production equipment and appurtenances used in and at wells, including costs, methods and practices, insofar as equipment was concerned.

Analyst, Production Division (1952-1953)

Did studies on oil cleaning, sampling and gauging, well pumps, production equipment and tools, production stimulation methods and application and other production problems.

Assistant General Shop Foreman (1953-1956)

Responsibility for successful conduct of all activities concerned with efficient and economical operation of general shops and for accomplishment of authorized work in field.

Job Engineer, Drilling (1956-1958)

Responsibility for application of sound engineering principles to selection, installation, use and repair of surface drilling equipment, including complete drill stem.

Engineer, General (1958-1959)

Supervised and performed complex engineering assignments involving construction of shore facilities and lines to and from offshore platform and operation, repair, alteration, etc. of platform, underwater lines and onshore facilities. Provided technical advice to district and division management.

Senior Engineer, Operations (1959-1963)

Planned, supervised and conducted engineering activity for assigned area, provided technical advice to Field Superintendent, represented department at technical meetings.

District Engineer (1963-1965) - title change only

Planned, supervised and conducted engineering activity for assigned area, provided technical advice to Field Superintendent, represented department at technical meetings.

Production Foreman (1965-1966)

Responsibility for successfully conducting activities concerning production, treating, gathering, cleaning, gauging and shipping of oil and gas from assigned area.

Area Supervisor (1966-1973)

Conducted departmental activities within assigned area, including production (oil and gas), maintenance, construction, gas processing (including sale of liquid products and distribution of gas).

1973-1977 CHEVRON OIL CO. - MINERALS STAFF - GEOTHERMAL DIVISION
Operations Supervisor, Geothermal

1977-Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
Operations Supervisor, Geothermal

Plan, coordinate, direct and have responsibility for field operations and engineering required to conduct geothermal exploration and development well drilling, production test evaluations of new discoveries, surface and subsurface operational requirements of producing and handling geothermal fluids from commercial projects, including associated construction activities.

ROBERT J. HAND

EDUCATION:

B.S. Petroleum Engineering - Agricultural & Mechanical College of Texas, 1950.
Reservoir Engineering Seminar - Texas A&M, 1956.
Management Development Course.

OUTSIDE ACTIVITIES:

Member: American Institute of Mining & Metallurgical Engineers
API Vocational Training Committee
API Advisory Committee
Permian Basin Oil Show Board of Directors.
Professional Engineer, State of Texas.
President, Fort Stockton Chamber of Commerce.
School Board Trustee.
Executive Committee Member, Permian Basin Oil Show, 1972.
Chairman, Permian Basin Deep Drilling Problems Committee, 1972.

PROFESSIONAL EXPERIENCE:

1950-1970 STANDARD OIL CO. OF CALIFORNIA - SOTEX DIVISION
Petroleum Engineer (1950-1952)

Assisted Senior Engineer, Gas and Secondary Recovery. Prepared payout calculations for North Snyder Plant and worked on projects pertaining to waterflood of South Ward Field. Supervised drilling and remedial operations on wells in various fields. Supervised drilling of wildcat wells. Prepared various engineering and production reports.

District Engineer (1952-1958)

Assisted District Superintendent in planning and executing engineering activities relating to drilling, production, construction and maintenance; collaborated with District Superintendent and Production Foremen in performance of work planned.

District Production Superintendent (1958-1964)

Was in immediate charge of and directly responsible for planning, direction and execution of production, drilling, maintenance and construction operations and associated staff activities.

Division Drilling Supervisor (1964-1968)

Supervised and coordinated Division's exploration development and remedial drilling activities, making certain they were carried out in accordance with sound engineering practices and company operating and safety standards.

Project Manager (on loan to Chevron Overseas Petroleum, Inc.) (1968-1970)

Supervised wildcat drilling operation offshore Nicaragua.

1970-1975 CHEVRON WEST - PRODUCTION
Division Drilling Supervisor (1970-1971)

Supervised and coordinated Division's exploration, development and remedial drilling activities, making certain they were carried out in accordance with sound engineering practices and company operating and safety standards.

Division Drilling Superintendent (title change only) (1971-1972)

Project Drilling Superintendent (on loan to Chevron Overseas Petroleum, Inc.) (1972-1973)

Supervised wildcat drilling operations offshore South Africa.

Division Drilling Superintendent (1973-1975)

Supervised and coordinated Division's exploration, development and remedial drilling activities, making certain they were carried out in accordance with sound engineering practices and company operating and safety standards.

1975-1976 CHEVRON PETROLEUM U.K. LTD.
Superintendent, Drilling - London

Special Assignment, Drilling Consultant - SKAUSHORE

1977-Present CHEVRON U.S.A. INC. - WESTERN REGION
Northern California Drilling Superintendent

Supervise and coordinate Division's exploration, development and drilling activities.

<u>EZZAT E. GOMAA</u>

<u>EDUCATION</u>:

B.S. Petroleum Engineering - Cairo University, Egypt, 1966.
M.S. Petroleum and Mechanical Engineering - University of California, Berkeley, 1971.
Ph.D. Petroleum Engineering - University of California, Berkeley, 1975.

<u>OUTSIDE ACTIVITIES</u>:

Member, Arab Student Association, University of California, Berkeley.
Fluent in Egyptian and German.

<u>PROFESSIONAL EXPERIENCE</u>:

1973-1978 STANDARD OIL COMPANY OF CALIFORNIA - PRODUCING DEPARTMENT
<u>Reservoir Engineer</u> (1973-1975)

Independently performed assignments requiring competence and experience in engineering varying from general to complex duties, such as preliminary subsurface studies, writing programs for routine wells, remedial and redrill jobs, designing routine oilfield installations and following performance of smaller secondary recovery projects.

<u>Senior Reservoir Engineer</u> (1975-1978)

Performed complex, important and difficult assignments requiring extensive engineering background and high degree of technical competence, such as programs for directionally drilled wells from offshore platforms or urban drillsites. Participated as engineering member of oil and gas review team; made complex reservoir and economic studies; represented company in engineering negotiations with other companies and governmental agencies.

1978- Present CHEVRON RESOURCES CO. - GEOTHERMAL DIVISION
<u>Senior Reservoir Engineer</u>

Plan, coordinate and perform engineering and research and development activities required to delineate fundamental differences of geothermal reservoir systems; ensure that optimum reservoir techniques are developed and used in establishing parameters and predicting reservoir performance; recommend evaluation and development programs to achieve maximum economic recovery of geothermal resources; provide advice on these matters to management, operating, engineering and geological personnel.

APPENDIX V

BOARD OF DIRECTORS RESOLUTION

AND

LIST OF OFFICERS

RESOLVED: That the President, a Vice-President, the Treasurer, the Secretary, an Assistant Secretary, an Assistant Treasurer, or a duly appointed Attorney-in-Fact of Chevron Resources Company, a division of this corporation, be and each of them is hereby empowered in such capacity or as Agents or as Attorneys-in-Fact for said division, to execute for and on behalf of said division (without the necessity of affixing the corporate seal) all papers requiring execution in the name of said division, excepting no authority is conferred by this resolution for execution of any of the following:

1. leases to others covering oil, gas or other hydrocarbon or non-hydrocarbon minerals underlying fee lands of said division, or deeds or conveyances to others covering fee lands of said division, other than rights of way and similar easements, where either book value or sale price exceeds $50,000;

2. promissory notes or notes or other documents and agreements in support of any borrowings;

3. documents of agreements establishing bank accounts in the name of said division, or withdrawing of funds or closing of any bank accounts of said division, and be it further

RESOLVED: That each party empowered by this resolution is authorized to affix the seal of this corporation to such papers as require a seal and to acknowledge and deliver any such papers as fully as if special authority were granted in each particular instance; and be it further

RESOLVED: That the President or a Vice-President of said division be and each of them is hereby empowered on behalf of said division to appoint any person or persons whom they or any one of them may deem proper as Attorney or Attorneys-in-Fact of said division for a term not to exceed one year with such powers said persons or any of them may lawfully do by virtue of the authority herein granted to them.

I, J. D. FROGGATT , Assistant Secretary of CHEVRON INDUSTRIES, INC., a Delaware corporation, do hereby certify that the foregoing is a full, true and correct copy of certain resolutions unanimously adopted at a meeting of the Board of Directors of said corporation held at the office of said corporation in San Francisco, California, on April 13, 1977, and that said resolutions are in full force and unrevoked.

WITNESS my hand and the seal of said corporation this 25th day of May, 1978.

[signature]

Assistant Secretary

CHEVRON RESOURCES COMPANY DIVISION
OF
CHEVRON INDUSTRIES, INC.

Officers

President	R. F. Schlecht
Vice-President	C. Dahlstrom
Secretary	J. D. Froggatt
Treasurer	R. E. Willoughby
Assistant Secretary	Bruce Chalker
Assistant Secretary	Barbara F. Perez
Assistant Treasurer	C. B. Sonne
Assistant Treasurer	J. S. Tate

I, J. D. FROGGATT, Assistant Secretary of CHEVRON INDUSTRIES, INC., a Delaware corporation, do hereby certify that the foregoing is a true and correct list of the names of the officers of the Chevron Resources Company Division of said corporation authorized to execute papers of this corporation pursuant to resolutions adopted by the Board of Directors of said corporation on April 13, 1977, copy of which is attached hereto.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of said corporation this 25th day of May, 1978.

Assistant Secretary

EXPLORATORY PROPOSAL SUBMITTED TO THE
DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE

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

BY

AMINOIL USA, INC.

GEOTHERMAL RESOURCES DIVISION

1250 Coddington Center
Santa Rosa, California 95401

Mailing Address: P.O. Box 11279
Santa Rosa, California 95406

FOR

GEOLOGY, GEOPHYSICS, AND DEEP WELL DRILLING

LEACH HOT SPRINGS, NEVADA

Proposed starting date October 1, 1978. Proposed duration three years.

Project Manager - Claude B. Jenkins, Division Manager, Aminoil USA, Inc.

Telephone (707) 527-5332

Committing Authority - William H. Schell

Signature: ______________ Attest: ______________

Vice President of Production, Aminoil USA, Inc.

David M. Whitney
Assistant Secretary
Aminoil USA, Inc.

May 30, 1978

DISCLOSURE STATEMENT

"Data contained in Pages 1, 3, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, and 47, and Exhibits 1 and 2 and Figures 2 and 3 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."

TABLE OF CONTENTS

LIST OF FIGURES AND EXHIBITS

B. Technical Proposal

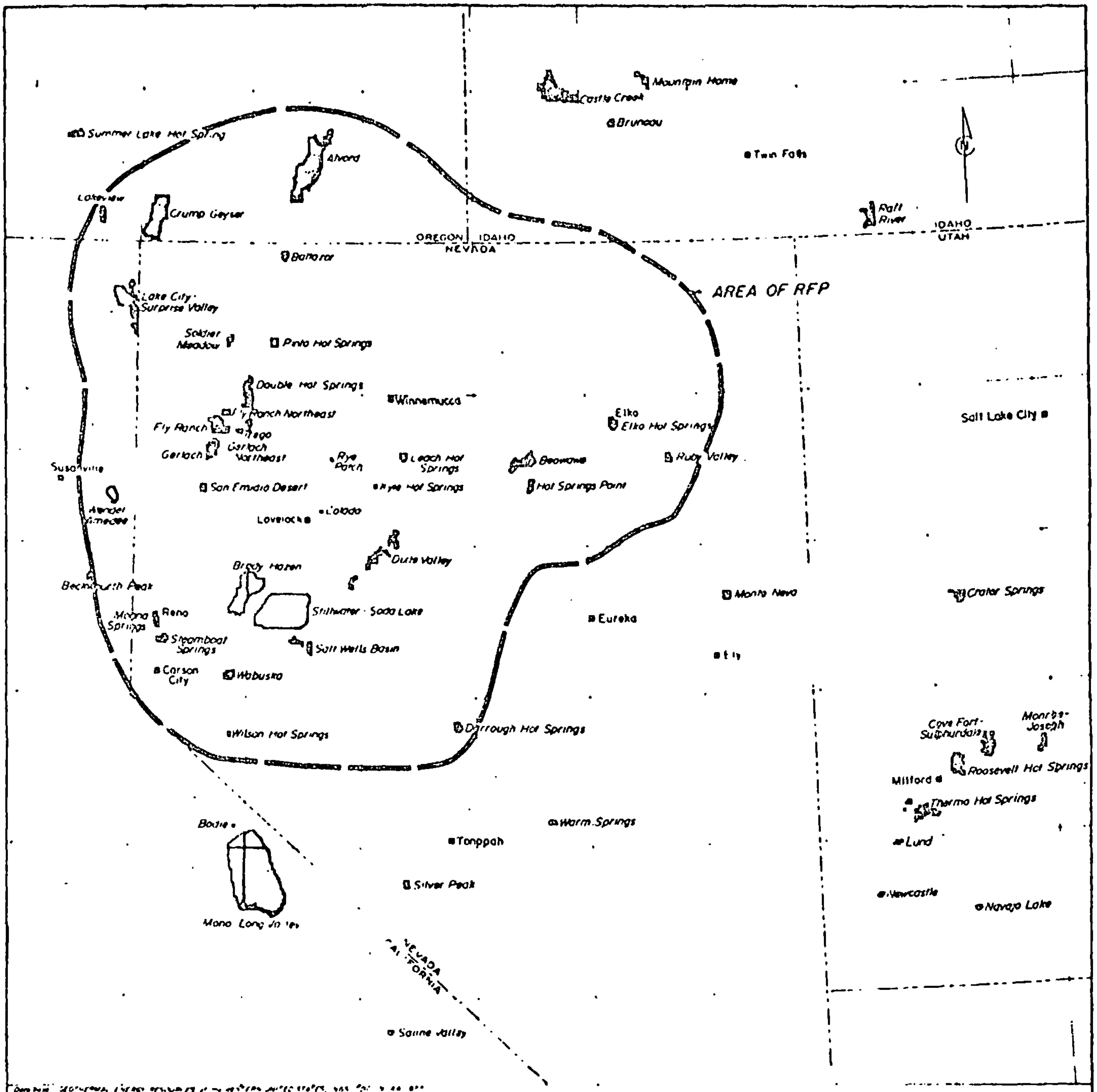
1. Investigation Site or Area

The Leach Hot Springs Known Geothermal Resource Area (KGRA) is located at the southern terminus of Grass Valley in Pershing County, Nevada (Figure #1). The KGRA is located twenty-five miles south of Winnemucca within the confines of the Battle Mountain Heat Flow High of the northern Basin and Range Province. The project investigation site encompasses portions of Township 30 through 32 North and Ranges 38 through 39 East (Figure #2).

a. Aminoil USA, Inc. is the Lessee of Record under five federal geothermal resources leases comprising 12,246.21 acres within the Leach Hot Springs KGRA, which lies within Aminoil's Grass Valley Prospect area. Additionally, Aminoil has filed two applications with the Bureau of Land Management for geothermal resources leases covering 4,480 acres within the prospect area. These lands are more particularly described on Exhibit No. 1.

b. Aminoil has reached agreement with Sidney E. Glenn, G. Martin Booth, III, and William N. Bucklin, III, who are Lessees or Applicants of Record on 33,613.61 acres described on Exhibit No. 1, to pursue all necessary steps with appropriate governmental agencies to form one or more federal unit agreement(s) on the prospect acreage. The lands proposed to be included within such federal unit agreement(s) total 52,499.82 acres, more or less, and are described on Exhibit No. 2.

c. Leach Hot Springs is located in the middle of the Battle Mountain Heat Flow High as defined by Sass (1971). The conductive heat flow is in excess of 3 heat flow units for the northern Basin and Range Province. The Battle Mountain Heat Flow High is characterized by calc-alkali volcanicity from 40-18 million years ago, Basin and Range faulting (20-18 million years ago), basaltic volcanicity (18-10 million years ago), and surface springs with temperatures of 95° Centigrade. Crustal thinning on the order of 7-8 kms is indicated by refraction and gravity anomalies.



AREA OF RFP

BATTLE MOUNTAIN HEAT FLOW HIGH
NORTHERN BASIN & RANGE PROVINCE

DEPARTMENT OF ENERGY
DIVISION OF GEOTHERMAL ENERGY

■ CITIES ◘ KGRA

Figure 1

Grass Valley is a graben bounded to the east by the Sonoma and Tobin Ranges and to the west by the East Ranges. Within the project area, the southern end of the valley is constricted by the Goldbank Hills and the northern end opens into the Humboldt River Valley. The eastern boundary is a major fault system with 3000-4000 feet of throw, whereas the western boundary of Grass Valley is not too distinct being comprised of a series of stair-step faults.

Three thermal anomalies (values greater than 3 heat flow units) have been defined by shallow thermal test holes: 1) in the vicinity of Leach Hot Springs (Section 36, T 32N, R 38E); 2) at the mouth of Panther Canyon (Section 17, T 21N, R 39W), and 3) in Section 14, T 31N, R 38E (Figure #3).

The Leach Hot Springs anomaly is associated with the intersection of a northeast trending fault (the Hot Springs Fault) and the Eastern Boundary Fault Zone. Lineament and gravity analysis indicate that the Panther Canyon and Section 14 thermal anomalies are also related to major fault intersections. The geothermal reservoir is interpreted to be fractured Tertiary volcanics and Palaeozoic sediments containing approximately 200° C hot water of low total dissolved solids. The inferred nature and boundaries of a geothermal reservoir(s) are based on regional surveys.

d. Since 1974, Lawrence Berkeley Laboratory has been conducting geological, geochemical, and geophysical studies in Grass Valley (under ERDA Contract #W-7405-ENG-48). Moreover, in cooperation with the USGS a total of eighty-two holes, varying in depth from 18-400 meters, have been drilled for thermal and hydrologic studies in the valley. These studies were undertaken to evaluate both the geothermal potential of Grass Valley and the applicability and cost effectiveness of various exploratory techniques. The results of these published surveys provide the technical basis for this project proposal. With regards to geothermal prospects in the Battle Mountain High region, the Leach Hot Springs area is unique for the variety of exploratory techniques employed and the current availability of these results to the public. To date no reservoir confirmation tests have been conducted.

The usefulness and applicability of all this published exploratory data is, however, conjectural without subsurface data. Using the current published data as a guide, Aminoil will undertake detailed geophysical surveys to complete the evaluation of the geothermal anomalies within the valley so that we can optimize the specific site selection for the expensive deep tests. The two most prospective deep exploratory tests currently indicated are: one to determine the content and extent of the shallow convection cell which feeds Leach Hot Springs, and the other to test one of the "blind geothermal reservoirs" (no surface manifestation) such as the Panther Canyon anomaly. The drilling of an injection well offsetting one of the exploratory wells followed by a prolonged testing program will provide reservoir evaluation information. The resultant combination of previously published surface information, newly acquired confirmation surface data, subsurface drilling, and testing results will provide a conceptual model for geothermal exploration that will be relevant throughout the entire Basin and Range Province.

2. Program Data Offered

a. Subsurface

(1) New subsurface geothermal well data - three wells

(a) Drilling technology

(b) Drilling history

(c) Formation and reservoir evaluation including electric/radioactive logs and temperature/pressure surveys.

(d) Well cuttings, lithology description, core chips, and core analysis.

(e) Fluid chemistry analyses

(f) Well scaling and corrosion investigations

b. Surface

(1) Existing data (available as of October 1, 1978)

(a) Gravity measurements - 500 stations

(b) Gravity interpretation - 900 stations

(c) Geochemical survey

(d) Surface geology/fracture pattern evaluation/hydrothermal alteration study

(2) New data

(a) Temperature gradients - eight 500-foot holes

(b) Temperature gradients - two 1000-foot holes

(c) Seismic survey - 30 line miles

(d) Pipeline design

(e) Separator design

(f) Flow test system design

(g) Scaling tendency and corrosion experiments

c. Reservoir Engineering Studies

(1) New data

(a) Flow testing

(b) Pressure drawdown and buildup analyses

(c) Isotopic studies

3. Program Description

Two deep exploratory wells (8000') will be drilled to test thermal anomalies defined by existing and new surface geological and geophysical techniques. One production-injection well will be drilled (if necessary) as an offset to the most viable e xploratory well for testing procedures. A nine-month flow testing program will be conducted to define pertinent parameters.

a. Subsurface

(1) New well data

(vi) Run suite of logs including temperature survey at 3000'.

(vii) Run 9-5/8", 36#, K-55 casing at 3000'. Equip casing with a guide shoe, a fill-up float collar two joints up and one centralizer on each of the bottom ten joints. Cement back to surface with Class "G" cement and perlite, 1:1 mix, with 3% gel, 40% silica flour, .5% CFR-2 and retarded for 2-3 hours thickening time. Last 200 cu. ft. to be Class "G" with 40% silica flour, .5% CFR-2 and 2-3 hours retarding time.

(viii) Cut off 13-3/8" head. Install and test 9-5/8" casing head. Install and test BOP with 1500 psi. Check closing once each day.

(ix) Drill 8-3/4" hole to 8000' T. D.

a) Take drift shots every 500'. Maintain angle under 10°. Dogleg less than 1-1/2°/100'.

b) Core as directed.

(x) Run temperature survey and other wireline logs as directed at T. D.

(xi) Run 6-5/8", 24#, K-55 liner to T. D. with slotted intervals as directed. Hang liner with top at 2800'. Use plain type liner hanger.

(xii) Change from mud to fresh water.

(xiii) Test well and complete or abandon as directed.

(3) Mud Loggers

Commercial service to monitor mud temperature and gases (methane, CO_2, H_2S), collect well cuttings and identify lithology from surface to total depth. Three sets will be collected at ten-foot intervals from surface to total depth. One set of samples will be provided to University of Utah Research Institute, Earth Science Laboratory, 391 Chipeta Way, Salt Lake City, Utah, to conduct 36 trace element chemical analyses.

(a) Drill deep exploration well in vicinity of Leach Hot Springs KGRA.

(b) Drill deep exploration well in vicinity of Panther Canyon Anomaly.

(c) Drill injection well in vicinity of one of the above wells.

(2) Drilling and completion procedures for wells.

(a) Total depth - 8000 feet.

(b) Hole size and depths

(i) 25" hole to approximately 50'.

(ii) 17-1/2" hole to approximately 300'.

(iii) 12-1/4" hole to approximately 3000'.

(iv) 8-3/4" hole to approximately 8000'.

(c) Drilling fluids

(i) From surface to 300 feet: use gel-water mud

(ii) From 300' to 8000': use Ligno-sulphonate mud to maintain weight of 66-68 pounds per cubic foot, viscosity 40-45 seconds, water loss 6-8 cubic centimeters, per API standards.

(d) Casing

(i) 20" conductor pipe to approximately 50'.

(ii) 13-3/8", 54.5#, K-55, casing from 300' to surface.

(iii) 9-5/8", 36#, K-55 casing from 3000' to surface.

(iv) 6-5/8", 24#, K-55 liner from total depth (8000') to 2800'.

(e) Cementing

(i) 13-3/8" casing cemented with Class "G" cement with 3% calcium chloride.

(ii) 9-5/8" casing cemented with Class "G" cement and perlite 1:1 mix, with 3% gel, 40% silica flour, .5% CFR-2 and retarded for 2-3 hours thickening time. Last 200 cubic feet to be Class "G" with 40% silica flour, .5% CFR-2 and 2-3 hours retarding time.

(iii) 6-5/8" liner held with plain type liner hanger.

(f) Drilling program sequence

(i) Build necessary roads and level drill site location approximately 150' x 300'. Construct 8' x 8' x 4' deep cellar with wood sides. Cement 50'± of 20" conductor pipe using rathole digger.

(ii) Move in drilling equipment. Drill 17-1/2" hole to 300'. Use gel-water mud.

(iii) Cement 13-3/8", 54.5#, K-55 casing at 300'. Cement back to surface with Class "G" cement with 3% calcium chloride. Equip casing with a fill-up float shoe, a baffle 1 joint up and one centralizer on each joint.

(iv) Install and test 13-3/8" casing head. Install and test BOP with 1500 psi. Use double gate and Hydril.

(v) Drill 12-1/4" hole to 3000'.

a) Take drift shots every 300'. Maintain angle under 6°. Doglegs less than 1-1/2°/100'.

b) Use Ligno-sulphonate mud. Maintain weight 66-68 lbs/cubic foot viscosity, 40-45 seconds, water loss 6-8 cubic centimeters per API standards.

c) Use mud logging unit starting at 300'. Monitor temperature in and out, pit volume and H_2S detection. Take three sets of 10' samples; one unwashed and two washed and dried.

(4) Coring and Analysis

Cores will be taken at selected intervals below 3000 feet in 8-3/4" hole. Analysis will consist of porosity, permeability, density, magnetic susceptibility, and radioactivity to be performed by Core Laboratory in Bakersfield, California.

(5) Drill stem testing - none anticipated

(6) Logging - geophysical

At casing points, total depth, and where deemed necessary, a suite of electric and radioactive logs will be run. This will consist of, but not be limited to, induction, electric, formation density, gamma ray, neutron, four pad high resolution dipmeter, temperature log, and at a total depth a velocity check shot survey.

(7) Flow testing - conducted upon completion of injection well.

(8) Fluid chemistry (see production testing, Sec. 3.c.1).

(9) Wellbore treatment - none anticipated.

b. Surface Investigation

(1) Existing surface investigations

(a) Gravity survey - 509 stations

Survey to be conducted by Exploration Data Consultants, Inc. of Denver, Colorado. Survey will be initiated July 1 and completed August 1, 1978. The 509 station survey will cover 180 sections of the Leach/Panther Canyon prospect area (T 38 & 39N, R 28 & 29E). Approximately 259 stations will infill a 387 station survey done by Lawrence Berkeley Laboratory in 1970 and another 250 stations will expand the survey to cover all thermal anomalies in the prospect area.

(b) Gravity survey interpretation - 896 stations

A geological/geophysical interpretation of a total 896 gravity stations (509 acquired, 387 published). This interpretation will be conducted by Exploration Data Consultants, Inc. of Denver, Colorado from August 1 to September 1, 1978. This interpretation will consist of:

(i) Ten two-dimensional gravity models with detailed fault analyses.

(ii) Three-dimensional gravity modeling on a 1000-foot grid.

(iii) Ground magnetics and depth estimates.

(c) Geochemical survey

Ten samples will be collected from major springs and water wells in the vicinity of Leach Hot Springs KGRA. A total of 20 element analyses will be conducted on the samples to determine important chemical concentrations related to geothermal reservoirs. Survey will be conducted from July 1 to August 1, 1978 by a consultant geologist.

(d) Surface geology/fracture pattern evaluation/hydrothermal alteration study

A one-month field geological program will be conducted from July 1 to August 1, 1978 by a consultant geologist. Photo geologic mapping and surface evaluation will be used to define the principal surface lithology, fracture pattern and hydrothermal alteration of the prospect area.

(2) New Data

(a) Temperature gradient program

A total of ten gradient holes will be drilled in the prospect area to confirm presently indicated geothermal anomalies and to determine the presence of other and perhaps more prospective geothermal anomalies in the vicinity of the KGRA.

Eight of the holes will be 500 feet deep and logged for gradient information. Two holes will be drilled to 1000 feet to evaluate the surface effects of ground water flow in the basin and confirm the existence of heat anomalies at depth. Program will commence October 1, 1978 and be completed in January of 1979. The contractor will be Western Geophysical Company of America. Aminoil personnel will do the gradient logging and heat determination. Samples from the ten gradient holes will be delivered to the University of Utah Research Institute, Earth Science Laboratory, 391 Chipeta Way, Salt Lake City for trace element analyses. Thirty-six separate trace elements will be analyzed for determination of anomalous quantities over or near the geothermal reservoir.

(b) Seismic survey

A thirty mile seismic program will be conducted to determine the subsurface structural picture on the Leach and Panther Canyon anomalies. The program will be a Vibroseis® survey conducted by Western Geophysical Company of America beginning November 1, 1978 and completed December 31, 1978.

c. Engineering Studies

(1) New Data

(a) Flow testing

(i) Short-term flow tests, if feasible, will be performed on all wells. These tests will be supervised by an Aminoil field technician assisted by a contract field crew. The results will be analyzed by Aminoil reservoir engineer for total flow, flowing temperature, and percent of flow flashed to steam.

(b) Pressure drawdown and buildup analyses

(i) Perform long-term flow, interference and reservoir pressure buildup tests. These tests will be supervised by an Aminoil field technician. A flow period of up to nine months will be utilized and the results will be analyzed for permeability-thickness/porosity-thickness reservoir properties, well bore damage, interference, etc.

(c) Isotopic studies

(i) Samples will be collected and analyzed for stable and radiogenic isotopes.

4. Schedule

Sequence of proposed program investigation to acquire new data encompassed by this contract is divided into phases as shown below and indicated on the attached Activity Schedule (Exhibit #3).

a. Performance Schedule

(1) <u>Phase I</u>

(a) Drill and log eight 500-foot temperature gradient holes located in T 30, 31, 32N, R 38-39E, Pershing County, Nevada.

(b) Drill and log two 1000-foot temperature gradient holes located in T 31N, R 38 and 39E, Pershing County, Nevada.

(2) <u>Phase II</u>

(a) Acquire and interpret 30 miles of seismic reflection data over thermal anomalies located in T 30-31N, R 38-39E, Pershing County, Nevada.

(3) <u>Phase III</u>

(a) Drill well to approximately 8000 feet in vicinity of Leach Hot Springs KGRA.

(b) Drill second well to approximately 8000 feet in vicinity of Panther Canyon anomoly.

(4) <u>Phase IV</u>

(a) Drill injection well to approximately 8000 feet in vicinity of Leach Hot Springs KGRA.

(b) Conduct short-term flow test on all wells and perform physical analyses.

(c) Perform long-term flow, interference, and reservoir pressure buildup tests.

b. Deliverable Data

Numbers under Release Schedule indicate timing of release of data as defined in c. (Data Public Release Schedule)

	Release Schedule
(1) Existing surface geological data (available 10/1/78)	
(a) Gravity measurements - 500 stations	(1)
(b) Gravity interpretation - 900 stations	(1)
(c) Geochemical survey	(1)
(d) Surface geology/fracture pattern evaluation/ hydrothermal alteration study	(1)
(2) New surface geological data	
(a) Temperature gradients, 8 holes - 500 feet deep	(1)
(b) Temperature gradients, 2 holes - 1000 feet deep	(1)
(c) Seismic survey - 30 line miles	(1)
(3) New subsurface geothermal well data - 2 deep tests	
(a) Drilling technology	(2)
(b) Drilling history	(2)
(c) Formation and reservoir evaluation including electric/radioactive logs and temperature/ pressure surveys	(2)
(d) Core analysis	(3)
(e) Fluid chemical analysis	(3)
(f) Well scaling and corrosion investigations	(3)
(4) New subsurface geothermal well data - 1 injection well	
(a) Drilling technology	(3)
(b) Drilling history	(3)

(c) Formation and reservoir evaluation data includes electric and radioactivity logs, pressure and temperature surveys (3)

(d) Core analysis (3)

(e) Fluid chemical analysis (3)

(f) Well scaling and corrosion investigations (3)

(5) New surface test system operational data

(a) Pipeline design (4)

(b) Separator design (4)

(c) Flow test system design (4)

(d) Scaling tendency and corrosion investigation (4)

(6) New reservoir engineering studies

(a) Flow testing (4)

(b) Pressure drawdown and buildup (4)

(c) Isotope studies (4)

(7) Miscellaneous

(a) Drill cuttings samples (gradient and deep wells) (5)

(b) Core samples (5)

(c) Reservoir and miscellaneous fluid samples (5)

c. Data Public Release Schedule

(1) Data to be delivered upon commencement of drilling of second deep test [Phase III (b)].

(2) Data to be delivered upon commencement of drilling the injection well [Phase IV (a)].

(3) Data to be delivered within three months of completion of injection well [Phase IV (a)].

(4) Data to be delivered within five months of completion of testing program [Phase IV (c)].

(5) Delivery to be taken from time to time by a Department of Energy or University of Utah Research Institute representative at well site.

d. Data to be Withheld

The following information shall not be delivered under this contract:

(1) All computer programs utilized in calculations and evaluations relating to geothermal wellbore and production characteristics, geothermal pipeline gathering systems and separators, and reservoir simulation, well interference tests, and proprietary interpretation methods and computer algorithms of contractor data.

5. Environmental Evaluation

a. Description of the Environment Affected

(1) Non-Living Components

(a) Air

Air Quality and Pollutants

Present air quality in the area is high except during the spring and early summer months when particulate concentrations (dust) become excessive.

During winter stagnating air masses called anti-cyclones often remain over the area for two or more days preventing vertical atmosphere movement. However, because the area is virtually undeveloped and free of pollution sources, this condition causes negligible impact.

Level of Air Pollutants

Except for dust other pollution emission forms are inconsequential. In future years, these pollutant sources may become important particularly if industrialization or population increases occur within the area.

Temperatures

Temperatures in the area exhibit a wide range between the daily maximum and minimum. Daily temperature variations of 50° F are not uncommon. Temperature extremes in the vicinity of Winnemucca have ranged from 108° F in July 1931, to a low of -36° F at Winnemucca. The Winnemucca growing season is sixty-three days.

(b) Land

Land Forms and Topography

The area lies within the Great Basin section of the Basin and Range physiographic province which is characterized by generally elongated roughly parallel north-trending mountain ranges separated by alluvium filled basins.

The area is relatively high with crests of mountain ranges reaching 3,000 feet to 5,000 feet above valley floors and 7,000 feet to 10,000 feet above sea level.

Intervening valleys of the area typically include the valley floor, the intermediate slopes or alluvial apron, and mountain highlands.

Geologic Hazards

It is expected that relatively few geologic hazards will be associated with geothermal exploration and development. Hazards taken under consideration are: landslides, flash floods, seismicity - induced and natural, and subsidence.

Soils

In general, the bottomland and floodplains have soils that are mostly deep, medium to moderately fine grained, and moderately well drained. Very little salts and alkali concentrations exist in Grass Valley. There are some well drained soils which are shallow to moderately deep and composed of silty clay interbedded with sand and gravel.

Land Use Compatibility and Suitability

Land within the area is used for a variety of purposes including livestock grazing, minerals, crop production, outdoor recreation, fish and wildlife, watershed, transportation and utility systems. In general, the suitability of land for the various uses overlap and tend to be controlled by physical factors such as soil properties, topography, climate and vegetation. In some instances, conflicts between competing uses of the resources are apparent or imminent. It is expected, therefore, that in the future, certain compromises will be made in land management decisions and practices which will allow optimum concurrent use of the same lands by non-conflicting uses.

The heaviest use of the land occurs in the summer and fall months when livestock are grazed, and when recreationists, hunters, and fishermen pursue their various activities. Except for big game, upland game birds, and other wildlife use, most of the area receives little use during the winter.

(c) Water

Hydrologic Cycle

Precipitation in the area is largely controlled by the topography. The prevailing westerly winds rise along the windward flank of each succeeding mountain range, releasing precipitation as they gain altitude. Moving down the east slopes, the winds are warming and dry, thus creating arid conditions and releasing decreasing amounts of precipitation at lower elevations. Most of the precipitation occurs during the winter months as snow, which at higher elevations may remain several weeks or months. The summers are notably dry. Although the usual precipitation may be as much as 15 to 20 inches along the crests of the higher ranges, the valley floor itself may receive about 5 inches per year.

Streams

The smaller streams which drain the basin from the surrounding mountains are fed principally by stream runoff and snow melt. Their flow is, therefore, ephemeral, generally occurring during the spring and early summer.

Thermal Springs

The temperatures of springs range from warm to boiling and issue from the desert floor. These springs are probably associated with recent movement along fault zones, which provide paths along which ground water, heated at depth, can rise to the surface.

Water from thermal springs is commonly highly mineralized due to its high temperature, which is conducive to chemical reaction with the enclosing rock environment and to its history of deep circulation. Most of the thermal water is derived from the same ultimate source as all ground water - precipitation.

Water Quality

Generally, waters of the area are suitable for drinking water after treatment, agricultural use, aquatic life and wildlife propagation, recreation, industrial supply and aesthetics.

(2) Living Components

(a) Plant Life

Soils, topography, climate and vegetation combine to produce ecological zones between the high mountain areas and desert lowland. Vegetation varies from scattered salt tolerant shrubs on desert playas through many varieties of desert shrubs and grasses to dense scattered stands of aspen and scattered conifers on the intermediate to steep mountain slopes and basins.

In the valley bottoms the vegetation consists primarily of shadscale (Atriplex confertifolia), budsage (Artemisia spinescens), big sagebrush (Artemisia tridentata), and black greasewood (Sarcobatus vermiculatus), in descending order of occurrence.

(b) Animal Life

The region supports a large and varied cross section of animal life. Eighty-two species of mammals, 260 species of birds, 160 species of amphibians and reptiles, and 23 species of fish inhabit the region.

Major game species of the region include mule deer, antelope, rabbits, pheasant, mourning dove, chukar and Hungarian partridges, sage grouse, quail and several species of ducks and geese.

The most abundant animal life in hot springs and other aquatic areas are invertebrates. Insects appear to be the most important invertebrates present. Annelida, Crustacea, and Gastropoda are also represented.

(c) Human Values

Economic Implications of Geothermal Development

Between 1960 and 1977, exploratory efforts were made in Nevada to develop geothermal resources as a power source. As a result of these efforts, Known Geothermal Areas (KGRA's) totalling about 635,000 acres were classified by the U. S. Geological Survey.

It is anticipated that there will be two geothermal power plants in Nevada by 1981, and several more of large capacity operating by the year 2000. These plants will probably use an essentially closed system, returning the water to the geothermal reservoir through discharge wells. Some plants may be operated in conjunction with desalination plants, thus combining power production with the production of fresh water and mineral recovery.

If current interest in geothermal power continues, it can be expected that positive net economic changes to the area's income base will occur.

Attitude and Expectations

The presence of geothermal resources in the area has been known for many years. However, use of this resource has been limited to "hot spring" bath areas developed in a crude fashion to serve local owners and residences. Local people hope that geothermal resources within the area can be developed thereby assuring a clean, low-cost power source.

Hazards to Human and Animal Health

The range fire hazard would be increased due to a greater level of human activity and traffic associated with geothermal development. In any drilling into pressured zones, which could occur in a geothermal reservoir, there is a hazard of uncontrolled release of pressurized fluid.

Road construction and well site preparation could produce soil movement which if uncontrolled could cause damage to adjacent areas and to aquatic life in nearby streams. Dam failure in sump ponds is a potential threat to fish and other stream life.

Wildlife road kills is another potential hazard which results from increased miles of road, improvement of roads that increase vehicle speed, and increased vehicle use.

b. Analysis of the Potential Environmental Impact

The degree of potential environmental impacts associated with the proposal is dependent upon a number of factors including the type and extent of the geothermal resource, the probable sequence and success or failure of the various phases, i. e., exploration, development, production, close-out after abandonment or production ceases, the proportion of government to private land ownership, and lastly, the biological, physical, and demographic characteristics of the area.

Because the geothermal potential of the area is largely speculative and because there is limited knowledge concerning the occurrence, location and proportion of geothermal resources as related to both energy and by-products, it is not possible to predict accurately any environmental impacts. As a result of such uncertainties concerning the utilization of geothermal resources, environmental impacts can only be estimated as to their frequency, duration, and severity. However, if exploration, development, production, and close-out activities are properly planned, regulated and operated, no appreciable or significant adverse affects should occur, thus providing an environmentally acceptable energy source.

Accordingly, the various activities are regulated by the authorities of the Bureau of Land Management and the U. S. Geological Survey, with additional controls in the form of special stipulations, Geothermal Resources Operational (GRO) Orders, and approved operational plans. In addition, compliance with applicable Federal and State laws and regulations is required.

(1) Non-Living Environment

(a) Air

General provisions for the prevention of air pollution and related employees health and safety are included in the leasing and operating regulations. In addition, Federal air quality standards and Nevada Air Quality Regulations (NAQR) are applicable; lease stipulations are issued and technologic methods may allow mitigation of air pollution and related health and safety hazards.

Particulate Matter (Dust)

Dust generated by the movement of geothermal related vehicles over untreated local roads, and airborne dust resulting from earth moving, construction, or wild fires, will add particulate material to the atmosphere.

Although a quantitative measurement of potential increases in particulates is not possible, no serious impacts are anticipated. Over time, a combination of restoration and natural revegetation should bring disturbed areas back to their natural condition.

Gases and Vapors

Motor vehicles used to move men and equipment, and for subsequent development phases will contribute a negligible pollution load to the local atmosphere. In almost all cases, diesel engines will be used on the drilling rig and heavy construction equipment. Low hydrocarbon emissions of diesel engines will minimize the impact of these operations.

Noncondensible noxious gases, particularly hydrogen sulfide (H_2S), emitted from a well during testing and bleeding can cause unpleasant (rotten egg smell) in and around the developed area. This is more of a disturbance factor rather than a hazard.

Condensed steam from geothermal development may contain contaminants which if present in high concentrations could be damaging to plant and animal life. Terrestrial and aquatic animals by ingesting natural food contaminated by emission fallout could be adversely affected. However, existing geothermal experience indicates that biotic problems of this nature are generally negligible.

The highest levels of gas and vapor emission would normally occur through venting during test drilling and during production.

Any accidental discharges during the rupture of pipelines or well blowout will also yield gases and vapors to the atmosphere.

Nevada Air Quality Regulations require toxic gases to be removed to such a degree as to render them nonhazardous to plant and animal life in areas surrounding geothermal producing areas.

Noise

The noise level for any geothermal area can be expected to increase as the various phases of activity are implemented. The construction of access roads, test drilling, vehicular movement, and other ancillary sound sources tend to raise background noise. Normally these are of relatively short duration and more of a disturbance factor rather than being associated with resource damage.

Operations producing the greatest amounts of noise are air drilling, well testing, and bleeding. By comparison, noise produced by a fully developed power producing steam field is modest, originating from the occasional venting of wells through mufflers, and pipeline leaks.

If present, excessive noise levels can pose a health and safety hazard to workers in close proximity, are objectional to area residents and visitors, and may disturb wildlife distribution and breeding habits. Although it is presumed that noise may have an adverse impact on wildlife, such impacts have not been substantiated.

(b) Land

The development of geothermal resources and appurtenant transmission facilities on essentially undeveloped Federal lands will involve changes in present land utilization and could affect the use and quality of adjacent lands, including both private and Federal. Developed portions of Federal leases could ultimately consist of single-purpose industrial use. Undeveloped or nonintensively used leased lands would continue to support multiple land uses, including such values as watershed, grazing, recreation, and wildlife habitat. New access, developed on leased land not specifically restricted to protect property, public health or for safety reasons, will open up these lands to additional uses, particularly recreation.

Land use in the vicinity of actual developments will be changed by the construction of roads, wells, pipelines, power lines, power plants, and by-product facilities that may be associated with industrial development. Previous uses such as watershed, grazing, recreation, and wildlife habitat will necessarily be preempted or curtailed depending on the intensity of the development. Mitigating measures to control, reduce, or overcome adverse environmental impacts would, however, be employed. The rules and regulations, lease provisions, and GRO Orders are designed to assure that geothermal resources are developed and utilized in an environmentally acceptable manner.

Geologic Structure

The role of fluid pressure changes in triggering seismic activity is not well known, however, a causative relationship has been established in some areas. To date, earthquakes associated with fluid pressure changes have been small and nonconsequential; some evidence indicates that seismic activity associated with a geothermal area is a continuous process tending to relieve regional stresses, thus reducing the probability of large earthquakes.

Subsidence of the ground surface over and around a geothermal reservoir can result from the withdrawal of large volumes of fluids. Subsidence could reach a maximum rate during full-scale operations unless replacement fluid is returned to the reservoir. Fluids are returned to replenish the reservoir in hot water geothermal operations. In many instances, it is possible that there would be no serious land or environmental consequence if in fact subsidence did occur.

Land Use Compatibility and Suitability

To a large degree land use compatibility and suitability will vary according to the characteristics of each specific site and the phase of development. For example, unsuccessful exploration activities resulting in lease termination would result in a relatively small scale impact on surface resources and existing uses. However, as development proceeds through the sequential stages, of test drilling, production testing, field development, power plant and power line construction, and full-scale production, resource impacts will become more intensified.

During exploration activities there will be a minimal amount of disturbance of vegetative cover and soil movement. Resource impacts will vary depending upon the nature of exploration activities and composition of vegetal communities. Those containing shrub species in moderate to heavy densities could be most affected. Even with mitigation it is possible that road and trail scars will remain for years, particularly if they are conducive to casual use after abandonment.

For subsequent stages of development, physical land modifications will increase resulting in loss of wildlife forage and wildlife values in the areas of operations. Land surface scars would be larger and possibly permanent in nature. Where public access is restricted either to reduce hazards or to protect facilities, there could be an accompanying reduction in hunting, recreational, or other uses of those lands. The importance of these losses would depend on the amount of such uses displaced and the capacity of other areas to absorb like pressures.

Full-scale operation will require complete development of well and steam transmission systems, power generation facilities, brine disposal facilities, transmission lines, permanent roads, etc. Many of the potential unavoidable adverse impacts associated with exploration and testing will no longer exist but other impacts may increase in proportion to the scale of the development. Each well will involve clearing, grading, and improvements. Steam pipelines connecting wells to the generators likewise require clearing and grading. During construction there will be considerable activity, noise, movement of earth, dust, etc. After construction is completed and all necessary environmental protection measures are taken, the nature of the site will be changed from its former state to an industrial complex. Cleared areas, buildings, power lines, brine ponds, etc., will represent long-term changes in the landscape and a change in land use.

With adequate controls on surface use, combined with well-conceived and strictly applied surface protection stipulations, sequential stages of geothermal development will be compatible with existing or potential surface land uses.

(c) Water

The basic law governing water quality is the Federal Water Pollution Control Act (FWPCA), as amended. Under this act the primary responsibility for water pollution control is assigned to the states. Under the Act, each state is required to promulgate intrastate water standards which then must be approved by the Environmental Protection Agency (EPA). Nevada has Federally approved standards.

Geothermal steam development is included under Nevada Water Law and a permit is required before the steam may be diverted to generate power. The appropriation procedure insures that existing water rights and the public welfare are not adversely affected. In designated critical ground-water areas, such as Grass Valley, a permit is needed from the Nevada Division of Water Resources before an exploratory hole may be drilled.

Hydrologic Cycle

The potential impacts of the geothermal program upon the water resources generally would be in proportion to the scale and location of the activity. Springs, ponds, reservoirs, streams and ground-water areas are not expected to be adversely impacted under the normal exploratory stage. Generally, possible impacts are considered as low.

Drilling could adversely impact springs by causing a drop in the water table thereby impacting surface flow, dependent life forms, and domestic livestock.

Water supplies can be lost or reduced during exploration. Seismic testing, stratigraphic testing, and wildcat drilling can alter the ground-water hydrology by fracturing impermeable zones below aquifers, permitting them to be lost or reduced through vertical drainage. The probability of this happening is, however, low due to current drilling technology.

Reduction of the ground-water supply might occur as a result of development and production. If the geothermal field is large enough to cause significant water reduction, the result might reduce the livestock and wildlife uses. The impact might displace families, livestock, and wildlife.

With close-out, the affected water table may rise and be tapped for beneficial uses.

A benefit from an exploratory program is the discovery of water bearing strata for future development in providing water for use in water-short areas.

Sediment Load

The significance will depend upon amounts and location. Generally the impact potential for sediment transport is considered modest because land surface slopes are slight in the valley areas.

Dissolved Solids and Acid Balance

Exploratory drilling could yield large amounts of briny waters. Briny water production can contaminate surface waters if washed from evaporation ponds during flash-floods or dike failure.

Geothermal fluids could raise the pH of these already alkaline waters (6.5 to 9.6) thereby decreasing the range of existing aquatic life.

The aquifers could be polluted by these brines and the results could be degraded water quality to the degree that it would not be suitable for human and animal use and in extreme cases could even be toxic to plant life.

Toxic Pollution

Highly toxic drilling fluid additives such as caustic, if used, could contaminate local ponds by washing down a natural drainage or be bound by soil particles and carried there by wind forces. The closed basin areas are particularly impacted because there is no means of flushing the toxicants.

Thermal Pollution

Temperature contamination of existing surface waters by hot waters produced from geothermal operations would have significant impact upon aquatic flora and fauna. Many of the aquatic plants and animals have restrictive temperature adaptation.

(2) Living Environment

The rules and regulations, lease provisions, and Geothermal Resources Operational (GRO) Orders are so designed to assure that geothermal operations will result in the least disturbance of soil, stream, native vegetation, and fish and wildlife populations and habitat. In addition remedial measures are required for the restoration of land surfaces upon abandonment or completion of the various phases.

(a) Vegetation

Native vegetation will be disturbed or destroyed where the construction of access roads, drill pads, ponds for collection of drilling mud, and other ancillary or service support activities are required. In addition, the construction of power units, by-product facilities, maintenance areas, etc., during the development and production phases will result in both the permanent and temporary loss of native vegetation and a minor to major alteration of specific types.

An exploration drilling model prepared by the Bureau of Land Management (BLM) for one 2,560 acre lease projects that 1.5 percent (38 acres) of the total lease area will be disturbed. A similar model for the development of two 100 megawatt power plants on one 2,560 acre lease projects that 14 percent (360 acres) of the total lease area will be disturbed.

(b) Animal Life

As a specific development proceeds through test drilling and production testing, physical land modification and human occupation would occur. These activities include such things as con struction of roads, ponds, drill sites and drilling of wells, and transmission facilities, which could result in loss of wildlife values, including both habitat and recreational use of wildlife within the area of influence. Such modifications would physically alter or remove existing wildlife habitat and the permanence of these effects would be dependent upon the nature of the particular construction or operational activity. However, in some instances clearings, revegetated areas and roads or trails resulting from geothermal operations could improve wildlife habitat. It also should be recognized that many animals have the ability to adapt to changed environments. In addition to land modifications, noise, and other man-induced phenomena may have an effect on the wildlife community surrounding lease areas. Noise may drive some species from the area, may disturb normal predator-prey relationships or may affect mating and rearing habits. Most areas adjacent to or outside of the immediate areas of influence would, however, be expected to retain part or all of their fish and wildlife population and habitat. The degree of permanence of displacement or disturbance would depend upon the scope, duration, and type of activity.

Potentially significant impacts upon fish and wildlife could result from improperly planned or executed handling of geothermal fluids. If controlled releases, spills, seepage or well blowouts were to result in significant additions of toxic, mineralized, or saline geothermal waters to streams, ponds, game management areas, etc., adverse impact s would result.

(3) Ecological Interrelationships

The principal ecological processes at work with the ecosystem are succession, food relationships and community relations. To summarize, the subject area is a delicately balanced shrub-vegetated ecosystem which is exceptionally vulnerable to misuse. Because of past history of overuse, a general decline in desirable plant communities has been the rule. This trend is still in evidence and is expected to continue until natural forces or surface management practices come into balance with climate, site, and environmental factors. In the cumulative aspect the proposed geothermal program represents still another use which could conceivably influence and disrupt existing ecological processes.

(a) Animal Life

Livestock
The impact of geothermal activities on livestock forage would be negligible during the exploration phase, but increasing during the development and production phases.

Wildlife
Any large scale reduction in the quantity of vegetation would directly impact the distribution and abundance of wild animals by reducing forage and cover.

(4) Human Interest Values

(a) Aesthetics

Impacts on aesthetic quality would begin with the construction of temporary roads into test drilling sites and would increase as drilling operations, pipelines, storage facilities, power plants, transmission lines, etc., are added. The visual impact associated with scarring, alteration of the landscape, or unsightly surface disturbance would occur not only at specific sites but also in linear corridors occupied by transmission lines. For Federal land developments, full consideration will be given to aesthetic design, placement of man-made structures, use of compatible colors, landscaping and vegetative restoration, in order to minimize those impacts.

(b) Recreation

During the sequential stages of geothermal development there would be an impact on the landscape and it's component parts which contribute to outdoor recreation. Most recreation uses would be adversely affected in the immediate vicinity of test wells or subsequent field developments.

Conversely, new roads required for access could eventually improve recreation access.

It is anticipated that with geothermal development public interest will be aroused. Many may wish to see this unique power source in operation.

(c) Sociocultural Values

Geothermal resource exploration and development activities could inadvertently destroy archeological or historic values. Lease stipulations require the operator to notify the supervisor if any artifacts are unearthed.

Local spending by temporary construction workers and drilling crews will contribute to the local economy. Discovery of a geothermal resource will result in an increased tax base for the area of development. Full scale development could cause temporary constraints on present day community services, schools, etc., and would tend to off-set any short-term gain in local economy.

In addition to the primary application of the geothermal resource to electrical power generation, several alternatives or complimentary uses may eventually be considered. Alternative or complementary uses could include space heating, stock water, irrigation, food, and industrial processing or municipal water supply.

c. Potential for Conflicts with Existing Land Use Patterns and Programs

Some conflicts with existing land use patterns and programs will result from the implementation of geothermal activities. Potential conflicts and mitigating measures associated with such activities have been discussed in preceding section "Analysis of the Potential Environment Impact."

The rules and regulations, lease provisions, and Geothermal Resource Operational (GRO) Orders are designed to assure that geothermal resources can be developed and utilized in an environmentally acceptable manner. Virtually any human use of the lands and their resources may have some degree of conflict or adverse impact. For example, the mere presence of man during exploration, development, production and close-out phases will have a cumulative residual impact upon existing resources and uses.

While geothermal development will impose some unavoidable land use conflicts and adverse environmental impacts, it appears to have potential of being less environmentally damaging than other power generating systems using coal, oil, or nuclear energy sources.

To the extent that these are net total system reductions in adverse air, water, or land impacts, such differences represent positive benefits from the use of geothermal resources even though there will be local land use conflicts and adverse impacts that cannot be avoided.

(1) Relationship Between Short Term Use and Long Term Productivity

It is significant to note that geothermal energy is a dissipating resource which is being wasted by failure to utilize this potential. Not only is the potential for energy utilization being ignored by lack of development, a substantial revenue source for both county and state is lost.

Land Use

Land use during the period of production operations would be changed to industrial operations from fish and wildlife habitat, recreation, and grazing. However, many such uses could continue on a reduced but compatible basis.

Should production result in land subsidence, the subsidence would constitute a long-term effect on land resources. Such subsidence would not significantly affect use of the land in most areas because of the low population density.

Water

The consumptive use of water resources, primarily geothermal fluids, in power generation would constitute a depletion of the gross water resources of the area. However, in most instances, due to the high mineral content, the geothermal fluids will be re-injected.

Vegetation

Geothermal production will affect the vegetal communities during the period of occupancy. After the areas are abandoned, re-establishment of natural productive communities should occur.

Fish and Wildlife

Geothermal resource development could result in localized and even regional adverse impacts on fish, wildlife, and their habitat. Wildlife values probably would re-establish themselves as soon as the operations are terminated. In some instances they may even benefit from this use.

Archeological and Historical Values

The development of geothermal resources may commit terrain where archeological and historic resources are deposited. Archeological and historic values could be damaged or destroyed. However, development also could result in significant finds that might otherwise have gone undetected.

Economic and Social

Geothermal development requires a substantial investment which results in an increased tax base.

There could be aesthetic or social impacts in terms of increased noise levels, odors, additional traffic, etc., even though all of the environmental stipulations of the permits had been met. These would be minor but objectionable in terms of pre-operational conditions.

(2) Irreversible and Irretrievable Commitments of Resources

The principal commitment of resources would be the depletion of thermal energy and water from the geothermal reservoir.

The thermal energy stored in the geothermal fluids presumably would be extracted at a rate greater than the natural terrestrial heat flow. Although the geothermal source will continue indefinitely the use of the stored energy is considered a depletable resource over a short-term if the withdrawal rate exceeds the re-heating rate.

The recharge mechanism of geothermal reservoirs of the area is presumed to be rainfall on the drainage basins tributary to the area. Thus, water evaporated in geothermal production should be considered as a water consumption chargeable to the area. However, as the water is renewable from rainfall, this charge is not irretrievable.

Compaction that may occur as a result of geothermal production is irretrievable in a sense that it is an irreversible process. Loss of porosity is a commitment of a resource because this is the storage volume for the heat conducting fluid.

Areas of natural vegetation will be altered or cleared due to construction of facilities required for the development and use of geothermal resources. Upon termination of production, all such areas are to be restored to as near a natural condition as is feasible but complete reversion to the pre-development conditions may not be possible. The impacts could be either adverse or beneficial, depending upon the nature of subsequent uses of the area.

Normal land uses of the area such as recreation, livestock grazing, and hunting would be affected during the period of operations, but such uses could return to pre-development levels after production stops and the areas are restored. The restrictions on use of leased lands and related impacts on adjacent lands could alter use patterns which could result in over use in other areas. However, all such impacts probably would be limited to the production life of the geothermal development.

REFERENCES

1. Environmental Analysis Record
Winnemucca District, Nevada
Bureau of Land Management, December 1975
EAR No. 27-020-4-103

C. Cost

1. Total Program Cost Summary

a. Cost of Existing Information - as of October 1, 1978	$ 79,064
b. Phase 1 - Temperature Gradient Survey	142,113
c. Phase 2 - Seismic Survey	177,160
d. Phase 3 - Drill and test two 8,000 ft. Exploratory Wells.	2,232,717
e. Phase 4 - Drill and test an Injection Well and conduct Long Term Tests on one well.	1,452,901
Total Project Cost	$4,083,955

SUMMARY - TOTAL ESTIMATED COSTS

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: AMINOIL USA

HOME OFFICE ADDRESS: P. O. Box 11279, Santa Rosa, CA. 95406

SUPPLIES AND/OR SERVICES TO BE FURNISHED: Existing Data - G&G Survey Information; Phase 1 - Temperature Gradient Survey; Phase 2 - Seismic Survey; Phase 3 - Two 8,000' well tests; Phase 4 - Injec. well & Long Pro. Test.

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Geothermal Division - Santa Rosa, CA.

TOTAL AMOUNT OF PROPOSAL: $ 4,083,955

GOV'T SOLICITATION NO.: RFP ET-78-R-08-0003

DETAIL DESCRIPTION OF COST ELEMENTS - See Attachments

	EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*			
a. PURCHASED PARTS			
b. SUBCONTRACTED ITEMS			
c. OTHER—(1) RAW MATERIAL			
(2) YOUR STANDARD COMMERCIAL ITEMS			
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*			
TOTAL DIRECT MATERIAL		844,253	
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)* Included in No. 11 below.		-	
3. DIRECT LABOR *(Specify)* — ESTIMATED HOURS / RATE/HOUR / EST COST ($)			
TOTAL DIRECT LABOR		83,174	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3] — O.H. RATE / X BASE = / EST COST ($)			
TOTAL LABOR OVERHEAD		32,437	
5. SPECIAL TESTING *(Including field work at Government installations)*			
TOTAL SPECIAL TESTING		224,600	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*		1,564,000	
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			
a. TRANSPORTATION			
b. PER DIEM OR SUBSISTENCE			
TOTAL TRAVEL		51,560	
8. CONSULTANTS *(Identify—purpose—rate)*			
TOTAL CONSULTANTS		341,348	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*		711,417	
10. TOTAL DIRECT COST AND OVERHEAD		3,852,789	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 6 % of cost element Nos. all)*[3]		231,166	
12. ROYALTIES[4]		-	
13. TOTAL ESTIMATED COST		4,083,955	
14. FEE OR PROFIT			
15. TOTAL ESTIMATED COST AND FEE OR PROFIT		4,083,955	

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.)*

U.S. Department of Energy RFP No. 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	
W. H. Schell Vice President Production	[signature]	
NAME OF FIRM		DATE OF SUBMISSION
Aminoil USA, 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 ($)
1	Direct Materials - Estimates are based on recent prices with 6% annual increase.	
2	Material Overhead - Not charged. Included in No. 11 below.	
3	Direct Labor - Hourly rates used are based on approximate salaries of personnel involved. The unit price is calculated on a 40 hour week.	
4	Labor Overhead - The company wide rate based on actual cost is currently 39% of direct labor.	
5	Special Testing - Estimates based on current prices plus 6% annual increase.	
6	Special Equipment - This category includes the drilling rig rental (including crew) and testing equipment (separator and meter run with instruments). Installation by a local contractor is included in the estimated price. These test equipment costs are shown as a cost of the first well drilled. Estimates are based on current prices plus 6% annual increase. It has been assumed that a rig will be available in the Nevada area.	
7	Travel - Estimated per diem costs for the area.	
8	Consultants - Includes contract services (other than drilling and related activities). Current prices plus 6% annually have been used.	
9	Other Direct Costs - Includes Contingency Provisions.	
11	General and Administrative - To cover Geothermal Division and Home Office supervision and assistance. The rate of 6% is frequently used for billing joint venture partners for this type of work.	

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)

2. Cost To Government

It is Aminoil's proposal that the Government pay one-half of the cost of all cost elements for each phase of the project, with payroll burden and general and administrative expense being charged as shown in the cost estimate. We propose monthly billing of costs recorded in the prior month, with payment due by the end of the month of billing.

Based on this concept and our present estimates, the Government's share, by phase would be:

	50% of Total
Existing Data (as of Oct. 1, 1978)	$ 39,532
Phase 1 - Temperature Gradient Survey	71,056
Phase 2 - Seismic Survey	88,580
Phase 3 - Drill and Test two wells	1,116,359
Phase 4 - Drill Injection Well and conduct Long Term Test.	726,450
Estimated Government 50% Share	$2,041,977

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: AMINOIL USA

HOME OFFICE ADDRESS: P. O. Box 11279, Santa Rosa, CA 95406

SUPPLIES AND/OR SERVICES TO BE FURNISHED: EXISTING DATA - Aerial Photos, Geological Mapping, Geochemical and Gravity Survey.

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Geothermal Division - Santa Rosa, CA.

TOTAL AMOUNT OF PROPOSAL: $4,083,955

GOV'T SOLICITATION NO.: RFP ET-78-R-08-0003

DETAIL DESCRIPTION OF COST ELEMENTS - See Attachment

1. DIRECT MATERIAL *(Itemize on Exhibit A)*			EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
a. PURCHASED PARTS Aerial Photos - Cost			1,253		
b. SUBCONTRACTED ITEMS					
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				1,253	
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)* In No. 11 below				-	
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)		
(a) Senior Geologist - Mapping.	80	$22	1,760		
(b) Senior Geologist - Gravity Survey Supervision & Interpretation.	160	22	3,520		
TOTAL DIRECT LABOR				5,280	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
Payroll Burden	39%	5,280	2,059		
TOTAL LABOR OVERHEAD				2,059	
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 Sr. Geologist - 42 days @ $25			1,050		
b. PER DIEM OR SUBSISTENCE Sr. Geologist - 42 days @ $40			1,680		
TOTAL TRAVEL				2,730	
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
a. Field Geologist - Mapping & Geochemical Survey - 45 days at $375.			16,875		
b. Laboratory - Geochemical analysis-20 samples @ $100 ea			2,000		
c. Gravity Survey incl. interpretation & reports.			34,663		
TOTAL CONSULTANTS				53,538	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* Contingency				9,729	
10. TOTAL DIRECT COST AND OVERHEAD				74,589	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate* 6 *% of cost element Nos.* all *)*[3]				4,475	
12. ROYALTIES[4]				-	
13. TOTAL ESTIMATED COST				79,064	
14. FEE OR PROFIT				-	
15. TOTAL ESTIMATED COST AND FEE OR PROFIT				79,064	

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

ATTACHMENT TO: "EXISTING DATA"

GRAVITY SURVEY

QUOTATION BY EDCON, DENVER

Data Acquisition	
225 Stations on existing roads, $26/station	$ 5,850
284 Stations off existing roads $29/station	$ 8,236
Total Data Acquisition Costs	$14,086
Data Reduction	
Terrain Correction $3/station	$ 1,527
Data Interpretation and Report	
A. Ten 2-D gravity models with detailed fault analysis	$ 4,400
B. Three dimensional gravity modeling on 1000-foot grid	$ 4,500
C. Interpretation of ground magnetics including five depth Estimates	$ 1,000
D. Field Trip - 3 days - Geologist $400 per day.	$ 1,200
E. Drafting, Secretarial, Reproduction and verbal presentation of results	$ 2,550
F. Integration and final report	$ 5,400
Total data interpretation and report	$19,050
Total expenses charged by Edcon	$34,663

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: AMINOIL USA

SUPPLIES AND/OR SERVICES TO BE FURNISHED: Phase 1 - Temperature Gradient Survey.

HOME OFFICE ADDRESS: P. O. Box 11279, Santa Rosa, Calif. 95406

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Geothermal Division - Santa Rosa, CA.

TOTAL AMOUNT OF PROPOSAL: $4,083,955

GOV'T SOLICITATION NO.: RFP 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 ($)		
Senior Geologist - Supervision and interpretation.	176	$22	3,872		
TOTAL DIRECT LABOR				3,872	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
Payroll Burden.	39%	3,872	1,510		
TOTAL LABOR OVERHEAD				1,510	
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 30 days @ $25			750		
b. PER DIEM OR SUBSISTENCE 30 days @ $40			1,200		
TOTAL TRAVEL				1,950	
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
Temperature gradient contractor - drilling and logging - estimate based on recent prices and information requirements.			109,250		
TOTAL CONSULTANTS				109,250	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* CONTINGENCY				17,487	
10. TOTAL DIRECT COST AND OVERHEAD				134,069	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 6 % of cost element Nos. all)*[3]				8,044	
12. ROYALTIES[4]				-	
13. TOTAL ESTIMATED COST				142,113	
14. FEE OR PROFIT				-	
15. TOTAL ESTIMATED COST AND FEE OR PROFIT				142,113	

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

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: AMINOIL USA	SUPPLIES AND/OR SERVICES TO BE FURNISHED: Phase 2 - Seismic Survey
HOME OFFICE ADDRESS: P. O. Box 11279, Santa Rosa, California 95406	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Geothermal Division - Santa Rosa, CA.	TOTAL AMOUNT OF PROPOSAL: $4,083,955
	GOV'T SOLICITATION NO.: RFP ET-78-R-08-0003

DETAIL DESCRIPTION OF COST ELEMENTS - See Attachment

1. DIRECT MATERIAL *(Itemize on Exhibit A)*	EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
a. PURCHASED PARTS			
b. SUBCONTRACTED ITEMS			
c. OTHER—(1) RAW MATERIAL			
(2) YOUR STANDARD COMMERCIAL ITEMS			
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*			
TOTAL DIRECT MATERIAL		-	
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)*		-	

3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)	TOTAL EST COST	REFERENCE
Senior Geologist - Supv & Analysis.	176	$22	3,872		
TOTAL DIRECT LABOR				3,872	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
Payroll Burden.	39%	3,872	1,510		
TOTAL LABOR OVERHEAD				1,510	

5. SPECIAL TESTING *(Including field work at Government installations)*	EST COST ($)	TOTAL EST COST	REFERENCE
TOTAL SPECIAL TESTING		-	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*		-	
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*	EST COST ($)		
a. TRANSPORTATION 30 days at $25	750		
b. PER DIEM OR SUBSISTENCE 30 days at $40	1,200		
TOTAL TRAVEL		1,950	
8. CONSULTANTS *(Identify—purpose—rate)*	EST COST ($)		
Seismic contractor - estimate based on quote from Western Geophysical Company.	138,000		
TOTAL CONSULTANTS		138,000	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* Contingency		21,800	
10. *TOTAL DIRECT COST AND OVERHEAD*		167,132	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate* 6 *% of cost element Nos.* all *)*[3]		10,028	
12. ROYALTIES[4]		-	
13. *TOTAL ESTIMATED COST*		177,160	
14. FEE OR PROFIT			
15. *TOTAL ESTIMATED COST AND FEE OR PROFIT*		177,160	

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

May 21, 1978

ATTACHMENT TO PHASE 2

SEISMIC SURVEY

ESTIMATED COST BASED ON QUOTATION FROM WESTERN GEOPHYSICAL

Data Acquisition

A. Mobilization and demobilization: One day for mobilization, one day for demobilization, to and from Sacramento, California.

Cost $6500 per day. Total Cost $13,000

B. Field Expenses: 30 line miles, using four vibrators, 48 channel system, 12 fold, 165 foot group interval, 16 sweeps per V.P., 4 seconds listening time.

Cost $3500 per line mile; total cost $105,000

C. Ground noise survey: One 10 hour day

Cost $ 6,500

Total Data Acquisition Cost $124,500

Data Processing

Standard, RAP and migrated sections for 30 line miles, $450 per line mile.

Total Data Processing Cost $13,500

Total Expenses charged by Western Geophysical $138,000

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 AMINOIL USA	SUPPLIES AND/OR SERVICES TO BE FURNISHED Phase 3 - Drill and test two 8,000' wells.
HOME OFFICE ADDRESS P. O. Box 11279 Santa Rosa, Calif. 95406	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Geothermal Division - Santa Rosa, CA.	TOTAL AMOUNT OF PROPOSAL $ 4,083,955
	GOV'T SOLICITATION NO. RFP ET-78-R-08-0003

DETAIL DESCRIPTION OF COST ELEMENTS - See Attachment.

	EST COST ($)	TOTAL EST COST[1]	REFERENCE[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*			
a. PURCHASED PARTS			
b. SUBCONTRACTED ITEMS			
c. OTHER—*(1)* RAW MATERIAL			
(2) YOUR STANDARD COMMERCIAL ITEMS			
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*			
TOTAL DIRECT MATERIAL		542,000	
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)*		–	

3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/HOUR	EST COST ($)	TOTAL EST COST	REFERENCE
TOTAL DIRECT LABOR				26,729	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST ($)		
TOTAL LABOR OVERHEAD				10,424	

	EST COST ($)	TOTAL EST COST	REFERENCE
5. SPECIAL TESTING *(Including field work at Government installations)*			
TOTAL SPECIAL TESTING		148,300	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*		932,000	
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			
a. TRANSPORTATION			
b. PER DIEM OR SUBSISTENCE			
TOTAL TRAVEL		13,925	
8. CONSULTANTS *(Identify—purpose—rate)*			
TOTAL CONSULTANTS		26,780	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*		406,179	
10. TOTAL DIRECT COST AND OVERHEAD		2,106,337	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate* 6 *% of cost element Nos.* all *)*[3]		126,380	
12. ROYALTIES[4]		–	
13. TOTAL ESTIMATED COST		2,232,717	
14. FEE OR PROFIT			
15. TOTAL ESTIMATED COST AND FEE OR PROFIT		2,232,717	

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

ATTACHMENT TO PHASE 3

DRILL AND TEST TWO EXPLORATORY WELLS

(All estimates are based on current costs plus approximately 6% annual increase and drilling experience for anticipated conditions).

DESCRIPTION	Well #1	Well #2	Total
1. Direct Materials			
Tangible - Drilling			
a. Casing	95,000	101,000	196,000
b. Tubing	-	-	-
c. Wells and Assembly	11,000	12,000	23,000
d. Other Well Equipment	1,000	1,000	2,000
Intangible - Drilling			
e. Rotary Mud & Chemicals	50,000	53,000	103,000
f. Bits and Reamers	55,000	58,000	113,000
g. Cement and Cementing Services	25,000	27,000	52,000
h. Small Tools and Supplies	3,000	3,000	6,000
i. Fuel, Water and Power	23,000	24,000	47,000
Total Direct Materials	263,000	279,000	542,000
2. Material Overhead (In 11 below)	-	-	-
3. Direct Labor			
a. Sr. Geologist - 176 hrs. per well at $22.	3,872	4,104	7,976
b. Drilling Supt. 352 hrs. per well at $22.	7,744	8,208	15,952
c. Engr/Supv. 40 hrs. per well at $22. - Testing	880	932	1,812
d. Field Test Technician - 40 hrs. per well at $12.	480	509	989
Total Direct Labor	12,976	13,753	26,729
4. Indirect Labor			
a. Payroll Burden - 39% of Direct Labor.	5,060	5,364	10,424
5. Special Testing			
a. Coring - Core Analysis	20,000	21,200	41,200
b. Logging - All types.	30,000	31,800	61,800
c. Geolograph & Mud Logging	22,000	23,300	45,300
Total Special Testing	72,000	76,300	148,300
6. Special Equipment			
a. Drilling Rig Rental with Personnel	348,000	370,000	718,000
b. Other Drilling Equipment Rental	18,000	19,000	37,000
c. Communications	1,000	1,000	2,000
d. Test Separator	140,000	10,000	150,000
e. Test Meter Run & Instruments	20,000	5,000	25,000
	527,000	405,000	932,000
7. Travel			
a. Transportation:			
Sr. Geologist - 30 days per well at $25.	750	795	1,545
Drilling Supt. - 60 days per well at $25.	1,500	1,590	3,090
Engr./Supv. - 7 days per well at $25.	175	185	360
Field Test Tech. - 7 days per well at $25.	175	185	360
b. Subsistence			
As above - 104 days per well @ $40	4,160	4,410	8,570
	6,760	7,165	13,925

PHASE 3 - (Cont'd)

	DESCRIPTION	Well #1	Well #2	Total
8.	Consultants/Contractors			
	a. Local - Installation of Surface Eq.	3,000	3,180	6,180
	b. Local - Surveys Foundations & Roads	10,000	10,600	20,600
		13,000	13,780	26,780
9.	Other Direct Costs			
	a. Moving Rig & Rigging Up	40,000	42,000	82,000
	b. Moving Supplies, Fuel, Pipe etc.	24,000	25,440	49,440
	c. Contingency	144,719	130,020	274,739
		208,719	197,460	406,179
10.	Total Direct Cost & Overhead	1,109,515	996,822	2,106,337
11.	General & Administrative Expense	66,571	59,809	126,380
12.	Royalties	-	-	-
13.	Total Estimated Cost	1,176,086	1,056,631	2,232,717
14.	Fee or Profit	-	-	-
15.	Total Estimated Cost & Fee or Profit	1,176,086	1,056,631,	2,232,717

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: AMINOIL USA

HOME OFFICE ADDRESS: P. O. Box 11279, Santa Rosa, CA 95406

SUPPLIES AND/OR SERVICES TO BE FURNISHED: Phase 4 - Drill and Test 8,000 ft. Injection Well and conduct Long Term Flow Test on one well.

DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: Geothermal Division - Santa Rosa, CA.

TOTAL AMOUNT OF PROPOSAL: $ 4,083,955

GOV'T SOLICITATION NO.: RFP ET-78-R-08-0003

DETAIL DESCRIPTION OF COST ELEMENTS

See Attachment.

	Est Cost ($)	Total Est Cost[1]	Reference[2]
1. DIRECT MATERIAL *(Itemize on Exhibit A)*			
a. PURCHASED PARTS			
b. SUBCONTRACTED ITEMS			
c. OTHER—(1) RAW MATERIAL			
(2) YOUR STANDARD COMMERCIAL ITEMS			
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*			
TOTAL DIRECT MATERIAL		301,000	
2. MATERIAL OVERHEAD[3] *(Rate %X$ base=)*		-	

3. DIRECT LABOR *(Specify)*	Estimated Hours	Rate/Hour	Est Cost ($)	Total Est Cost	Reference
TOTAL DIRECT LABOR				43,421	

4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. Rate	X Base =	Est Cost ($)	Total Est Cost	Reference
TOTAL LABOR OVERHEAD				16,934	

	Est Cost ($)	Total Est Cost	Reference
5. SPECIAL TESTING *(Including field work at Government installations)*			
TOTAL SPECIAL TESTING		76,300	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*		632,000	
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			
a. TRANSPORTATION			
b. PER DIEM OR SUBSISTENCE			
TOTAL TRAVEL		31,005	
8. CONSULTANTS *(Identify—purpose—rate)*			
TOTAL CONSULTANTS		13,780	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*		256,222	
10. TOTAL DIRECT COST AND OVERHEAD		1,370,662	
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate 6 % of cost element Nos. all)*[3]		82,239	
12. ROYALTIES[4]		-	
13. TOTAL ESTIMATED COST		1,452,901	
14. FEE OR PROFIT		-	
15. TOTAL ESTIMATED COST AND FEE OR PROFIT		1,452,901	

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

ATTACHMENT TO PHASE 4

DRILL & TEST INJECTION WELL AND CONDUCT NINE MONTH FLOW TEST ON A WELL

DESCRIPTION	INJECTION WELL	FLOW TEST	TOTAL
1. Direct Materials			
Tangible Drilling			
a. Casing	101,000		
b. Tubing	22,000		
c. Wellhead Assembly	12,000		
d. Other Well Equipment	1,000		
Intangible			
e. Rotary Mud & Chemicals	53,000		
f. Bits & Reamers	58,000		
g. Cement & Cementing Services	27,000		
h. Small Tools & Supplies	3,000		
i. Fuel, Water & Power	24,000		
Total Direct Materials	301,000	See 6 below	301,000
2. Material Overhead (In 11 below)	-	-	-
3. Direct Labor			
a. Sr. Geologist - 176 hrs. @ $22 plus 6%.	4,105		4,105
b. Drilling Supt. - 352 hrs. @ $22 plus 6%.	8,210		8,210
c. Aminoil Engr./Supv. - 2 months (352 hrs. @ $22 plus 6%).		8,210	8,210
d. Field Technician - 1 week for well test, 10 mos. for flow test (40 hrs.x 12 - 1760 hrs. x $12 plus 6%).	509	22,387	509 22,387
	12,824	30,597	43,421
4. Labor Overhead			
a. Payroll Burden - 39% of Direct Labor	5,001	11,933	16,934
5. Special Testing			
a. Coring - Core Analysis	21,200	-	21,200
b. Logging - All Types	31,800		31,800
c. Geolograph & Mud Logging	23,300		23,300
	76,300	-	76,300
6. Special Equipment			
a. Drilling Rig Rental with Personnel	370,000	-	370,000
b. Other Drilling Equip. Rental	19,000		19,000
c. Communications	1,000	2,000	3,000
d. Test Separator	10,000		10,000
e. Test Meter Run & Instruments	5,000		5,000
f. Pipeline - Test Well to Injection Well		225,000	225,000
	405,000	227,000	632,000
7. Travel			
a. Transportation:			
Sr. Geologist - 30 days @ $25 plus 6%.	795		795
Drilling Supv. - 60 days @ $25 plus 6%.	1,590		1,590
Engr/Supv. - 60 days @ $25 plus 6%.		1,590	1,590
Field Tech. - 300 " " " " "		7,950	7,950
b. Subsistence - 450 days @ $40 plus 6%.	3,816	15,264	19,080
	6,201	24,804	31,005

	DESCRIPTION	INJECTION WELL	FLOW TEST	TOTAL
8.	Consultants/Contractors			
	a. Local - Installation of Surface Equi.	3,180		3,180
	b. Local - Surveys, Foundations & Roads	10,600		10,600
		13,780	-	13,780
9.	Other Direct Costs			
	a. Moving Rig & Rigging Up	42,000	-	42,000
	b. Moving Supplies, Fuel, Pipe etc.	25,440	10,000	35,440
	c. Contingency	133,132	45,650	178,782
		200,572	55,650	256,222
10.	Total Direct Cost & Overhead	1,020,678	349,984	1,370,662
11.	General & Administrative Expense	61,240	20,999	82,239
12.	Royalties	-	-	-
13.	Total Estimated Cost	1,081,918	370,983	1,452,901
14.	Fee or Profit	-	-	-
15.	Total Estimated Cost & Fee or Profit	1,081,918	370,983	1,452,901

D. Business and Management

1. Previous Experience

Aminoil USA, Inc. is a wholly owned subsidiary of Aminoil International, Inc. which in turn is a wholly owned subsidiary of R. J. Reynolds Industries. American Independent Oil Company (Aminoil), which was the predecessor to Aminoil USA, Inc., was originally founded in 1948 by a number of small independent American oil companies including Phillips, Signal, Ashland and others. Aminoil was primarily engaged in international exploration and production activities in the Middle East but was also active in South America, Indonesia and the North Sea. Aminoil's Kuwait operation consisted of producing and refining approximately 90,000 B/D while their interest in the Iranian Consortium totaled approximately 43,000 B/D.

Aminoil was acquired by R. J. Reynolds Industries in 1970 and in 1976, Aminoil acquired Burmah Oil and Gas Company. Burmah, which had acquired Signal Oil and Gas Company in 1974 had production capabilities of approximately 45,000 B/D of oil and 116,000,000 CF/D of gas, primarily in California but also in Louisiana and Texas. The Signal Company, founded in 1922 at Signal Hill, was an active domestic and international exploration, development, refining and marketing company with refineries in the U.S., West Germany and Belgium and service station marketing facilities in the U.S., Belgium and England.

As of January 1, 1978, Aminoil USA, Inc. had gross United States lands under lease in excess of two million acres and in 1977 its domestic production was 15.6 million barrels of crude oil and 39.5 billion cubic feet of natural gas. The Company presently markets gasoline, natural gas liquid products, distillates and residual fuel oils in 21 states in the United States. In 1977 the combined wholesale and retail sales of these products amounted to 267.6 million gallons of gasoline, 370.5 million gallons of natural gas liquid products, and 282.5 million gallons of distillate and residual fuel oil.

<u>Oil and Gas Activities</u>
Aminoil USA, Inc. (or its predecessor companies) in the past has been engaged in petroleum exploration, drilling or production operations in Venezuela, Iran, Tunisia, Italy, West Germany, Mexico, Australia, Guatemala, Canada, Kuwait, Abu Dhabi, Indonesia, Jamaica, Netherlands, United Kingdom, Colombia, Spain, Norway, Ghana, Peru, Bolivia, Nicaragua, Honduras, Ethiopia, and Argentina. At the present time, Aminoil USA, Inc. activities are restricted to petroleum exploration in the United States.

Aminoil USA, Inc., a pioneer in directional drilling, began developing the Huntington Beach, California, offshore field from upland drillsites in 1938. Over 900 directional wells and redrills have been completed, some with horizontal deviations of over two miles. Water flooding of the two zones offshore Huntington Beach has resulted in the recovery of nearly 90 million barrels of additional oil. The current water injection rate of 350,000 barrels per day makes this the third largest water-flood in the United States.

Aminoil USA, Inc. has participated in the drilling of nearly 500 wells in the Gulf of Mexico and was responsible for the construction and installation of 22 drilling and production platforms, two onshore receiving stations and five sub-sea pipelines.

A pilot steam injection secondary project was initiated in a heavy oil zone at Huntington Beach, California, in 1964. Oil production increased from a rate of 150 barrels per day in 1964 to 1900 barrels per day in 1969. Production has been maintained between 1500 and 1800 barrels per day since 1969 by continually adding wells, replacing wells, and steaming wells.

In addition to the major construction work connected with oil and gas well drilling and producing, Aminoil USA, Inc. has been involved in gas plant, refinery and pipeline construction and operation both onshore and offshore.

A pilot in situ forward combustion project was started in the Santa Maria Valley, California, oil field in 1964. Although a favorable initial production response was obtained, the project was shut down prematurely in 1966 because of air pollution problems.

Preliminary work on a pilot Tertiary recovery alkaline flood project began in 1977 at Huntington Beach, California. The Department of Energy has obligated $499,400 under Contract No. EF-77-C-03-1476 in return for reservoir engineering information obtained from the redrilling of an injection well.

Geothermal Activities

Aminoil USA, Inc. has completed over 40 geothermal wells in the Geysers area of California, of which 24 are capable of commercial production. A contract has been signed with Pacific Gas and Electric Company for the purchase of steam from some of Aminoil's productive holdings. PGandE is currently constructing one 135 MW electrical generating plant (world's largest geothermal plant) and have another

110 MW plant in the permitting stage which will use steam from Aminoil's wells. The Company has a total of approximately 166,000 net acres under lease in the United States which have geothermal potential.

Other Activities

Aminoil USA, Inc. is, or has been, involved in the operation of three experimental tar sand extraction projects. These are located at Edna, California; Sunnyside and Asphalt Ridge, Utah. Work on the original Edna project dates back to 1948. Currently an in situ oil shale process is being field tested in Utah in a joint venture with Geokinetics, Inc. The Department of Energy is participating in the oil shale project under Cooperative Agreement ET-76-A-03-1787.

Technical Personnel

Aminoil USA, Inc. has over 1,000 people employed in various offices including those located in Houston and Midland, Texas; Denver, Colorado; Santa Rosa and Huntington Beach, California; Lafayette and New Orleans, Louisiana. The Aminoil USA, Inc. Production Department has the following technical personnel:

Petroleum Engineers	7
Development Geologists	17
Reservoir Engineers	14
Drilling Engineers	4
Chemical Engineers and Chemist	4
Construction Engineers	8
Production Engineers	19
Gas Engineers	5
Environmental Engineers	1
Enhanced Recovery Engineers	1
Total	80

In addition to the above, the Exploration Department employs 27 geologists and 15 geophysicists.

Aminoil USA, Inc. operates numerous joint ventures and has all support functions well staffed, which includes purchasing, exploration, land, environmental, tax, legal, accounting and computer facilities.

2. Principle Program Personnel

The Geothermal Resources Division of Aminoil USA, Inc. will assign personnel as needed to assist in carrying out this program from the attached organization chart (see Exhibit No. 4).

The persons who will be directly responsible for various functional activities are listed below; their individual resumes are listed following the organization chart.

Mr. Claude B. Jenkins	-	Project Manager
Mr. William M. House	-	Operations Manager
Mr. Walter W. Turnbull	-	Accounting
Mr. Carl E. Woods	-	Environmental
Mr. James M. Grubb	-	Geology
Mr. George A. Frye	-	Production/Reservoir Engineering

3. The management plan for this project is to negotiate a contract between DOE and Aminoil in which each organization agrees to pay its 50% share for both existing and new data to be acquired and then to sequentially conduct the four major Phases of the plan as indicated on the Activity Schedule unless DOE or Aminoil has not approved their continued participation as required at the major decision points. Throughout the program, technical guidance and supervision will be provided from Aminoil's Santa Rosa, California office with support from Aminoil's field and staff people in other locations as required. The use of consultants, service companies and outside contractors is planned as indicated.

Specific plans for each Phase are as follows:

Phase I - Utilize outside contractors to drill and log 8-500 foot and 2-1000 foot temperature gradient holes. The interpretation, mapping and supervision of this phase will be conducted by Aminoil geologists.

Phase II - Utilize an outside contractor to shoot and interpret 30 miles of seismic reflection; Aminoil geologists and geophysicists would supervise this work.

Phase III - Depending upon the results of Phase I and Phase II, specific optimum deep well location sites would be selected for the two best geothermal prospects. This will probably call for the drilling of one well at Leach Hot Springs and one well on the Panther Canyon anomaly. An outside drilling contractor would be utilized as well as multiple third party contractor services for cementing, mud, logging, etc. Aminoil drilling engineers, under the direction of the Operations Manager, would supervise drilling operations while Aminoil geologists would conduct and/or supervise geological activities.

Phase IV - If one or more of the wells in Phase III encounter commercial geothermal production, a deep injection well plus both short and long term production testing may be deemed advisable by both DOE and Aminoil. Again, an outside drilling contractor under the supervision of Aminoil personnel would be utilized. The short and long term production test facilities would be built by outside contractors while the tests themselves would be run and/or supervised by Aminoil engineers.

Concurrent with the conduct of Phase I and Phase II of this program, Aminoil will be proceeding with their attempts to form one or more Federal Unit areas to facilitate exploration and development efforts. As indicated under sections B. 1. a. and B. 1. b. of the technical proposal, approximately 95% of the lessees or applicants of record have agreed to pursue the formation of such a unit or units.

There are four major decision points in the program as indicated on the Activity Schedule. The first decision point is reached when DOE and Aminoil execute a contract wherein DOE agrees to reimburse Aminoil 50% of the cost for existing data, Phase I and Phase II. The second decision point is after data from Phase I and Phase II has been obtained and reviewed by both DOE and Aminoil and there is mutual agreement to proceed with the drilling of the first 8000 foot deep test. The third decision point is when sufficient data has become available from the first deep test to satisfy both DOE and Aminoil that a second deep test is warranted. The fourth decision point is dependent upon mutual agreement between DOE and Aminoil that the data obtained from the two deep tests warrant the drilling of an injection well to permit production testing for reservoir evaluation.

During the drilling phase of the program, daily reports giving the current total depth, footage made during the previous day and/or over the weekend and the current well status will be TWX'd or telephoned to the DOE technical representative. During the entire program, a monthly Technical Progress Report will be prepared which will give brief, factual descriptions of the overall progress on each major phase of the program. A Progress Status Report shall be prepared quarterly to summarize accomplishments/problems of each phase of the program during the preceeding quarter. A Final Technical Report will be prepared summarizing the results of each phase of the program upon completion of the entire program.

A Cost Plan for the project will be submitted upon contract execution which shall be the base line for comparing costs and program progress. A Cost Management Report will be prepared monthly and show estimated, actual and projected cost for each phase of the program.

The schedule for releasing data to the public for both existing and to be acquired data is shown on the Data Public Release Schedule. DOE will be delivered Data as acquired and on a current basis.

4. During normal business hours the personnel below can be contacted at 707/527-5332. The mailing address for the Geothermal Resources Division of Aminoil USA, Inc. and each of the below is P. O. Box 11279, Santa Rosa, CA 95406:

C. B. Jenkins	-	Management
W. M. House	-	Operations
J. M. Grubb	-	Geology
G. A. Frye	-	Engineering
W. W. Turnbull	-	Accounting

5. The draft contract provisions as shown in RFP No. ET-78-R-08-0003 dated March 31, 1978 are considered acceptable as the basis for contract negotiations.

6. The "Program Technical Scope" set forth in RFP No. ET-78-R-08-0003 has been reviewed and all data furnished pursuant to a contract may be published in accordance with the Data Public Release Schedule.

7. The 1977 Annual Report by R. J. Reynolds Industries (wholly owns Aminoil USA, Inc.) is attached as Exhibit No. 5.

8. This proposal will remain in effect at least until October 1, 1978.

CERTIFIED COPY OF RESOLUTION

I, David M. Whitney, Assistant Secretary, of Aminoil USA, Inc. (formerly Aminoil Resources, Inc.), a corporation organized and existing under the laws of the State of Delaware, do hereby certify that pursuant to unanimous consent of all of the Directors of said corporation on December 31, 1976, the following resolution was adopted and is now in full force and effect:

> RESOLVED: That the President and Chief Executive Officer, the Executive Vice President or a Vice President, together with the Secretary or an Assistant Secretary of this Corporation be, and they hereby are, empowered to execute all documents, instruments and papers requiring execution in the name of this Corporation, and the Secretary or an Assistant Secretary of this Corporation is hereby authorized to affix the seal of this Corporation to such documents, instruments or papers as require a seal, and each of said persons is hereby empowered to acknowledge and deliver any such instruments as fully as if special authority were granted in each particular instance.

IN WITNESS WHEREOF, I have hereunto set my hand and the seal of said corporation this 19th day of May, 1978.

David M. Whitney

CERTIFICATE OF INCUMBENCY
AND RESOLUTION

I, the undersigned, David M. Whitney, Assistant Secretary of AMINOIL USA, INC., a corporation organized and existing under the laws of the State of Delaware, do hereby certify that the persons named below have been duly elected and appointed and this day are the directors and officers of AMINOIL USA, INC. holding the respective offices set forth opposite their names.

DIRECTORS

Robert A. Bussian	George K. Ross
Howard L. Clark	W. H. Schell
J. Dwayne Taylor	George W. Dawson
George E. Trimble	P. Fred Sollars

OFFICERS

J. Dwayne Taylor	Chairman of the Board of Directors
George E. Trimble	President and Chief Exec. Officer
Howard L. Clark	Senior Vice President
Robert A. Bussian	Vice President, Secretary and General Counsel
George K. Ross	Vice President, Finance
W. H. Schell	Vice President, Production
P. Fred Sollars	Vice President, Exploration
J. T. Rice	Vice President, Employee Relations
John M. Moore	Vice President, Land
Mark R. Wellman	Treasurer
Paul W. Cain	Controller
Leo C. Wilkerson	Assistant Secretary
Tom P. Smith	Assistant Secretary
David M. Whitney	Assistant Secretary
J. H. Loeb	Assistant Secretary
N. D. Young	Assistant Secretary
E. W. Richie, Jr.	Assistant Treasurer
C. W. Straw	Assistant Treasurer
D. A. Peppers	Assistant Treasurer
H. J. Wherley	Assistant Treasurer
J. W. Dowdle	Assistant Treasurer
Robert Bennett, Jr.	Assistant Treasurer
Zachary Smith	Assistant Treasurer
E. B. Hall	Assistant Treasurer
A. H. Ness	Assistant Controller

I FURTHER HEREBY CERTIFY THAT the following resolution was duly adopted by written consent of the Board of Directors of the Corporation on December 31, 1976, and is now in full force and effect:

RESOLVED: That the President and Chief Executive Officer, the Executive Vice President or a Vice President, together with the Secretary or an Assistant Secretary of this Corporation be, and they hereby are empowered to execute all documents, instruments and papers requiring execution in the name of this Corporation, and the Secretary or an Assistant Secretary of this Corporation is hereby authorized to affix the seal of this Corporation to such documents, instruments or papers as require a seal, and each of said persons is hereby empowered to acknowledge and deliver any such instruments as fully as if special authority were granted in each particular instance.

I FURTHER HEREBY CERTIFY THAT there are no laws or provisions in the Certificate of Incorporation or Bylaws of said Corporation limiting the power of the Board of Directors to pass the foregoing Resolution and that same are in conformity with the laws and provisions of said Certificate of Incorporation and Bylaws.

IN WITNESS WHEREOF, I have hereunto set my hand and the seal of said Corporation this 19th day of May, 1978.

David M. Whitney
Assistant Secretary

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)*
Aminoil USA, Inc/
1250 Coddington Center
Santa Rosa, California 95401

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 ... Delaware

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 [X] 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 [X] 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? [X] 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)*
R.J. Reynolds Industries, Inc.	RJR World Headquarters Reynolds Boulevard Winston-Salem, North Carolina 27102

(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
	56-0950247	62-0978410

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 [X], 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): None

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:

*not yet known

NAME OF CONTRACTOR	DATE	FEDERAL AGENCY
Aminoil USA, Inc. (include known first-tier subcontractors)	July 8, 1977	Department of Interior

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, [ ] 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: Aminoil USA, Inc.

Name: W. H. Schell

Date: May 30, 1978

Title: Vice President - Production

EXHIBIT 1

Legal Description and Land Status

FEDERAL LANDS:

Lessor	Lessee	Lease Date	Description	Acres
N-13896	Aminoil USA	6/1/77	T. 32 N., R. 38 E., M.D.M. Sec. 13: All Sec. 14: All Sec. 24: All T. 32 N., R. 39 E., M.D.M. Sec. 18: N½, N½S½, S½SW¼, SW¼SE¼	2520.00
N-13897	Aminoil USA	6/1/77	T. 31 N., R. 38 E., M.D.M.,(Pro Dia.No.129) Sec. 2: Lots 1,2,3,4, S½N½, S½ (All) T. 32 N., R. 38 E., M.D.M. Sec. 23: All Sec. 26: All Sec. 35: NE¼NE¼, W½E½, W½, SE¼SE¼	2482.42
N-13898	Aminoil USA	6/1/77	T. 31 N., R. 39 E., M.D.M. (Pro Dia.No.129) Sec. 5: All T. 32 N., R. 39 E., M.D.M. Sec. 19: All Sec. 29: All Sec. 32: All	2609.00
N-13899	Aminoil USA	6/1/77	T. 32 N., R. 38 E., M.D.M. Sec. 25: All Sec. 36: N½N½ T. 32 N., R. 39 E., M.D.M. Sec. 30: All Sec. 31: All	2080.00
N-13900	Aminoil USA	6/1/77	T. 31 N., R. 38 E., M.D.M. (Pro Dia.No.129) Sec. 1: Lots 1,2,3,4, S½N½, S½(all) Sec. 12: All T. 31 N., R. 39 E., M.D.M (Pro Dia No. 129) Sec. 6: Lots 1 thru 7, S½NE¼, SE¼NW¼, E½SW¼, SE¼ (All) Sec. 7: Lots 1,2,3,4, E½, E½W½ (all)	2554.79

Lessor	Lessee	Lease Date	Description	Acres
N-17456	Aminoil USA	*	T.32 N. R. 39 E., M.D.M. Sec. 17: N½N½, S½NW¼, SW¼NE¼, NW¼SW¼ SE¼SW¼, S½SE¼, and NE¼SE¼ Sec. 20: All T. 32 N., R. 38 E., M.D.M. Sec. 33: E½, SW¼ Sec. 34: All	2240.00
N-17457	Aminoil USA	*	T. 31 N., R 38 E., M.D.M. Sec. 3: All Sec. 4: All Sec. 9: S½ Sec. 16: All	2240.00
N-11923	Sidney E. Glenn	6/1/76	T. 31 N., R. 38 E., M.D.M. (Pro Dia.No.129) Sec. 10: All Sec. 23: All Sec. 34: All Sec. 36: All	2560.00
N-11924	Sidney E. Glenn	6/1/76	T. 30 N., R 38 E., M.D.M. Sec. 14: All Sec. 15: All Sec. 23: Lots 1,2,3,4, N½S½, N½(All) Sec. 24: Lots 1 thru 7, W½NE¼, NW¼, N½SW¼, NW¼SE¼ (All)	2552.50
N-11925	Sidney E. Glenn	6/1/76	T. 31 N., R. 38 E., M.D.M. (Pro Dia.No.129) Sec. 11: All Sec. 22: N½, SW¼, N½SE¼, SE¼SE¼ Sec. 35: All T. 30 N., R. 38 E., M.D.M. Sec. 1: Lots 3-9, SW¼NE¼, S½NW¼, SW¼, W½SE¼ (All)	2509.22
N-11926	Sidney E. Glenn	6/1/76	T. 30 N., R. 38 E., M.D.M. Sec. 3: Lots 1,2,3,4, S½N½, S½ (All) T. 31 N., R. 38 E., M.D.M. (Pro.Dia. No. 129) Sec. 15: All Sec. 25: N½NE¼, SE¼NE¼, NW¼, S½ Sec. 27: All	2525.92

essor	Lessee	Lease Date	Description	Acres
N-11927	Sidney E. Glenn	6/1/76	T. 30 N., R. 38 E., M.D.M. Sec. 11: All Sec. 13: Lots 1,2,3,4, W½E½, W½ (All) Sec. 22: Lots 1,2,3,4, N½S½, N½ (All) T. 31 N., R. 38 E., M.D.M. (Pro.Dia. No. 129) Sec. 26: All	2561.11
N-11928	Sidney E. Glenn	6/1/76	T. 30 N., R. 38 E., M.D.M. Sec. 2: Lots 1,2,3,4, S½N½, S½ (All) Sec. 10: All Sec. 12: Lots 1,2,3,4, W½E½, W½ (All)	1914.76
N-12129	Sidney E. Glenn	7/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 8: All Sec. 16: All	1308.00
N-12130	Sidney E. Glenn	7/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 17: All	640.00
N-12130-A	G. Martin Booth III	7/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 21: NE¼, NE¼NW¼, S½NW¼, S½ Sec. 27: N½, W½SW¼, SE¼SW¼, SE¼	1200.00
N-12131	Sidney E. Glenn	7/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 20: All	640.00
N-12131-A	G. Martin Booth III	7/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia No. 129) Sec. 22: N½, W½SW¼, SE¼SW¼, SE¼	598.00
N-12645	Sidney E. Glenn	8/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 33: E½SW¼ Sec. 35: N½, N½S½, SW¼SW¼	600.00
12645-A	G. Martin Booth III	8/1/76	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 33: N½, SE¼ Sec. 34: N½NE¼, SE¼NE¼, W½, SE¼	1080.00

essor	Lessee	Lease Date	Description	Acres
N-12646	Sidney E. Glenn	8/1/76	T. 31 N., R 39 E., M.D.M. Sec. 15: All Sec. 23: All Sec. 26: All	1916.00
N-12892	G.Martin Booth III	4/1/77	T. 31 N., R. 39 E., M.D.M. Sec. 29: N½, E½SE¼ Sec. 30: Lots 1,2,3,4, NE¼, E½W½ Sec. 31: Lots 1,2,3,4, E½W½ Sec. 32: NE¼NE¼	1238.56
N-12892	G. Martin Booth III	**	T. 31 N., R. 39 E., M.D.M. Sec. 29: N½SW¼, W½SE¼ Sec. 30: SE¼ Sec. 31: E½ Sec. 32: SW¼NW¼, SW¼	840.00
N-13322	G. Martin Booth III	8/1/77	(Pro Dia.No. 285) T. 30 N., R. 39 E., M.D.M./ Sec. 3: Lots 1,2,3,4, S½N½, S½ (all) Sec. 4: Lots 1,2,3,4, S½N½, S½ (all) Sec. 5: Lots 1,2,3,4, S½N½, S½ (all) Sec. 6: Lots 1,2,3,4, S½NE¼, SE¼NW¼, S½, (all)	2535.02
N-13323	G. Martin Booth III	8/1/77	T. 31 N., R. 39 E., M.D.M. (Pro. Dia. No. 129) Sec. 12: All Sec. 13: All Sec. 14: All T. 31 N., R. 40 E., M.D.M. Sec. 7: Lots 1,2,3,4, E½, E½W½ (all)	2559.48
N-15774	William N. Bucklin III	11/1/77	T. 31 N., R. 38 E., M.D.M. Sec. 13: All Sec. 24: All T. 31 N., R. 39 E., M.D.M. Sec. 18: Lots 1,2,3,4, E½, E½W½ (All) Sec. 19: Lots 1,2,3,4, E½, E½W½ (All)	2555.04
N-15777	G. Martin Booth III	11/1/77	T. 31 N., R. 39 E., M.D.M. Sec. 28: All	640.00
N-18649	G. Martin Booth III	*	T. 31 N., R. 38 E., M.D.M. Sec. 14: All	640.00

*Application to Lease Geothermal Resources Pending

Total Federal Lands 50,339.82

**Application to Lease Geo. Res. Pending (Stock Raising Homestead Act of 1916 lands)

LEASED PRIVATE LANDS:

ssor	Lessee	Lease Date	Description	Acres
Allied Properties	Union Oil Co.	10/31/73	T. 32 N., R. 38 E., M.D.M. Sec. 36: E½SW¼, SE¼NW¼, S½NE¼, SE¼ T. 32 N., R. 39 E., M.D.M. Sec. 18: SE¼SE¼ T. 31 N., R. 39 E., M.D.M. Sec. 32: SE¼SE¼ Sec. 33: SW¼SW¼	480.00
Burke, et ux.	Union Oil Co.	12/31/74	T. 32 N., R. 38 E., M.D.M. Sec. 35: SE¼NE¼, NE¼SE¼ Sec. 36: SW¼NW¼, W½SW¼	200.00
Woolfolk, et ux.	Union Oil Co.	11/6/73	T. 31 N., R. 39 E., M.D.M. Sec. 29: S½SW¼ Sec. 32: N½NW¼, SE¼NW¼, W½NE¼, SE¼NE¼ W½SE¼, NE¼SE¼ Sec. 33: NW¼SW¼	480.00
rke, et al.	Aminoil USA, Inc.	5/17/78	T 31 N., R. 38 E., M.D.M. Sec. 22: SW¼SE¼ Sec. 25: SW¼NE¼ T. 31 N., R. 39 E., M.D.M. Sec. 21: NW¼NW¼ Sec. 22: NE¼SW¼ Sec. 27: NE¼SW¼	200.00

Total Leased Private Lands 1360 acres

UNLEASED PRIVATE LANDS

Description	Acres
T. 32 N., R 39 E., M.D.M.	160
Section 17: SW¼SW¼, NE¼SW¼, NW¼SE¼, SE¼NE¼	
T. 32 N., R. 38 E., M.D.M.	
Section 33: NW¼	160
T. 31 N., R. 38 E., M.D.M.	
Section 9: N½	320
T. 31 N., R. 39 E., M.D.M.	
Section 34: SW¼NE¼ Section 35: SE¼SW¼, S½SE¼	160
Total Private Unleased Lands	800 acres

LEGAL DESCRIPTION

PROPOSED UNIT AGREEMENT

T. 32 N., R. 38 E., M.D.M.

All of Sections: 13, 14, 23, 24, 25, 26, 33, 34, 35, and 36

T. 32 N., R. 39 E., M.D.M.

All of Sections: 17, 18, 19, 20, 29, 30, 31, and 32

T. 31 N., R. 38 E., M.D.M.

All of Sections: 1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, 24, 25, 26, 27, 34, 35, and 36

T. 31 N., R. 39 E., M.D.M.

All of Sections: 5, 6, 7, 8, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 29, 30, 31, 32, 33, 34, and 35

T. 31 N., R. 40 E., M.D.M

Section 7: All

T. 30 N., R. 38 E., M.D.M.

All of Sections: 1, 2, 3, 10, 11, 12, 13, 14, 15, 22, 23, and 24

T. 30 N., R. 39 E., M.D.M.

All of Sections: 3, 4, 5, and 6

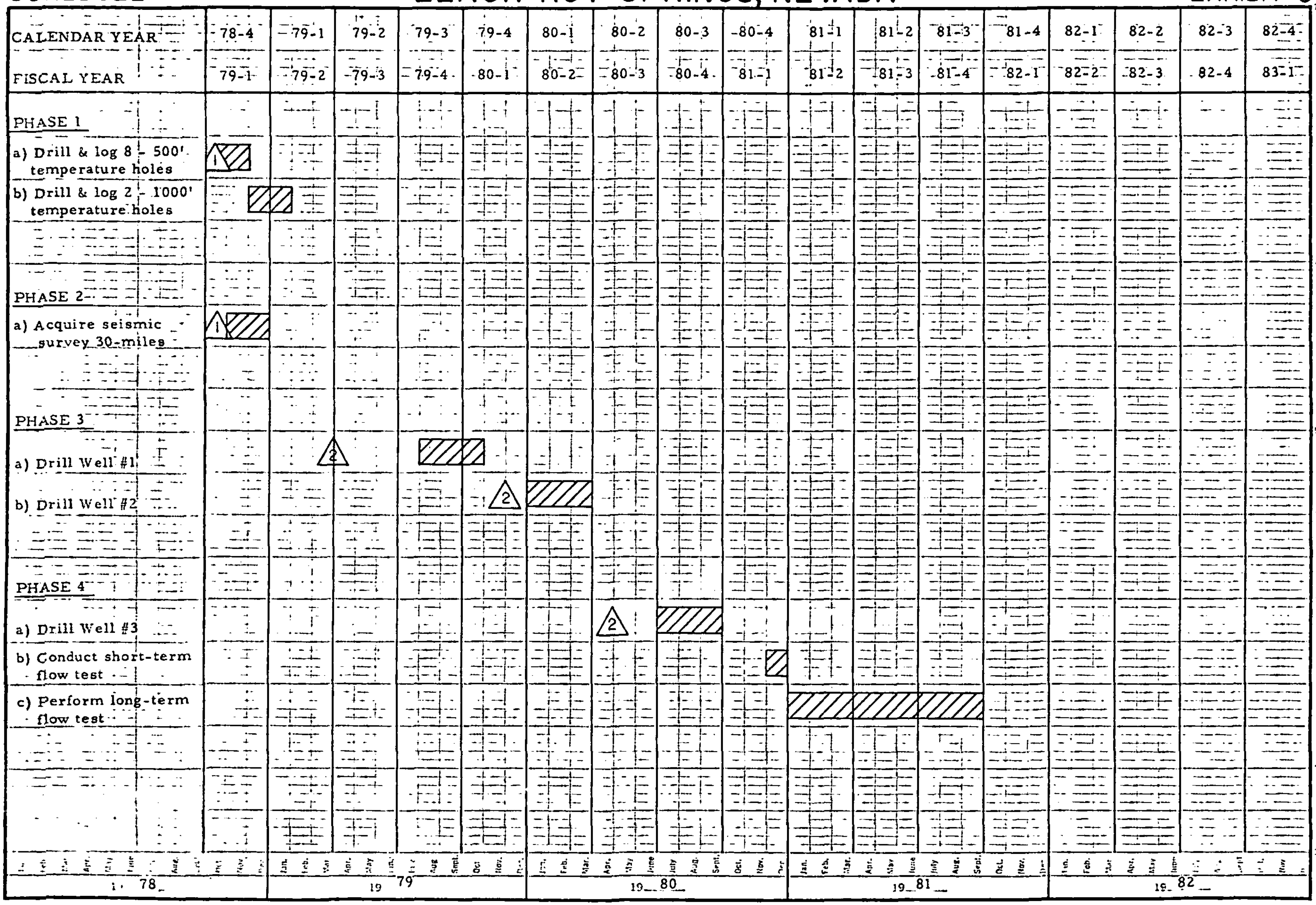
Containing in all: 52,499.82 ± acres

ACTIVITY SCHEDULE

AMINOIL USA, INC.

LEACH HOT SPRINGS, NEVADA

EXHIBIT 3



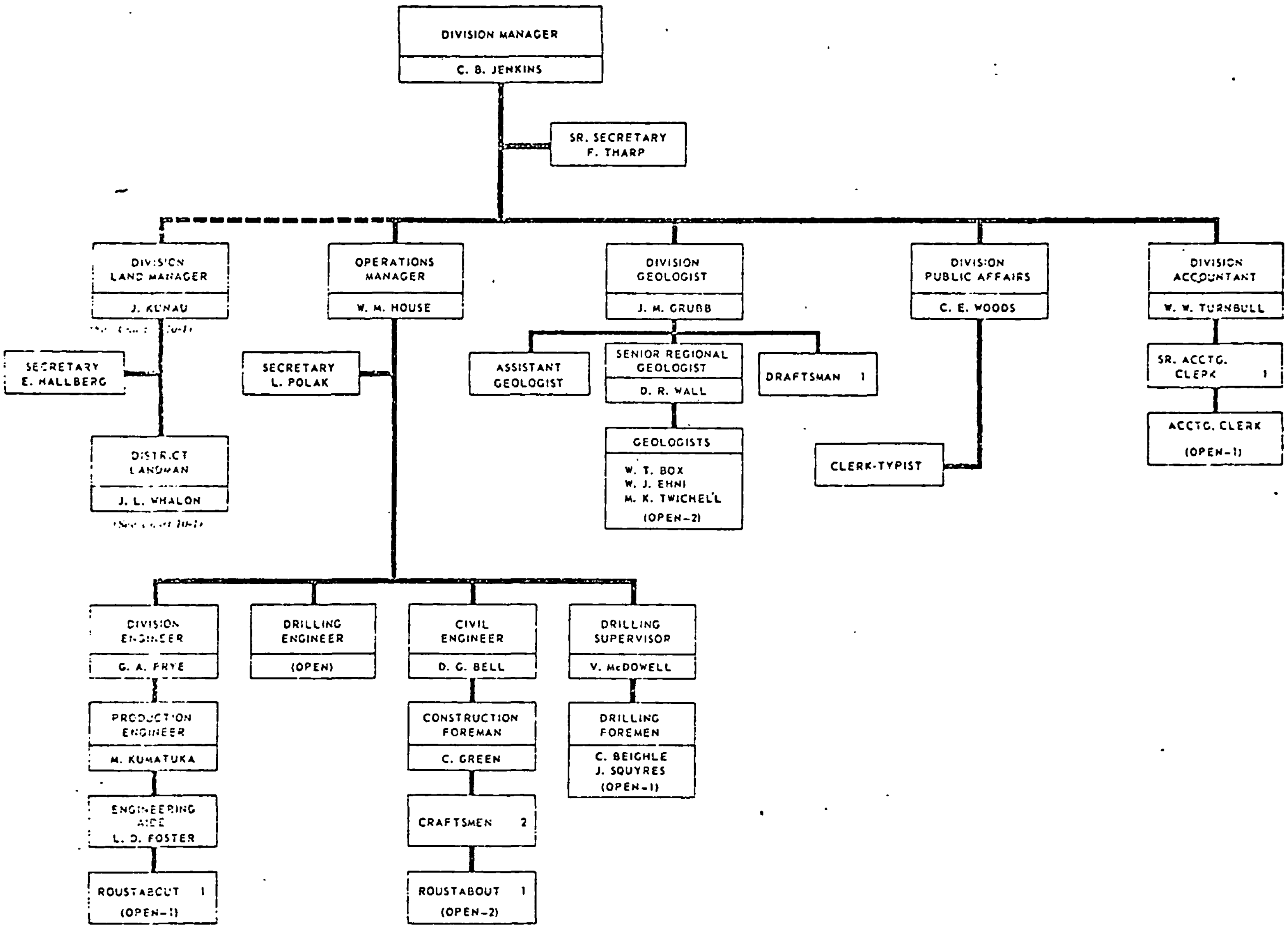
Decision Points

△1 DOE agreement to fund 50% of program

△2 Dependent on mutual agreement between DOE and AUSA to proceed

5/23/78

EXHIBIT 3



AMINOIL USA	DECEMBER 31, 1977	PRODUCTION DEPARTMENT GEOTHERMAL RESOURCES	CHART 15-3

CLAUDE B. JENKINS
Manager, Geothermal Resources Division - Aminoil USA, Inc.

EDUCATION: A.A., 1949, Glendale College, California.
Geological Engineering Degree, 1952 - Colorado School of Mines.
M.B.A. 1958, University of Denver, Colorado.
L.L.B. 1964, La Salle University.
Executive Management Seminar, 1975 - Columbia Graduate School.
Blake Grid Management Seminar, 1978 - Houston.
Additional specialized courses in Geological, Geophysical, Reservoir Engineering and Data Processing.

WORK EXPERIENCE:

Aminoil USA, Inc./American Independent Oil Company (14 years)

January, 1977 to date: Manager, Geothermal Resources Division. Responsible for directing all administrative, accounting, land acquisitions, geology and geophysical, environmental studies and public affairs, engineering, construction, and drilling operations. Principal operations in the Geysers Area of Northern California, but also active in Nevada, Utah, New Mexico and Oregon.

1973 to 1977: Deputy General Manager of Aminoil's Kuwait/Neutral Zone operation. Responsible for most administrative and all operational aspects including exploration, drilling, production, pipeline, refinery, storage terminal and marine facilities. Over 500 wells involved producing approximately 180,000 B/D with pipelines and processing through 144,000 B/D refinery including 35,000 B/D residual desulphurization unit. Storage facilities in excess of 5 million barrels with two off-shore marine loading berths. Personnel supervised - 900.

1968 to 1973: Manager of Operations. Responsible for monitoring and coordinating exploration and production operations in Kuwait/Neutral Zone for corporate headquarters. Participated in concession negotiations and operationally responsible for exploration/drilling activities in Abu Dhabi, Saudi Arabia, Equador and Indonesia. Vice President and General Manager of Aminoil Indonesia, Inc. supervising the drilling of three off-shore wells in the Indian Ocean and Sunda Strait.

1964 to 1968: Chief Petroleum Economist. Responsible for preparing and reviewing project economic analyses, budgets and long term forecasts.

Core Laboratories, Inc, (3 years)

1961 to 1964: Sr. Geologist/Reservoir Engineer. Performed geological and engineering analyses of both U.S. and foreign properties. Extensive work on Zarzaitine Field in Algeria, Gialo Field in Libya, and Arabina Gulf off-shore concession evaluations.

Petrobras (National Brazilian Oil Company) - 3 years

1959 to 1961: Development geologist responsible for directing development program on Aqua Grande, largest oil field in Brazil. Also participated in development programs of all other oil fields in Bahia Basin of Brazil.

McElroy Ranch Company (4 years)

1955 to 1959: Project geologist. Conducted regional and geological studies in Central and West Texas and the Rocky Mountain area. Made prospect analyses, sat on wells and supervised casing programs. Conducted surface field mapping and aerial photography studies.

REGISTRATIONS:

Registered Professional Engineer, State of Texas - Certificate No. 21119.

PUBLICATION:

"New Concept in Geothermal Steam Pricing", 1978.

PROFESSIONAL AFFILIATIONS:

American Association of Petroleum Geologists.
Society of Petroleum Engineers, AIME.

W. M. HOUSE

OPERATIONS MANAGER - AMINOIL USA, INC.

EDUCATION: B.S., 1943, Petroleum Engineering, University of California-Berkeley. Additional courses in Aeronautical Engineering, 1943, Yale University, New Haven, Connecticut; Structural Engineering courses 1944, University of Illinois, Champagne, Illinois.

Other Training - attended schools on Drilling Mud; Electrical Logging; Oilwell Cementing; Well Completion; Well Testing; Well Control; Directional Drilling; Petroleum Safety; Geothermal Technology, also completed the Louis Allen Management Training Program and the Management Grid School.

MILITARY EXPERIENCE: Entered U. S. Air Force 1943 - discharged 1946 with rank of Captain.

WORK EXPERIENCE:

Aminoil USA, Inc., Burmah Oil and Gas Company, and Signal Oil and Gas Company (thirty-two years)

1977 to present date: Operations Manager, Geothermal Resources Division. Responsible for all phases of construction, drilling, and producing operations for locating, developing, and testing geothermal energy. This also includes supervision of civil engineering, petroleum engineering, and reservoir engineering as it relates to geothermal technology. Current activities are located in Lake, Sonoma, and Mendocino Counties - The Geysers area, California. Active in geothermal since 1965 with first drilling operations commencing in 1967 and first successful production in 1969. Have supervised the drilling of a total of forty steam wells, of which twenty-five were commercial geothermal producers. Have over thirteen years experience in all phases of the Geothermal Industry.

1974 to 1977: Manager, Geothermal Resources Division, Long Beach and Santa Rosa, California. In addition to the drilling and operating matters, was responsible for the geologic staff recommendations on geothermal steam, approval for the various land functions, and closely coordinating environmental and permitting processes and procedures to obtain the necessary permits to explore for and develop geothermal energy.

At the same time was Manager of the Joint Venture District of the Western Division of Signal Oil and Gas Company. This included oil and gas operations in the Wilmington Oil Field representing the company as a member of the Working Interest Owners of Fault Blocks IV and V. Was also the company's representative on the Voting Party Committee of the Long Beach Unit (Thums Long Beach Company). Was on the Operating Committee of the Long Beach Oil Development Company 1967 to 1977, member of the Board of Directors of the Long Beach Oil Development Company 1973 to 1977. In the above assignments I represented the company's interest in all phases of drilling and production relating to the development in those various units. It should be noted that LBOD's production at that time was 24,000 B/D of oil.

1971 to 1974: Manager, Northwest Division - responsible for oil and gas drilling and producing operations in Sacramento and San Joaquin Valley, and the Ellwood, Santa Maria and Edna Oil Fields.

In addition I was personally responsible for the geothermal drilling, testing, and reservoir evaluation. I actively participated in successfully negotiating the steam sales contract with Pacific Gas and Electric Company, San Francisco.

1965 to 1971: Manager, Joint Venture Division. During this period was responsible for representing the company's interest in nonoperated joint ventures. In 1965 actively participated in the evaluation for bidding on the Long Beach Unit, the Nation's largest undeveloped oil field. Was to be Signal's representative if our bidding group was successful in acquiring the Long Beach Unit. In 1968 participated in the evaluation for bidding for the Signal Group on the North Slope of Alaska. Was directly involved with drilling a 13,000-foot core hole in Prudhoe Bay area to provide data necessary for the economic evaluation to bid on Federal Lease Sale in Alaska. Also represented the company in the "B" Unit, a very successful waterflood in South Glenrock, Wyoming.

In 1965 and 1966, recommended to company management that they should become involved in the exploration and development of geothermal steam. Commenced acquisitions and operations in 1966 and a successful steam well was completed in 1969, with the result that the company now has an excellent position in The Geysers Geothermal Steam Field.

1961 to 1965: Manager, California Division. Was directly responsible for this Division which encompassed approximately 90 percent of the company's oil production. This included operations at Huntington Beach as well as Wilmington, Redondo Beach, Beverly Hills, Ellwood, Santa Maria, and the San Joaquin Valley. Production rates were approximately 30,000 barrels per day with 700 producing wells. Supervised 400 employees. During this period was involved in the construction and installation of the company's first offshore drilling and producing platform in the Pacific Ocean off Huntington Beach - Platform EMMY; from this platform 50 producing and injection wells have been completed.

1960 to 1961: Assigned to the Company's Profits Committee to study and investigate ways of improving the company's profits in the various areas of operation such as refining, marketing, gas processing, and overall efficiency of the various departments.

1957 to 1960: Manager of Operations. During this period was responsible for overseeing the company's activities in drilling and production in Texas, Louisiana, Oklahoma, and New Mexico. In addition was temporarily assigned to Signal's offshore operations in Lake Maracaibo, Venezuela. Was responsible for consolidating the Production Department operations following the acquisition of Hancock Oil Company, Bankline Company and Eastern States Oil Company by Signal Oil and Gas Company in 1959.

1946 to 1957: Was involved in production, drilling, and engineering training programs. Much of this time was spent in both the Home Office and field operations. Worked as a drilling engineer from 1947 to 1949 on both exploratory wells and development wells in California. Was Production Engineer from 1949 through 1953, and from 1953 to 1957 worked as Production Foreman at Huntington Beach, Long Beach, and Redondo Beach.

REGISTRATIONS: Registered Petroleum Engineer, State of California, Certificate No. 355

PROFESSIONAL AFFILIATIONS:

- Society of Petroleum Engineers - Member of Board of Director, Golden Gate Section
- Geothermal Resources Council - Member of Board of Directors
- American Petroleum Institute
- Western Oil and Gas Association - Vice Chairman Geothermal Committee

WALTER W. TURNBULL
Division Accountant - Geothermal Division
Production Department - Aminoil USA, Inc.

EDUCATION: B.S. in Accounting, University of Oklahoma 1942. Past Graduate Studies following military service 1946/1947.

WORK EXPERIENCE:

Aminoil USA, Inc.

January 1978 to date: Assigned as Geothermal Division Accountant when position was created. Responsible for formulation of accounting and financial procedures for Geothermal operations, and for supervision of field accounting.

Aminoil International

Jan. 1977 to Dec. 1977: Deputy General Manager in Kuwait. Responsible for implementation of policies for exploration, producing and pipeline operations through Joint Operating Committee with Getty Oil Company; responsible for accounting, financial, personnel, contract, and service functions.

June 1976 to Jan. 1977: Manager of Finance and Administration in Kuwait. Responsible for all accounting, financial, personnel, contract, and service functions. Approx 900 employees engaged in producing, refining and terminal operations for about 80,000 bpd.

June 1973 to June 1976: Vice President and Deputy General Manager of Iricon Agency Ltd. This agency represented Aminoil and five other American companies (Arco, Continental, Getty, Sohio, and Charter) on the Board of Directors of the Iranian Oil Participants (Iranian Consortium). Responsible for communicating with the six companies to develop policy, and presentation of their views and votes to Consortium Board; also for scheduling crude and product liftings from Iran of Iricon allocations.

"continued"

Jan. 1971 to June 1973: Controller of Iranian Oil Operating Companies (Iranian Consortium). Responsible for all accounting for both a producting and refining company. Responsibilities included coordination of budget preparation and control. Production - 6 million bpd. Refining 350, 000 bpd.

April 1961 to Dec. 1969: Controller, Kuwait Operations. Responsible for all accounting and financial activities of company in Kuwait, including contract administration, and coordination of oil accounting with Government of Kuwait.

Creole Petroleum Corp. (Venexuelan Subsidiary of Exon)

July 1947 to March 1959: Initially served as Chief Accountant in various production/refining districts. During final four years I was head of Accounting Procedures Section, directing 10 to 15 senior accountants in preparation of uniform accounting instructions for 8/10 production districts, 2 refineries, and for retail marketing. Extensive Joint Interest operations were involved.

JAMES M. GRUBB

Division Geologist, Geothermal Division, Aminoil USA, Inc.

EDUCATION: Bachelor of Science Degree 1966, Business Administration and Geology, Bowling Green University, Bowling Green, Ohio
Master of Art's Degree 1968, Geology, Bowling Green University, Bowling Green, Ohio

WORK EXPERIENCE:

Aminoil USA, Inc. (4 years)

1977 to present: Division Geologist, Geothermal Resources Division. Responsible for directing the geological evaluation of geothermal resources on Aminoil lease holdings and for defining other prospective trends. Emphasis is on establishing the optimum programs to delineate economic geothermal prospects. Projects include The Geysers of California and the major thermal trends of the Western United States.

1976 to 1977: District Geologist, Gulf Coast Division. Responsible for the exploration of offshore petroleum prospects in the Oligocene, Miocene, and Pleistocene. Emphasis was on seismic interpretation, well log analysis, and economic viability in prospects development.

1974 to 1976: Senior Geologist-Internation Exploration. Responsible for petroleum prospect evaluation in Latin America and the North Sea.

Chevron Oil Company (6 years)

1968 to 1974: Exploration and development geologist Oil and Gas Division. Evaluated and defined oil and gas prospects in mid-Continent (Oklahoma and Texas) and Rocky Mountains (Colorado and Wyoming). Emphasis was on well log correlation integrated with seismic interpretation to develope prospects.

One year of evaluation of sedimentary uranium deposits in same areas.

PROFESSIONAL AFFILIATIONS:

American Association of Petroleum Geologist
Geological Society of America
Geothermal Resources Council

DR. DAVID ROGER WALL

SENIOR REGIONAL GEOLOGIST - AMINOIL USA, INC.

EDUCATION:

1963 - 1966 BSc University of Hull, Yorkshire, England - BSc Honors Geology

1966 - 1969 PhD University of Wales, Aberystwyth - PhD Geology

1969 - 1977 Various courses in borehole logging and geophysical interpretation.

WORK EXPERIENCE:

1976 - Present Aminoil USA, Inc. - Geothermal Resources Division, Senior Regional Geologist. The evaluation of geothermal prospects within western United States. This includes recommendations concerning new lease acquisitions and the formulation and interpretation of geophysical, geochemical, and geological surveys.

1974 - 1976 Burmah Oil and Gas Company, Geothermal Resources Division, Senior Geologist. Geologic and geophysical evaluation of The Geysers steam field.

1973 - 1974 Burmah Oil and Gas Company - Geologist for the Dampier subbasin, Australia. Analysis of the regional geology and geophysics leading to the identification and maturing of new exploration prospects.

1971 - 1973 Burmah Oil and Gas Company - Geologist for the Goodwyn Field, Australia. The job involved the interpretation of the structure, stratigraphy, reservoir characteristics and reservoir distribution of the Goodwyn Field and nearby prospects.

1969 - 1971 Burmah Oil and Gas Company - Chief Micropalaeontologist. The position involved the setting up of a micropalaeontological/palynological laboratory and the erection of a zonal scheme based on Foraminifera for the Tertiary and Cretaceous strata of the Northwest Shelf of Australia.

PUBLICATIONS:

R. C. Whatley and D. R. Wall 1969. A preliminary account of the Ecology and Distribution of Recent Ostracoda in the S. Irish Sea. In the Taxonomy, Ecology and Morphology of Recent Ostracoda.

R. C. Whatley, D. R. Wall and J. E. Whittaker 1971. A taxonomic note on the genus Leptocythere Sars with particular reference to the type specids. Bull., Centre Rech., Pau, SNPA, 5 Suppl.

R. C. Whatley and D. R. Wall 1975. The relationship of Recent Ostracoda to Algae. Crustaceana, 1975.

D. R. Wall 1976. Ostracodes from the Deep Sea Drilling Project, Vol. XXXIV.

PROFESSIONAL AFFILIATIONS

American Association of Petroleum Geologists

D.O.E. COMMITTEES

1977 - 1978	Steering Committee for Geothermal Exploration Technology, lead agency University of Utah.
1977 - 1978	Steering Committee for Geothermal Logging Instrumentation, lead agency Sandia Laboratories.

JOHN W. KUNAU
Division Land Manager
Geothermal Resources Division - Aminoil USA, Inc.

EDUCATION: B.S. (Marketing/Management), Oklahoma City University, 1960

WORK EXPERIENCE:

Aminoil USA, Inc. (1 year)

1977 to date: Division Land Manager. Responsible for planning, organizing, supervising, coordinating and executing land acquisition programs, farmouts, farmins, joint ventures, unitization agreements, and special projects to enable the company to conduct exploration, development and producing operations on geothermal resources properties. Maintain liaison with various governmental agencies for leasing and permitting purposes and to insure conformance with applicable governmental regulations.

Occidental Petroleum Corporation (12 years)

1965 to 1977: Supervisor, California, Governmental Liaison and Land Acquisitions. Responsible for securance of governmental permits and authorizations for oil and gas drilling projects, preparing EIR's, negotiating inter-company agreements (farmouts, joint ventures, etc.), supervising Oil and Gas and Geothermal lease acquisition programs.

Superior Oil Company (5 years)

1960 to 1965: Assistant District Landman. Assisted in directing lease and mineral acquisition programs in New Mexico, Arizona, Texas, Colorado, Utah and Nevada. Negotiated various inter-company agreements, prepared federal type unit agreements.

PROFESSIONAL AFFILIATIONS:

American Association of Petroleum Landmen,
Western Oil and Gas Association (former member - Production Ordinance Committee. Alternate - Geothermal Committee).

CARL E. WOODS

Manager Public and Environmental Affairs
Aminoil USA, Inc. - Geothermal Resources Division

EDUCATION: 1948-56, Long Beach City College - additional courses in Economics and Machine Accounting, Orange Coast College; and Environment and Public Affairs, U. C. Irvine.

WORK EXPERIENCE:

Aminoil USA, Inc./Burmah Oil & Gas Co./Signal Oil & Gas Co. (30 years)

1976 to date: Manager, Public and Environmental Affairs, Geothermal Resources Division. Responsible for coordination and procurement of governmental permits and authorizations for geothermal construction and drilling activities including the implementation and administration of environmental impact reports and environmental research and monitoring activities. Also, responsible for monitoring of activities of government regulatory bodies and the implementation and administration of studies and programs to enhance public acceptance of Geothermal Division with principal operations in the Geysers Area, Northern California and activities in west coast states of Nevada, Utah, New Mexico and Oregon.

1974 to 1975: Manager West Coast Public and Environmental Affairs, Production Department. Responsible for acquisition and expediting of governmental permits and authorizations for oil and gas and geothermal operations for California Division Production Department and Geothermal Resources Division, including the implementation and administration of environmental studies and monitoring programs. Also, responsible for implementation and administration of programs and procedures to enhance the public acceptance of oil and gas and Geothermal Resources Division's operations in the State of California.

1970 to 1974: Community Relations Representative - California Division, Production Department. Responsible for implementation and coordination of programs and procedures to assist in the achievement of Department objectives and enhance company public image and acceptability in areas where drilling and producing operations were conducted. Also, responsible for assistance to Corporate Government Relations and Real Estate groups.

1959 to 1970: District Office Manager - Huntington Beach District, Production Department. Responsible for general services, personnel, production accounting and secretarial pool functions related to district production office operating 600 + oil and gas wells producing 40,000 + barrels of oil per day from state and fee leased properties.

1956 to 1959: Special Projects Coordinator - Huntington Beach Division, Production Department. Assigned to special projects as assistant to Division General Manager. Trained in operations of payroll, accounting, personnel and purchasing departments.

1948 to 1959: Field Technician and Parts Expeditor - Huntington Beach Division, Production Department. Responsible for parts acquisition and inventory control for Maintenance Department operating 50 + road and heavy duty vehicles and 400 + natural gas engines and oil well pumping units. Also, responsible for set up and operation of gas engine magneto repair shop.

1944 to 1947: Military Service - U. S. Maritine Service, Radio Officer.

1943 to 1944: U.S.M.S.R.T.S., Gallups Island, Mass.

PROFESSIONAL AFFILIATIONS:

Western Oil and Gas Association (former member and chairman 1976 - Public Affairs Committee/former member - Environmental Conservation Committee and Production Ordinance Committee. Current alternate - Public Affairs Committee and Geothermal Committee).
Air Pollution Control Association, West Coast Section
Geothermal Resources Council
American Petroleum Institute.

2 H (1)

PROPOSAL FOR
SEISMIC EMISSIONS STUDY
GERLACH, NEVADA

May 1978

Submitted to:

U.S. Department of Energy

Nevada Operations Office

Las Vegas, Nevada

In Response to:

RFP ET-78-R-08-0003

Geothermal Assessment Case Study
Northern Basin and Range Province

Submitted by:

Utah Geophysical, Inc.
P.O. Box 9344
Salt Lake City, Utah 84109

and

John Doe Corporation

Lewis J Katz

LEWIS J. KATZ
President
(801) 272-1289

TABLE OF CONTENTS

SEISMIC EMISSIONS STUDY AT GERLACH, NEVADA

Section 1: Technical Proposal

1.1. Introduction:

Utah Geophysical, Inc. (UGI) of Salt Lake City, Utah proposes to conduct a Seismic Emissions Study at Gerlach, Nevada, Figure 1, with the cooperation and support of a major oil company that is actively involved in geothermal exploration and development (among top 3 companies in geothermal). This company wishes to have its name withheld until after the July, 1978, lease sale in this area. They believe that release of their name and interest in this area at this time would jeopardize their chances in the upcoming lease sale. However, after the lease sale they are presently willing to supply a letter in support of this survey and to cooperate in defining a more specific site for this survey. This site will be chosen on geological and geophysical information that they have as well as preliminary well site locations. The option to have Senturion Sciences of Tulsa, Oklahoma perform a scaler magneto-telluric (MT) survey is also provided for. By performing these surveys together results can be integrated in the final interpretation of the data for a more comprehensive evaluation of the prospect. A description of the scaler MT survey is described in Appendix A. It includes one tensor MT base station to determine structural orientation and 25 scaler MT stations.

The Gerlach area lies in the Basin and Range province and consists of Quaternary sediment filled grabens bounded by Cretaceous igneous and metamorphic rocks. Several significant hot springs can be found within the area. Great Boiling (Gerlach) Springs can be found just south of the town of Gerlach and is classified by White and Williams (1975) among those hot water

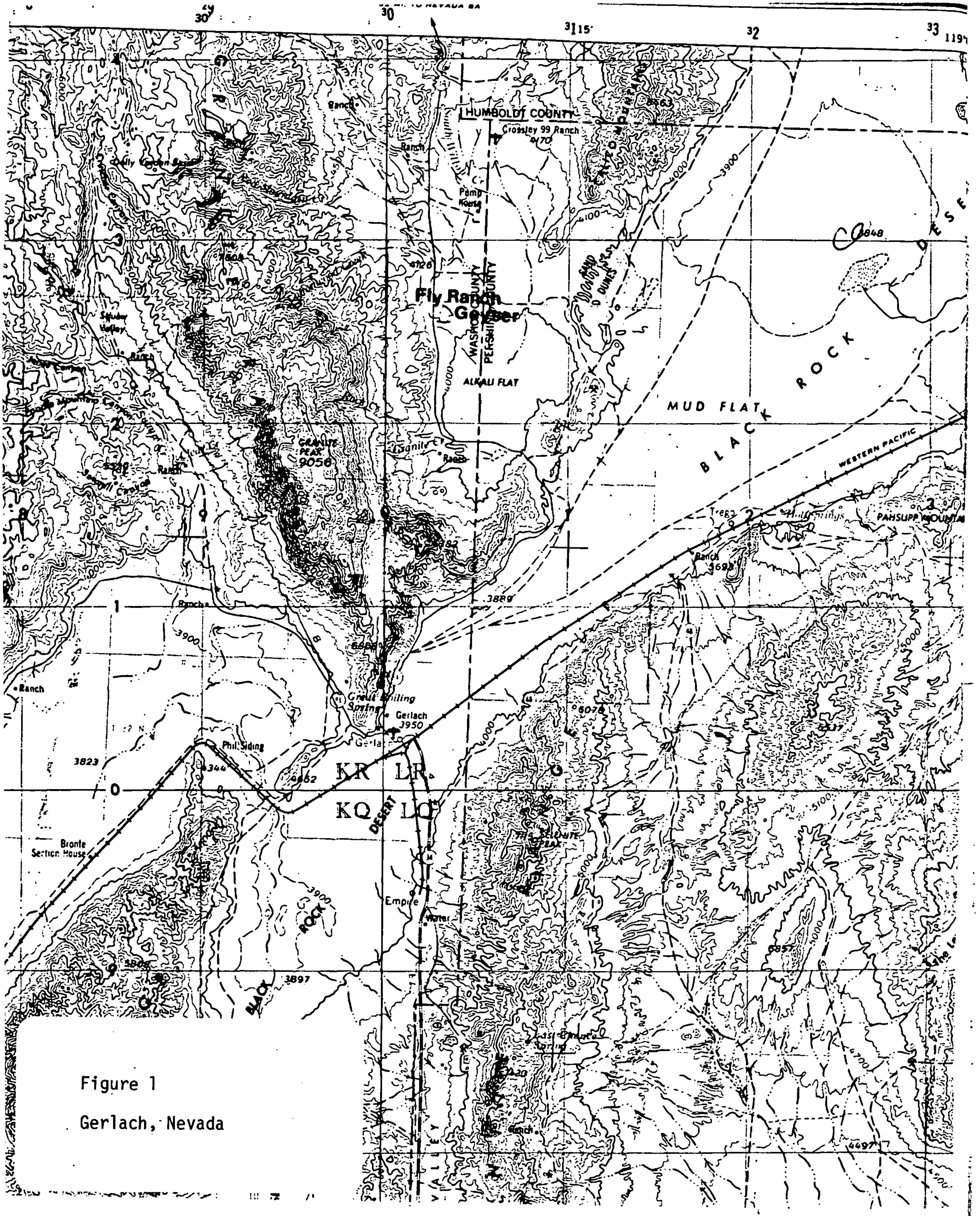


Figure 1

Gerlach, Nevada

convection systems with subsurface temperatures above 150°C (170°C). North of Gerlach lies Fly Ranch Hot Springs having a subsurface temperature estimated at about 130°C (White and Williams, 1975).

1.2 Significance of Proposal:

A Seismic Emissions Study is used to delineate zones of faulting and fractures. These fractures are necessary for permeability and production. Without these fractures one may encounter hot rock (i.e., Phillips Petroleum Well 9-1 at Roosevelt Hot Springs) and not have reservoir fluids present that are needed for production. Obviously, the ability to accurately locate these fracture zones would reduce the risk of dry holes and thus encourage drilling.

1.3 Program Descriptions:

The definition of "reservoir engineering" as defined in the Los Alamos Scientific Laboratory report on Hot Dry Rock Geothermal Energy Development Project FY 1977, includes "those activities directed at understanding the creation, characterization and performance of a hot dry rock reservoir. It includes . . . the development of means to map fractures and boreholes which comprise the reservoir." Using this definition, this proposal is submitted under the caption to collect new reservoir engineering data. The purpose of this survey is to locate the source of seismic emissions as a means of delineating fracture zones. Some advantages of these surveys over conventional high power groundnoise surveys are: (1) they provide a depth estimate for the geothermal cell, (2) spatial distribution allows discrimination of geothermally produced seismic emissions from those produced by cultural sources, and (3) more prevalent but lower magnitude seismic events can be identified through sensitive multistation array processing.

Three seismic emissions studies to date have been performed on a non-proprietory basis. In all three surveys groundnoise anomalies have been found at resistivity lows and/or faulting. At Long Valley, California, the groundnoise anomaly agreed with the Cashbaugh low resistivity anomaly. At Roosevelt Hot Springs, Utah, the anomalies occur at a resistivity low (Geonomics survey) on the Getty Oil prospect and at a zone of highest conductivity mapped by Ward and Sill (1976) in the northern (Union Oil survey) area. Results from the Union Oil survey are shown in Figure 2. The anomalous zone, trending north-south through sections 15, 22, 27, 34, and 3 is coincidental with faulting mapped by Crebs and Cook (1976) and significant resistivity lows (Ward and Sill, 1976). It also appears to delineate a fracture system that could be a northern extension of the Dome fault. Anomalies E and F are not real. The significance of agreement between seismic emissions anomalies and resistivity lows are twofold. First, a fracture system would have increased porosity, and an expected decrease in resistivity. Second, Sill and Bodell (1977) have interpreted low resistivity and high temperature gradients at Roosevelt as possibly being caused by hot water movement along faults. Since the groundnoise anomaly defined by the seismic emission study also agrees with the above hypothesis it too may be associated with hot water movement. However, alone the seismic emission study cannot determine water temperature.

Historically, groundnoise surveys were based entirely on amplitude data. This resulted in ambiguous interpretations in some cases since the amplitude contribution could have come from several sources (instrumentation, geology, weather) other than the geothermal system. Seismic emission surveys are not dependent on amplitude information, therefore, these problems do not occur. In addition, cultural noise sources are deleted from the data by both frequency and velocity filtering.

1.4 Theory:

Combs and Hadley (1977) report recording small magnitude (<0) nanoearthquakes at the East Mesa geothermal anomaly. They also report a coincidence between areas of high seismic noise, high heat flow zones, and nanoearthquake activity. It is our belief that seismic emissions (groundnoise) in the vicinity of geothermal anomalies are a continuous stream of seismic events smaller than the discrete nanoearthquakes of Combs and Hadley. Recurrence curves (Figure 3) indicate statistically that the number of seismic events increase as the magnitude of events decrease. Theoretically, therefore, extremely low magnitude events would occur in the thousands perhaps continuously in the form of microtremors (groundnoise).

Since areas of high heat content limit the buildup of stresses (Brace and Byerlee, 1970; Combs and Hadley, 1977), smaller magnitude events (seismic emissions) are likely to occur in these areas. Evidence of this has been seen at several geothermal areas having known commercial heat sources. Roosevelt Hot Springs, Utah, has been classified aseismic, nanoearthquakes have been reported at East Mesa and the Geysers-Clearlake area of California (Figure 4).

It is of interest to compare predictions of Knapp and Knight (1977) with the above hypothesis. Knapp and Knight have theoretically shown that geothermal temperature gradients (15-20°/km) cause pore fluid pressure changes in rocks that result in hydraulic fracturing. From their calculations, the energy released from total fracturing of a cubic meter of crystalline rock would cause a magnitude zero earthquake. They state that the "frequency of production for microearthquakes with a magnitude of zero

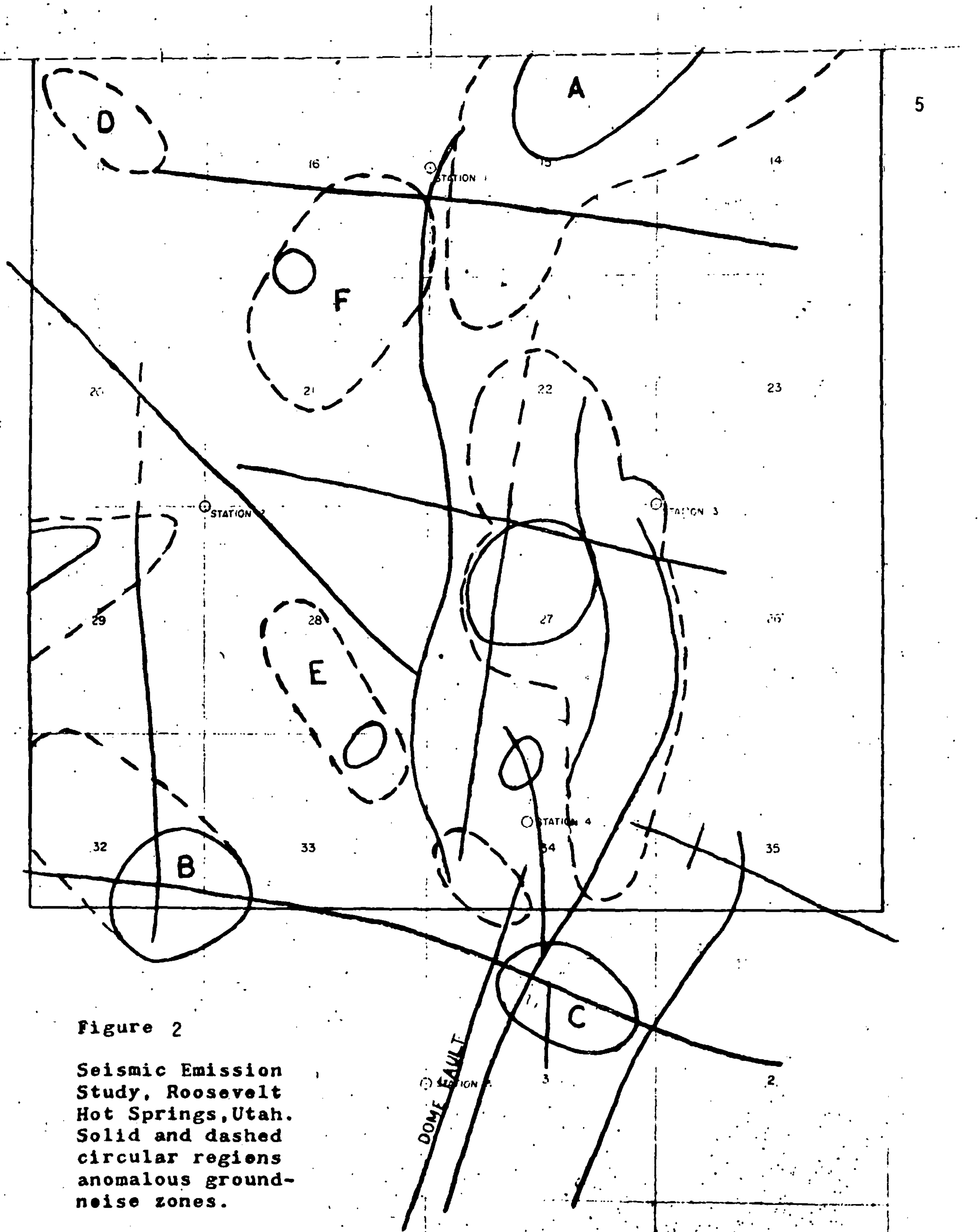


Figure 2

Seismic Emission Study, Roosevelt Hot Springs, Utah. Solid and dashed circular regions anomalous ground-noise zones.

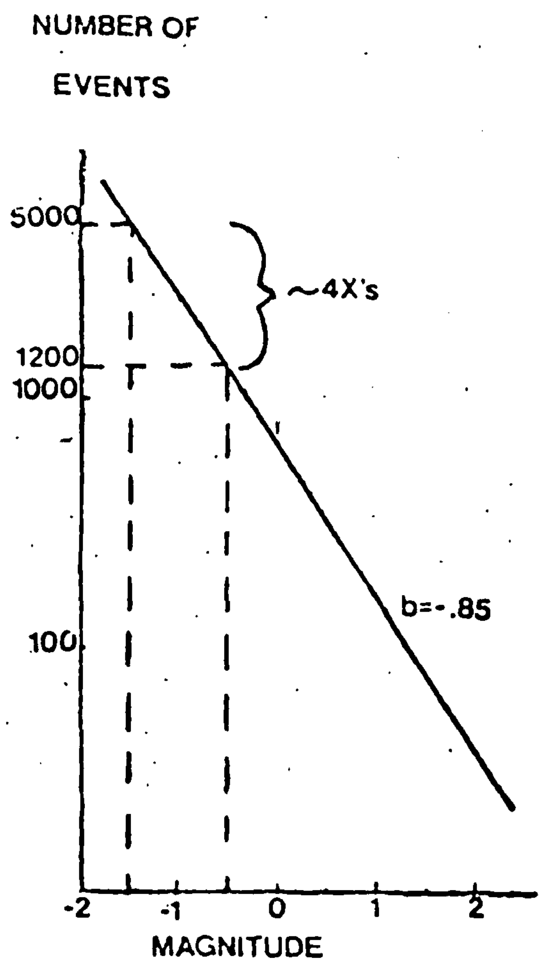


Fig. 3. Recurrence curve, Calif.

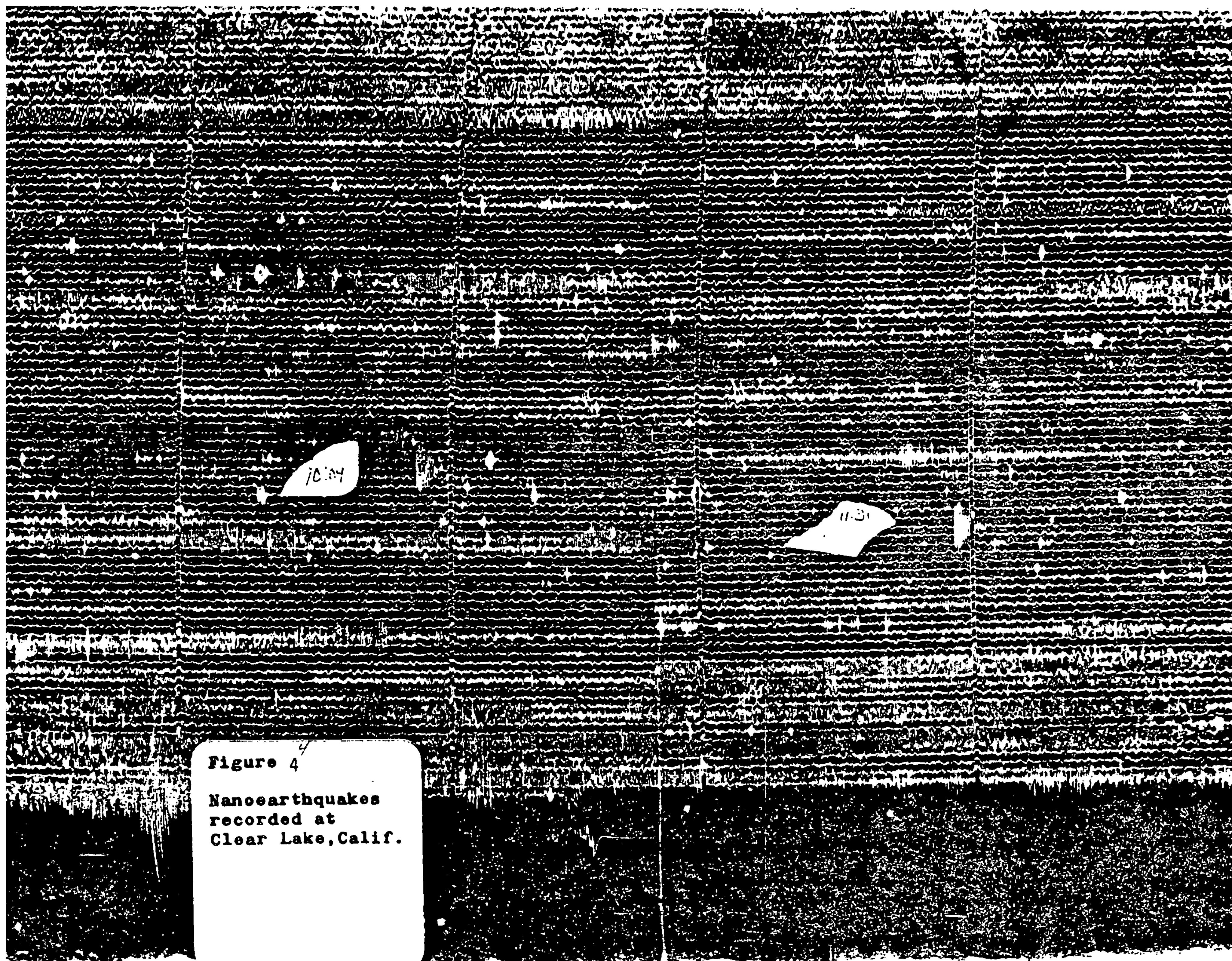


Figure 4

Nanoearthquakes recorded at Clear Lake, Calif.

varies in time from over 10^4 events/day for the first thousand years after emplacement of the pluton to about 500 events/day at an elapsed time of 10^5 years." Figure 5 (Knapp & Knight's Fig. 9), summarizes the above predictions.

Comparing Knapp and Knight's predictions (Fig. 5) to the recurrence curve of Figure 3 there is remarkable agreement at zero magnitude if the curve in Figure 5 is considered to asymptotically approach 500 events/day. This is a reasonable assumption since the recurrence curve (Fig. 3) is a generalized curve for California and in time the geothermal curve (Fig. 5) will approach normal temperature gradients. Although, both curves are not truly comparable there are compensating factors that permit comparisons for illustrative purposes. That is, the recurrence curve (Fig. 3) is for the amount of seismicity observed over a period of one year (number events/year), whereas, the curve of Figure 5 is for number events/day. However, in a geothermal region the "b" value (slope) would be larger for the recurrence curve which would represent considerably more events/year than shown in Figure 3. There is also a difference in the spatial area of observation considered in each formulation.

Looking at geothermal prospects less than 2 x 10^4 years, to obtain the amount of fracturing predicted by Knapp and Knight, about 1200 events/day would be expected (Fig. 5). From the recurrence curve, Figure 3 this number of observed events would correspond to a magnitude of less than -0.5 which would be approaching groundnoise amplitudes. Therefore, the theoretical work of Knapp and Knight can be interpreted in a generalized fashion to mean that younger, hotter, geothermal systems are more likely to generate groundnoise (seismic emissions) than microearthquakes. Also, if the amount

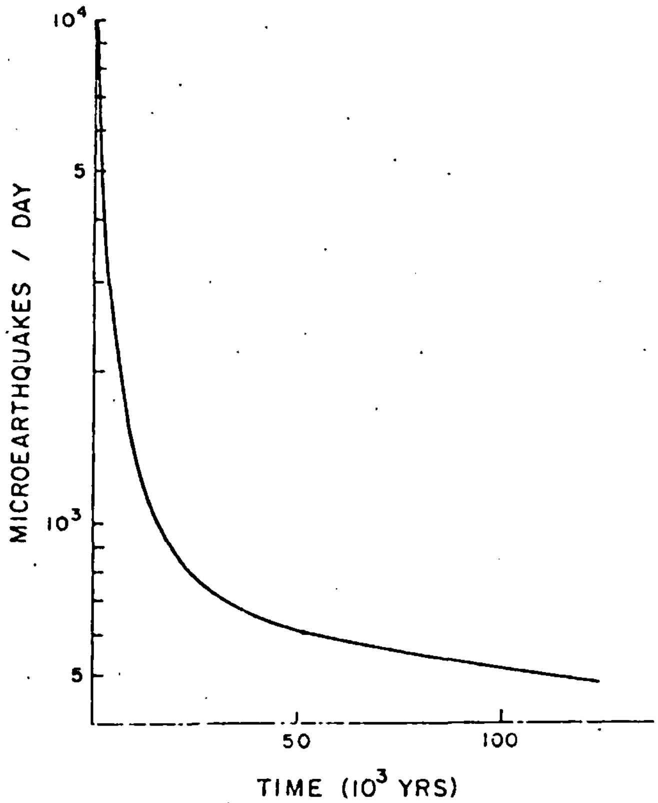


Figure 5. Frequency of microearthquake production as a function of time after emplacement of the pluton. All events are magnitude zero.

Source: Knapp, B. R. and J. E. Knight (1977).

of fracturing per unit volume is less than predicted above, the resulting magnitudes would be substantially reduced.

In actual observations at geothermal prospects the number of events/day are considerably lower than predicted by Knapp and Knight. This occurs because actual magnitudes are less than zero and are not normally detected. Their prediction of zero magnitude microearthquakes was based on the assumption that energy conversion is 100% efficient and that all pores fracture simultanesouly. Since this does not occur in the real world magnitudes are less than zero. These observations support the previous conclusion that observed magnitudes of seismic events resulting from hydraulic fracturing are probably less than -0.5 and thus appear in the form of groundnoise.

Most microearthquake recording systems have detection thresholds greater than zero. For example, Combs and Hadley's (1977) system had a detection threshold of about magnitude 1. For events of magnitude less than 1, they were not recording as many events as predicted (Fig. 6 of their paper). One means of improving on the detection threshold would be through signal processing of recorded data. This is the approach taken in seismic emission studies. Through signal processing, the detection threshold is increased, thus, smaller magnitude events (<-0.5) associated with the geothermal system can be detected.

1.5 Statement of Work

1.5.1 Data Acquisition:

Data will be recorded on UGI's data acquisition system specifically designed for seismic groundnoise studies. The system features a digital tape deck capable of multiplexing 5 data channels for absolute time alignment between seismometer channels and high dynamic range low system noise recording. Specially designed low frequency amplifiers using recent spaceage technology provide for passive seismic recording with amplifier noise levels an order of magnitude lower than any amplifier presently available for this purpose. Combining these features, UGI's data acquisition system provides the state-of-the-art in groundnoise recording. The importance of recording groundnoise data digitally has been well recognized (Minutes of Active and Passive Seismic Methods Consortium, DGE/DOE, Nov. 18, 1977) as a means of obtaining meaningful results.

Five instrument arrays, each consisting of 5 geophones positions at 1000 feet spacing from a center geophone are deployed to gather field data. All geophone positions are surveyed by tape and transit methods.

1.5.2 Data Processing:

Field data are stripped out and edited to find quiet sections of data. Data from four arrays are chosen for processing. Data processing and analysis incorporates multi-station array focusing techniques and stochastic averaging. Seismic array analysis involves the focusing of an array of geophones to a volume element centered at $\bar{r}$, through use of differential travel time information. Power emitted from this volume is computed and a source power map is obtained.

Typically, 20 x 20 arrays of possible source locations (hypocenters) are chosen. Each array is focused on possible source location points by using a ray tracing algorithm to calculate P-wave travel times from each point to each geophone position used in the correlation procedure. Recorded traces are then shifted by the appropriate delay times and multi-station correlations performed for each array. A listing of individual delay times, correlation values, and computer generated contour maps of correlation values are produced.

UGI's computer processing program offers several improvements over previous programs. Currently, processing is performed on a UNIVAC 1108. Provisions are also available for processing at Control Data Corporation's central computer via Senturion's remote terminal in Tulsa.

1.5.3 Data Analysis and Interpretation:

From each station directional vectors point to the locations of seismic emissions. By analyzing data from several arrays, vectors are seen to intercept, thus, uniquely defining emission source locations. These groundnoise anomalies are believed to delineate zones of faulting and fracturing associated with the geothermal reservoir. Resulting anomalous areas are compared to other geophysical and geological data in the final analysis of the survey.

Section 2: Cost Proposal

Utah Geophysical, Inc., proposes to perform this survey at a fixed price of $21,500.00. This is our published commercial rate for this survey (for mapping a 20,000 x 20,000 ft. area at 1,000 ft. resolution).

John Doe Corporation is willing to share in a sense the cost of this survey by using data they presently have to supply a precise location for this survey at an area that they are presently contemplating drilling a well on. This information will be supplied by John Doe Corporation at no cost to DOE.

Optional MT Survey

At DOE's discretion a magneto-tellurics survey may also be purchased. This survey will be performed by Senturion Sciences of Tulsa, Oklahoma. Results from both surveys would be integrated at no additional cost.

25 scaler MT stations	$20,000.00
1 Tensor MT station	2,000.00

This survey is also priced at the commercial advertised rate. Commercial rate sheet for the above surveys is attached.

The above prices will remain in effect for 120 days from closing date of this RFP (May 30, 1978).

UGI

Utah Geophysical Inc.

P.O. Box 9344 Salt Lake City, Utah 84109 (801) 272-1289

SEISMIC EMISSION--MAGNETO TELLURIC SURVEYS

By combining seismic emission and magneto-telluric surveys, Utah Geophysical and Senturion Sciences are offering a comprehensive geophysical package for detailed geothermal exploration. Since seismic emission studies have been found to correlate with resistivity lows, the two surveys complement each other. By performing these surveys together results are integrated for a more meaningful interpretation and evaluation of the geothermal prospect. Purchasers of this package are obtaining the state-of-the-art in both passive seismic and electrical surveys. A typical survey covers approximately a 4 x 4 mile area. The survey includes: a seismic emissions study, 25 scalar MT stations and 1 tensor MT station.

Prices:

Seismic emission study	$21,500.00
Magneto-telluric survey	22,000.00
Total	$43,500.00

Price includes data acquisition, processing, analysis, interpretation, and an integrated final report. Details of each survey are described in the enclosed literature. References are available upon request.

Section 3: Business and Management

3.1 Corporate Qualifications:

Presently, UGI is the only firm having personnel with field experience in Seismic Emission Surveys as well as processing and interpretation experience. Also, UGI has the field equipment to properly perform a survey such as this. In last year's RFP for southwest Utah, UGI's personnel (under the name Seismic Exploration, Inc.) performed a similar study for DOE and Union Oil. Members of UGI's technical staff have considerable experience in instrumentation, seismology, geothermal exploration, and computer processing. UGI is an established firm whose main business is providing geophysical services to major geothermal, mining, and oil companies. Clients include Phillips Petroleum, Union Oil, Sunoco Energy, Occidental, Getty Oil, Chevron Oil, among others. UGI has unique technology in geothermal and mining exploration in which it holds several contracts from private industry.

UGI personnel previously operating in the name of Seismic Exploration, Inc. have completed the following government contracts:

P-I-48 (subcontractor)--U.S. Geological Survey, Improved techniques for the Exploration and Characterization of Geothermal Sources from Seismic Activity.

DR-76-2645--U.S. Nuclear Regulatory Commission, Microtremor Site Analysis at Beatty, Nevada.

EG-77-C-08-1527--U.S. Energy Research & Development Administration, Seismic Emissions Study, Roosevelt Hot Springs, Utah.

UGI
Utah Geophysical Inc.
P.O. Box 9344 Salt Lake City, Utah 84109 (801) 272-1289

UTAH GEOPHYSICAL, INC
BALANCE SHEET
April 30, 1978

ASSETS

Cash	$ 4,528	
Accounts receivable	3,000	
Total Current Assets		$ 7,528
Equipment		19,650
Intangible assets (computer programs, organ. expense)		24,320
TOTAL ASSETS		51,498

LIABILITIES

None

STOCKHOLDERS EQUITY

Common stock at par authorized and issued	25,000	
Capital in excess of par	25,000	
	50,000	
Retained earnings	1,498	
Stockholders Equity		51,498

A line of credit for $25,000.00 is available.

3.2 Project Personnel:

UGI proposes to assign two members of its technical staff as key personnel for this project. Mr. Lewis Katz is designated the project manager, and is responsible for the program execution. Mr. Robert Bellon, Manager of Field Operations, will be responsible for instrumentation and data collection. Resumes for those individuals, together with resumes of other staff members who will be used on an as-needed basis, are given.

3.3 Schedule:

Data acquisition, processing and interpretation will take approximately 10 weeks to complete. Depending on availability of field crew, work will start about one month after contract is awarded.

3.4 Documentation:

Documentation will consist of a final report which may be published.

References

Brace, W. F. and J. D. Byerlee (1970). California earthquakes: Why only shallow focus? Science, v. 168.

Combs, J. and D. Hadley (1977). Microearthquake investigation of the Mesa geothermal anomaly, Imperial Valley, California, Geophysics, V. 42.

Knapp, B. R. and J. E. Knight (1977). Differnetial thermal expansion of pore fluids: Fracture propagation and microearthquake production in hot pluton environments, Jnl. Geophy. Res., V. 82, No. 17.

Sill, W. R. and J. Bodell (1977). Thermal gradients and heat flow at Roosevelt Hot Springs, Univ. of Utah Dept. Geol. & Geophys., Tech. Dept. V. 77-3.

Ward, S. H. and W. R. Sill (1976). Dipole-dipole resistivity surveys, Roosevelt Hot Springs KGRA: Dept. Geol. & Geophys., Univ. of Utah, NSF Report, Vol. 2.

White, D. F. and D. L. Williams (1975). Assessment of Geothermal Resources of the United States-1975, U.S.G.S. Cir. 726.

APPENDIX A
MAGNETO TELLURIC SURVEY

SENTURION SCIENCES, INC. • 1539 N. 105TH E. AVE. • P. O. BOX 15447 • TULSA, OKLAHOMA 74112 • (918) 836-6746

SCALAR MAGNETOTELLURICS

Senturion has developed a relatively inexpensive scalar magnetotelluric exploration tool pursuant to Cagniard's theory (1953) in which variations in the magnetic field along a given direction induce telluric currents normal to the magnetic field. Senturion's scalar magnetotelluric (one component of the telluric field) surveys incorporate tensor (three components of the magnetic field and two components of the telluric field) magnetotelluric data at each scalar base station. The tensor magnetotellurics permits a two-dimensional interpretation of the geologic complexities at each scalar base station before deployment of scalar telluric lines. Therefore, by measuring the earth's electromagnetic impedance along electrical strike, the resulting one-dimensional scalar interpretation best approximates the true resistivity of the geologic section.

The scalar magnetotelluric survey will utilize up to nine mobile scalar stations and one fixed base station tied via the WWVB time code. All units are designed to record low (0.01-25 Hz) and high band (0.1-25 Hz) tellurics continuously for 24 hours on seven-track magnetic tape. This exploration technique allows for fast, inexpensive and dependable data which can be integrated with well logs and other available geology and geophysics.

A typical record, low pass filtered at 0.1 Hz, is shown in Figure 1; a block diagram of the system is shown in Figure 2; and the system response curve is shown in Figure 3. Typical telluric amplifier gains are expected to be from 2500 to 10,000.

The 24 hours of data recorded at each station are played back and a compressed oscillographic record made. A time series (> 3 hours and < 10 hours) of data is spectrally analyzed using the compressed record as a guide to the best data interval. The telluric spectra at each station is then normalized to the telluric spectra of the base station made over the same time interval. WWVB recorded continuously at each station allows for accurate time alignment. The normalized power spectra at the stations are then multiplied by the tensor E-parallel base station sounding curve.

The magnetotelluric data for each station is inverted to a model of true resistivity with depth. This is done by computer using a generalized linear inverse scheme similar to methods used to invert D.C. resistivity and vertical magnetic dipole data (Inman, *et al*, 1973; Glen, *et al*, 1973). This method of inversion assumes a horizontally layered earth without lateral variations in lithology and structure.

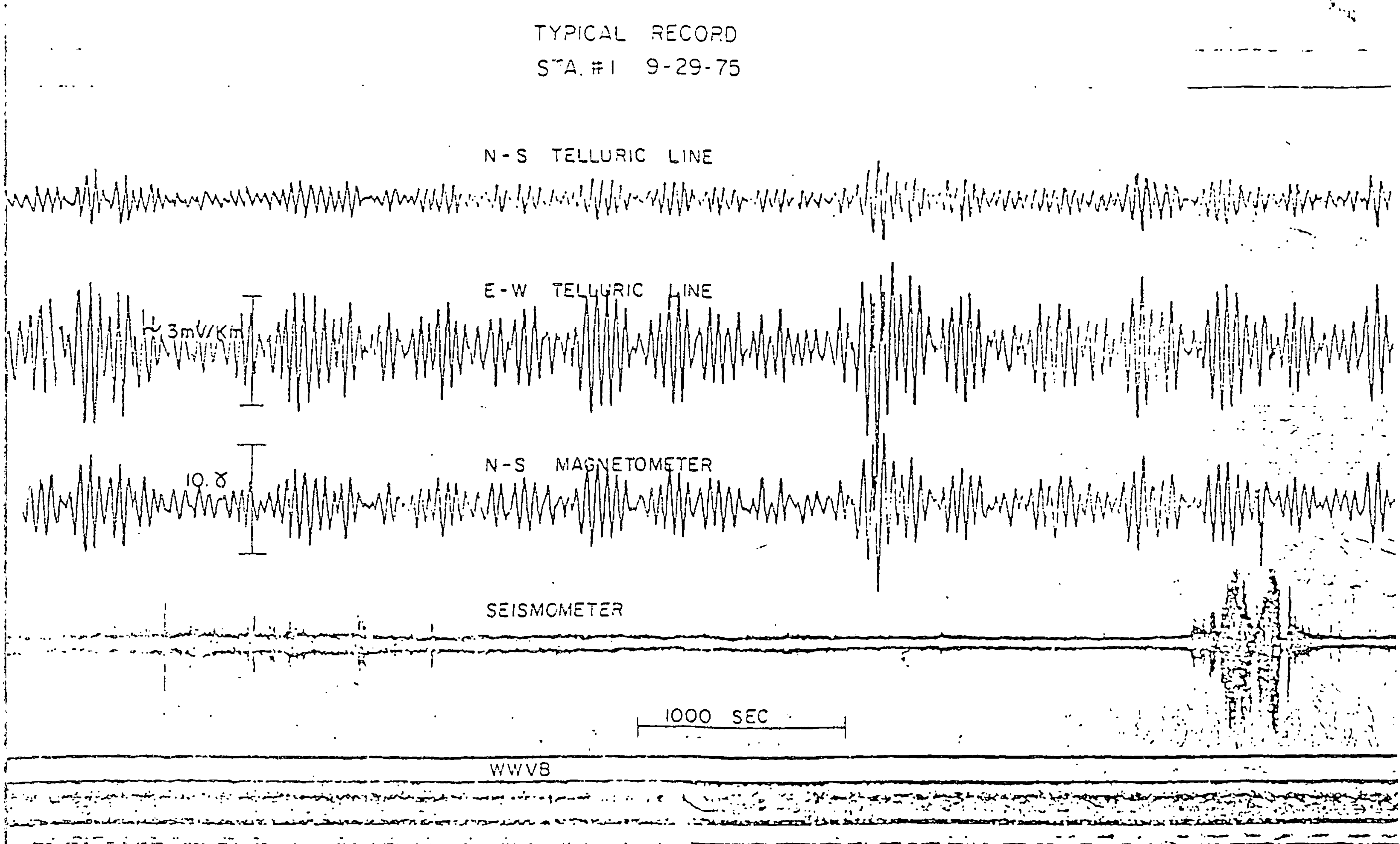
Figure 4 shows a sounding curve from an SMT station model generated by the generalized linear inverse program. Superimposed on the data is the theoretical response of the model. The match between the observed data and the theoretical response indicates the quality of data fit.

R E F E R E N C E S

CAGNIARD, L., 1953; *Basic theory of the magnetotelluric method of geophysical prospecting;* Geophysics, v. 18, pp. 605-635.

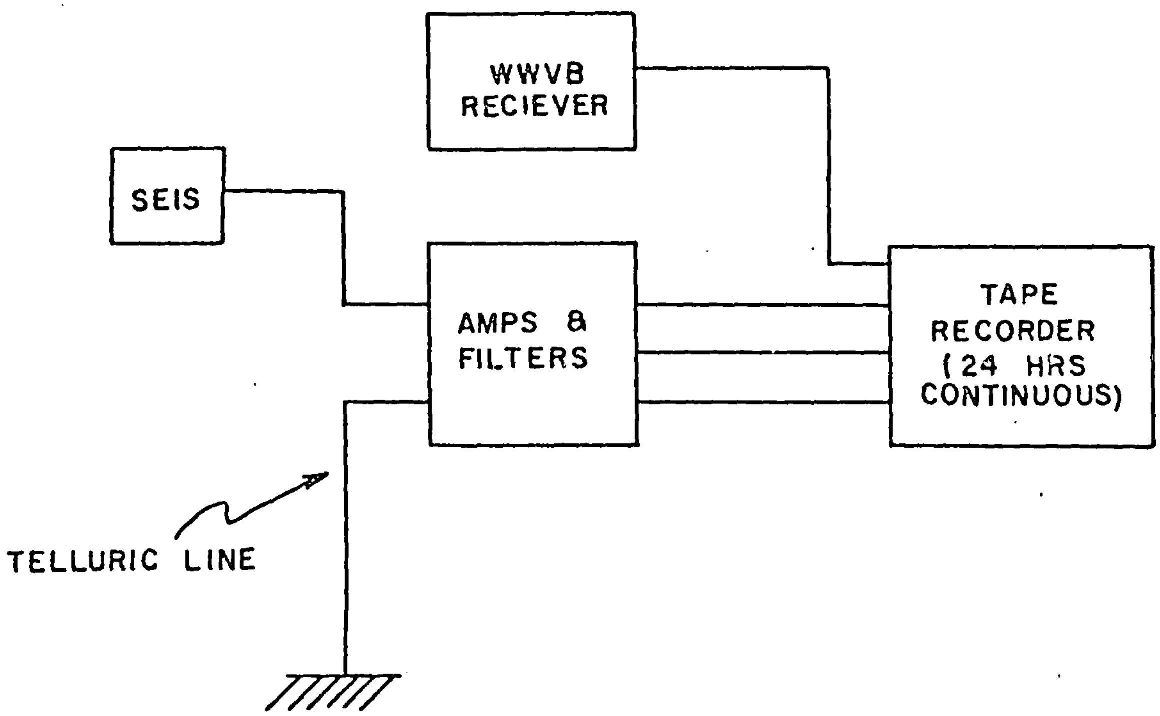
GLEN, W. E., J. Ryn, S. H. Ward, W. J. Peeples and R. J. Phillips, 1973; *The Inversion of Vertical Magnetic Dipole Sounding Data;* Geophysics, v. 38, no. 6, pp. 1109-1129.

INMAN, Joseph R., R. Ryn and S. H. Ward, 1973; *Resistivity Inversion;* Geophysics, v. 38, no. 6, pp. 1088-1108.



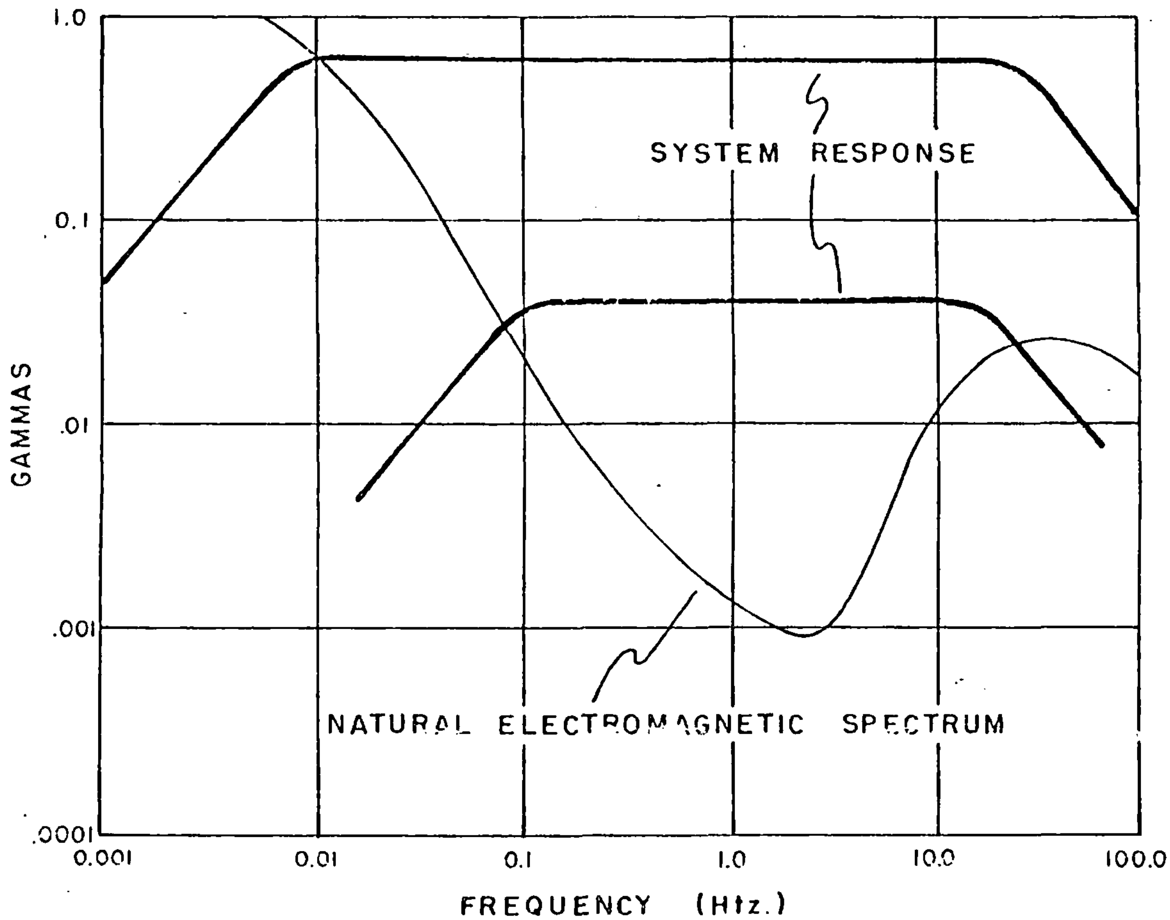
NOTE: TELLURIC & MAGNETOMETER TRACES LOW PASS FILTERED AT 0.1 HZ.

FIGURE 1



TELLURIC SYSTEM DIAGRAM

FIGURE 2



SYSTEM RESPONSE & TYPICAL NATURAL ELECTROMAGNETIC SPECTRUM

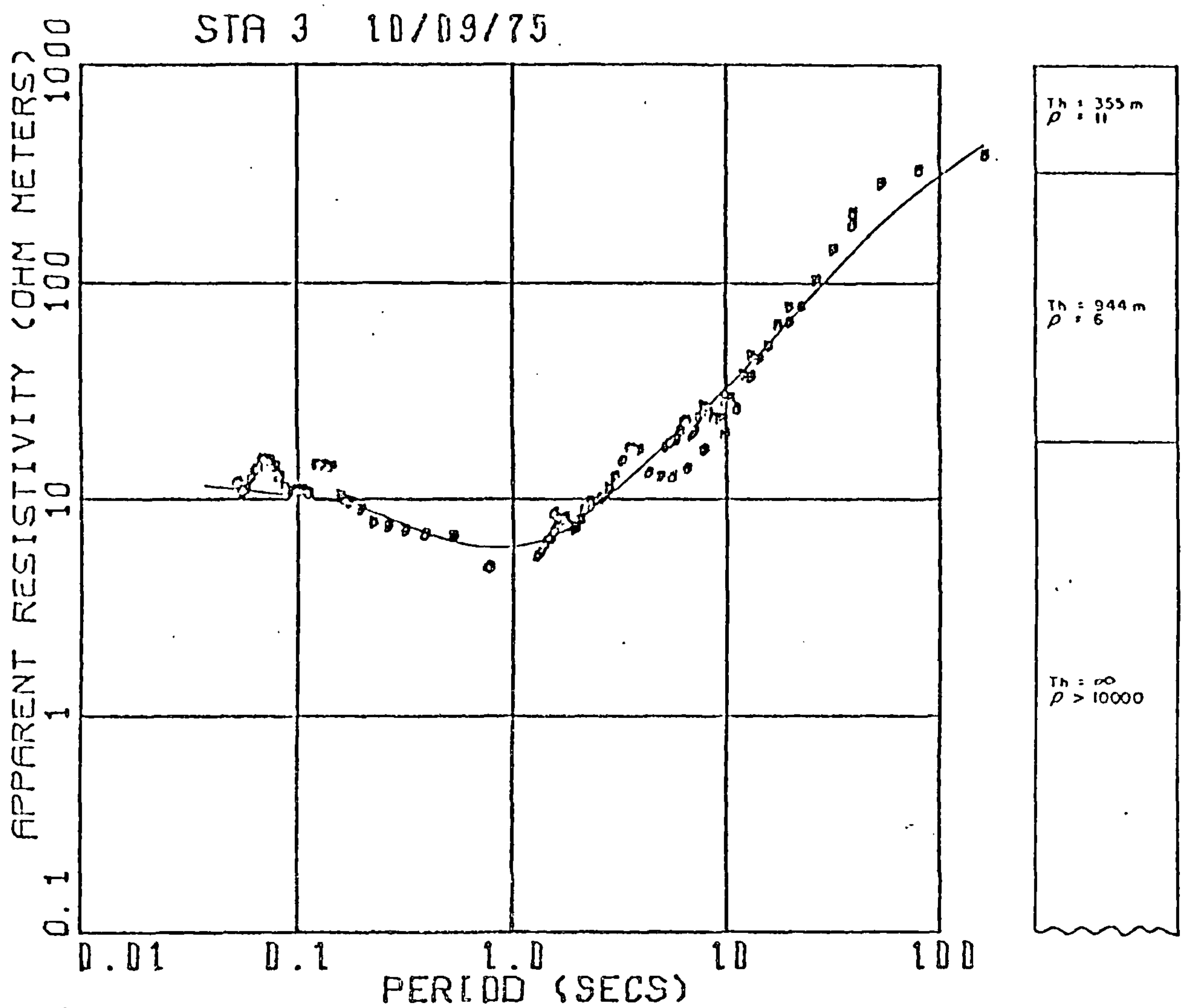

STA 3 10/09/75
APPARENT RESISTIVITY (OHM METERS)
1000
100
10
1
0.1
0.01
0.1
1.0
10
100
PERIOD (SECS)
Th : 355 m
ρ : 11
Th : 944 m
ρ : 6
Th : ∞
ρ > 10000

FIGURE 4

RESUMES

RESUME

LEWIS J. KATZ

Senior Geophysicist
Seismic Exploration, Inc.

EDUCATION: B.S. (Geophysics) 1971, University of Utah

M.B.A. Studies, University of Nevada

SUMMARY: Mr. Katz is Co-founder and President of Seismic Exploration, Inc. His responsibilities in this role include overseeing the company's marketing and technical programs in both private and government markets. Previously, he has had processing and interpretive experience in both geothermal and petroleum exploration as well as earthquake and nuclear seismology. He has analyzed seismic groundnoise and microearthquake data to locate geothermal energy sources. As a geophysicist with Mobil Oil he interpreted and mapped seismic horizons, processed seismic data, and performed "Bright Spot" modeling techniques. In earthquake seismology, he is familiar with epicenter determinations, seismicity mapping, site amplification analysis, and the application of strain and tilt meters to earthquake prediction methodology. He is the author of several reports on ground motions and has a knowledge of FORTRAN language and its application to the IBM 360, UNIVAC 1108, and CDC 6600 computer systems. Mr. Katz is a member of the Society of Exploration Geophysicists and Seismological Society of America. He has had an AEC "Q" clearance.

PROFESSIONAL EXPERIENCE

SEISMIC EXPLORATION, INC. (May 1975 to Present)

Co-founder and president. Responsible for supervising the company's marketing and technical programs. This includes visiting clients, writing advertising literature and government proposals, and developing pricing structure. Mr. Katz takes an active role in data field acquisition, processing, interpretation, and writing final reports. He also participates in basic research projects, programming, and design of passive seismic exploration programs. Among his more significant technical achievements is the development and application of microtremor (groundnoise) techniques in geophysical exploration and seismic risk studies. These methods have been successfully applied by him in the search for uranium, copper, and geothermal resources. Initial results from his work indicate an intriguing new tool for geophysical exploration.

SENTURION SCIENCES, INC. (one-half year) Project Geophysicist

Responsibilities include seismic evaluation of geothermal prospects and nuclear site analysis studies. In geothermal exploration, Mr. Katz has evaluated numerous geothermal prospects by passive seismic groundnoise and microearthquake methods throughout the western United States. Upon completion of evaluation, a written report was submitted to the client. As project manager for nuclear site evaluation, Mr. Katz has written proposals, calculated smooth design response spectra, and has estimated site amplification effects. His research achievements include correlating microtremor spectra to the frequency dependent amplification characteristics of local geologic layers. This work is relevant in understanding and correcting for geologic amplification effects in geothermal groundnoise and site analysis studies. Other interests involve modeling anomalous high amplitudes (bright spots) on reflection seismic surveys for geothermal reservoirs.

MOBIL OIL CORPORATION (one and a half years) Geophysicist

Mr. Katz has completed seismic interpretation and mapping projects in such areas as the North Slope of Alaska, Celtic Sea and Nigeria. He has processed and analyzed seismic data on the CDC 6600 and Raytheon Phoenix computers. He has also modeled anomalous high amplitude events (bright spots) for the presence of hydrocarbons.

ENVIRONMENTAL RESEARCH CORPORATION (two years) Member of Technical Staff

Worked under a U.S.G.S. contract studying the effect that reservoir loading, at Lake Mead, has on triggering earthquakes. Utilizing a two-dimensional seismic scale model, Mr. Katz has completed research on the effect that topography has on ground motions. This project required the generation, collection, processing (digitizing, Fourier Spectra, Response Spectra-PSRV), and analysis of data (seismograms). Mr. Katz has written a chapter on "The Effects of the Recording Site Geology on Ground Motions" which is to be incorporated into a manual on ground motion prediction procedures. An analytical model derived from the Thomson-Haskell matrix formulation is used in this chapter to estimate the amplification effect in terms of observable physical parameters. Other responsibilities included the assumption of project manager for comparing and analyzing the amplitude and frequency characteristics of observed nuclear generated seismic waves to those predicted.

UNIVERSITY OF UTAH SEISMOGRAPH STATIONS (one-half year, part-time)

At the University of Utah, Mr. Katz worked under Dr. Kenneth L. Cook, gathering and correlating data for the determination of epicenters of earthquakes occuring in Utah. These epicenters were used by Mr. Katz to compile a seismicity map of Utah which is to be published by the Utah Geological and Mineralogical Survey. He also collected strain and tilt meter data that were correlated to earthquakes to determine if it was feasible to use such data in predicting earthquakes.

PROFESSIONAL PUBLICATIONS

"A Model Study of P Waves Incident on a Two Dimensional Topographic Feature," (co-author), EOS Transactions of the American Geophysical Union, (Abstract), V53, No. 11, November, 1972.

"Ground Motions Recorded at Selected Stations from Nuclear Events Detonated Between September, 1970 and August, 1971," NVO-1163-TM-31, Report to the U.S. Atomic Energy Commission, 1968, (classified--not available to the general public).

"Topographic Effects on Ground Motions for Incident P Waves: A Model Study," (co-author), Report to the Atomic Energy Commission, NVO-1163-237, 1973, (available from Nat'l Tech. Inform. Service).

"Prediction of Ground Motion Characteristics of Underground Nuclear Detonations," (co-author), Report to the Atomic Energy Commission, NVO-1163-239, March 1974, (available from Nat'l Tech. Inform. Service).

"Topographic Effects on Ground Motions for Incident P Waves: A Model Study," (co-author), Bulletin of the Seis. Soc. Amer., Vol. 64, No. 2, April, 1974.

"Passive Seismic Exploration Programs for Geothermal Resources," (co-author), Geoth. Energy Magz., November 1975.

"Geologic Amplification Corrections for Geothermal Groundnoise Spectra," (co-author), (abstract), Trans. Am. Geop. UN (EOS), V. 56, No, 12, p. 1020.

"Microtremor Analysis of Local Geological Conditions," Bull. Seis. Soc. Am., V. 66, No. 1, February 1976.

"Alluvial Depth Determination by a Passive Seismic Technique," (co-author), paper presented at Soc. Explor. Geophys. 29th Annual Mid-Western Explor. Meeting, March 1976.

"Microtremor Applications in Site Evaluation Studies," (abstract), Earthquake Notes, Eastern Sect. Seis. Soc. Am., V. 47, No. 2, April 1976.

"Microtremor Site Analysis Study at Beatty, Nevada," (co-author) report to the U.S. Nuclear Regul. Comm., Wash. D.C., contract DR-76-2645, January 1977.

"Mapping Seismic Activity in Geothermal Regions," (co-author) (abstract), Trans. Am. Geophy. Un. (EOS), December 1977.

"Microtremor Site Analysis Study at Beatty, Nevada" (revised), (co-author), submitted for publication to Seis. Soc. Am., October 1977.

OTHER PROFESSIONAL PRESENTATIONS

Invited Panelist, Conference on Exploration for Geothermal Reservoir, sponsored by Natl. Sci. Found. & Colo. Sch. Mnes, May 1976.

Planning Consultant, ERDA's geothermal seismic program FY 1978, July 1, 1977.

RESUME

NAME - Robert Steve Bellon

EDUCATION - Salt Lake School of Electronics

CLEARANCE - Secret Clearance U.S.A.F.

SUMMARY - Mr. Bellon has twelve years experience with seismic recording systems. This experience includes the installation, maintenance, calibration, and operation of both strong motion and microearthquake networks. As field supervisor for the University of Utah seismograph stations Mr. Bellon has been responsible for the operation of a 40 element seismic array in addition to portable microearthquake systems. He also has several years of analytic experience in interpreting seismograms.

PROFESSIONAL EXPERIENCE

Seismic Exploration Inc. (1976 - present)

Manager of Field Operations - Responsibilities include system design, maintenance, and operation of sophisticated digital seismic recording system. He is experienced in deployment of this system which includes evaluating data quality in the field. Other responsibilities include writing pre-survey environmental impact statements and obtaining government permits to conduct exploration activities.

University of Utah Seismograph Station (1969 - 1976)

Seismic Field Supervisor - Mr. Bellon was responsible for the operations, calibration and maintenance of a 40 element seismic array and portable microearthquake systems. He also has installed various types of seismometers that required a working knowledge of electronics. In addition to supervising field operations. Mr. Bellon analyzed seismic data for epicenter determinations.

Teledyne - Geotech (1965 - 1969)

Research Technician - At geotech, Mr. Bellon installed, calibrated, and maintained seismological data systems. These systems required the use of electronics and electromechanical instrumentation to receive, graph, and record seismological data.

Texaco (1965)

Recorders Helper

PUBLICATIONS

"Microtremor Site Analysis Study at Beatty, Nevada," (co-author) report to the U.S. Nuclear Regul. Comm., Wash., D.C., Contract DR-76-2645, January 1977.

"Microtremor Site Analysis Study at Beatty, Nevada (revised), (co-author), submitted for publication to Seis. Soc. Am., October 1977.

RESUME: PAUL R. DONALDSON

ADDRESS:

Home: 2845 Snowflake Drive
Boise, Idaho 83706

Office: Department of Geology and Geophysics
Boise State University
Boise, Idaho 83725

PERSONAL DATA:

Birth date: January 11, 1945
Height: 68 inches
Weight: 150 pounds
Health: excellent, no physical limitations
Marital status: married, four children
Citizenship: U.S.
Social security number: 528 60 1813
Hobbies: golf, skiing, handball, camping, woodworking

EDUCATION:

Cyprus High School, Magna, Utah
Diploma: May, 1963, high honors
Received a congressional appointment to the U.S. Naval Academy (not accepted)

Stanford University, Stanford, California
Attended: 1963-64
Scholarship: National competition NROTC scholarship
Participated in intercollegiate wrestling and Naval ROTC

University of Utah, Salt Lake City, Utah
Attended: 1967-70
Bachelor of Science, Geophysics, Cum Laude, June, 1971
Scholarships: University Merit Scholarship, Humble Oil Scholarship in Geophysics, Society of Exploration Geophysicists Foundation Scholarship (2 years), AMAX Scholarship in Field Geology
Elected to Phi Eta Sigma national honorary fraternity

Colorado School of Mines, Golden, Colorado
Attended: September, 1971 to October, 1974
Degree: PhD. Geophysics, Geology Minor, Dec. 1974
Fellowships: National Science Foundation research assistanceship, Air Force Cambridge Research Laboratories research assistanceship, Office of Naval Research Fellowship
Elected President, Graduate Student Association, 1972-73

PROFESSIONAL ACTIVITIES: Organizations: Society of Exploration Geophysicists, American Institute of Mining, Metallurgical and Petroleum Engineers, Sigma Gamma Epsilon

EMPLOYMENT:

June, 1964--January, 1969
Kennecott Copper Corporation, Magna, Utah
Supervisor: Jay Perkins (most recent)
Worked in most phases of copper concentrator operations and in many areas of maintenance and support

June, 1969--September, 1969
Earth Resources Corporation, Golden, Colorado
Supervisor: Dean Millman, Project Geologist
Worked as an assistant geologist making detailed section measurement and description. This work was part of a uranium exploration program.

January, 1970--December, 1970 (summer and part time)
Kennecott Exploration Incorporated, Salt Lake City, Utah
Supervisor: Howard Ross, Geophysicist
Assistant Geophysicist: Conducted ground magnetic surveys, rock magnetic property determinations and related sampling programs. Participated in aeromagnetic interpretation and associated computer modeling. All activities were related to base metals exploration.

January, 1971--September, 1971
Amoco Production Company, Denver, Colorado
Supervisor: Tom Steele, Senior Geophysicist
Geophysicist: Worked in reflection seismic data processing, mapping and interpretation related to petroleum exploration.

May, 1972--September 1974 (summers and part time)
Group Seven Incorporated, Golden, Colorado
Supervisor: George V. Keller, president
Geophysicist and Field Party Chief: Collection of field resistivity data, reduction of data and preparation of maps. All work was related to the evaluation of geothermal energy potential.

EMPLOYMENT (continued):

October, 1974--January 1975
U.S. Geological Survey, Denver, Colorado
Supervisor: A. H. Balch
Research Geophysicist: Research related to the geophysical delineation of stratigraphic controls on petroleum and groundwater.

January, 1975--Present
Boise State University, Boise, Idaho
Supervisor: J. K. Applegate, Dept. Chairman
Assistant Professor, Geophysics
Primary research activities: Geophysical techniques applied to resource exploration, rock properties and engineering problems.

July, 1975--Present
GeoTechniques, Inc., Boise, Idaho
Principal Scientist and Exec. Vice President
Geophysical and geological engineering services to the civil engineering, mineral and energy industries.

PUBLICATIONS:

"Electromagnetic Surveying and Map Variation in Rock Strength," with G. V. Keller, AFCRL-TR-74-0087, 1974.

"Geotechnical Parameters and Their Relationship to Rock Resistivity," Proceedings of the 13th Annual Symposium on Engineering Geology and Soils Engineering, Moscow, Idaho, 1975.

"Boise Geothermal Project: A Progress Report," with others, The Geological Society of America Abstracts with Programs, Vol. 7, no. 5, 1975.

"Evaluation of the Geothermal Potential of the Boise Front, Idaho," with J. K. Applegate, abstract, Geophysics, Vol. 41, no. 2, 1976.

"Passive and Active Seismic Study and the Geologic Structure of the Boise Front, Idaho," with J. K. Applegate, abstract, Geophysics, Vol. 41, no. 2, 1976.

"Rock Resistivity and Geotechnical Parameters," abstract, Annual Meeting of Association of Engineering Geologists, Lake Tahoe, Nevada, 1975.

"The Cascade Area: A Geothermal Prospect in the Idaho Batholith," with others, abstract, The Geological Society of America Abstracts with Programs, Vol 8, no. 3, 1976.

PUBLICATIONS (continued):

"Geoelectrical Investigations of the Boise Idaho Geothermal System," with J. K. Applegate, abstract, The American Association of Petroleum Geologists, Rocky Mountain Section, 25th Annual Meeting, 1976.

"Geologic and Seismic Studies of the Boise Front, Idaho, for Geothermal Resource Evaluation," with J. K. Applegate and L. L. Mink, abstract, 25th Annual Meeting, Rocky Mountain Section of The American Association of Petroleum Geologists, Billings, Montana.

"Borehole Geophysics Evaluation of the Raft River Geothermal Reservoir, Idaho," with others, abstract, Geophysics, Vol. 42, No. 1, 1977.

"Characteristics of Selected Geothermal Systems in Idaho," with J. K. Applegate, in "Nature and Physical Properties of the Earth's Crust," American Geophysical Union Monograph 20, 1977.

"Geophysical Investigation of Rock Properties near Silver Creek, Boise National Forest, Idaho," with J. K. Applegate, Department of Geology and Geophysics, Boise State University, Geoscience Contribution No. 107, June, 1977.

"An Investigation of the Geothermal Potential of the Boise Area, Idaho", with others, DOE 1537-1, open file report.

"High Resolution Seismic Reflection Applied to Uranium Exploration in the Gas Hills, Wyoming", with J.K. Applegate, in preparation.

RESEARCH ACTIVITIES:

Principal Investigator, "Boise Geothermal Space Heating Project," ERDA.

Principal Investigator, "Borehole Geophysics and Microseismic Studies, Raft River Geothermal System," ERDA.

Consultant on Microseismicity, "Phase 2, Cascade Geothermal Project," Idaho Nuclear Engineering Commission.

Investigator, "Portneuf Valley Energy Evaluation," Energy Experiment Station, Idaho State University.

Principal Investigator, "Feasibility of Pre-Construction Surveys to Predict Bedrock Properties of Proposed Forest Roads," U.S. Forest Service.

Investigator, "High Resolution Seismic Reflection Applied to Uranium Exploration," ERDA.

Principal Investigator, "Seismicity of Idaho and Adjacent States," Boise State University.

Participant, Phase 0 Study to determine the feasibility of utilizing an MHD energy source for deep crustal geophysical investigation, multiple university consortium, ERDA.

Principal Investigator, "Microseismic Monitoring, Boise Front," ERDA.

Proposal Reviewer, U.S. Dept. of Energy.

Principal Investigator, "Seismicity of Idaho and Adjacent States, Phase II", Boise State University.

Member, Boise City Energy Task Force.

Paul J. Beck
4905 South Eastlake Drive
Salt Lake City, Utah 84107
Phone 801-262-1761
May 1978

RESUME' of PERSONAL, EDUCATIONAL and EMPLOYMENT DATA

Personal:	Present Age:	35
	Date of Birth:	April 2, 1943
	Place of Birth:	Midland, Michigan
	Height & Weight:	6'4" 235 lbs.
	Physical Condition:	Excellent
	Marital Status:	Single
	Military Status:	1-A
	Hobbies:	Outdoor Sports

Educational:

1970: M.S. Geophysics, Geology Minor
University of Utah
Salt Lake City, Utah

1966: B.S. Physics, Mathematics Minor
University of Utah
Salt Lake City, Utah

Additional graduate work has been performed at the U.of Utah towards PhD in Geophysics, with Computer Science Minor. All classwork and language requirements have been completed in this respect.

Professional Employment:

Present Position: Geophysicist/Manager

With: Geophysical Technology Incorporated

Duties: Geophysical data processing and interpretation-computer program development-organizational tasks-technical report writing -proposal writing-cost analysis.

PARTIAL CLIENT LIST

Projects directly dealt with
by Paul Beck as
Geophysicist/Manager of
G. T. I.

Aerial Surveys
3481 South 2300 East
Salt Lake City, Utah 84109
801/272-4255

GENERAL PROJECT DESCRIPTION: Aeromagnetic data processing presentation, plotting and interpretation.

****

Mr. John F. Powers-Consulting Geologist
6660 South 2300 East
Salt Lake City, Utah 84121
801/943-1834

GENERAL PROJECT DESCRIPTION: Specialized computer program development for geological modeling and interpretation of gravity, magnetic, electrical (I.P. and E.M.) and geochemical data.

****

Utah International
Mr. Dennis Stansbury-Mining Engineer
Cedar City Operations
20 West 2950 South
Salt Lake City, Utah 84115
801/487-9641

GENERAL PROJECT DESCRIPTION: Magnetic modelling of ground magnetic survey with interactive graphics computer program developed by Paul Beck for Utah International which resulted in location of addional iron ore reserves in Cedar City area.

****

NL Industries
Mr. Ted F. Posey-Geophysicist
5926 McIntyre
Golden, Colorado 80401

GENERAL PROJECT DESCRIPTION: Development of in-office teletype system for gravity and magnetic modelling to be used by NL Industries professional staff.

American Smelting and Refining Company (ASARCO)
Dr. Jerry Montgomery-Geophysicist
3422 South 700 West
Salt Lake City, Utah 84119
801/262-6621

GENERAL PROJECT DESCRIPTION: Applied the spectral analysis method of aeromagnetic data interpretation for depth to basement studies of several survey areas.

****

Kennecott Copper Corporation
Dr. Richard Fox-Geophysicist
2300 West 1700 South
Salt Lake City, Utah 84104
801/972-2004

GENERAL PROJECT DESCRIPTION: Multichannel airborne radiometric and magnetic data processing, reduction and interpretation.

****

Applied Geophysics Incorporated
Mr. S. Parker Gay, Jr.-Geophysicist
675 South 400 East
Salt Lake City, Utah 84111
801/328-8541

GENERAL PROJECT DESCRIPTION: Assisted development of computer programs for processing, presentation and interpretation of airborne multichannel radiometric and magnetic data. These programs were designed specifically for the AGI aerial platform systems.

****

Cities Service Minerals Corporation
Mr. Jack Corbett-Geophysicist
Kearns Building
Salt Lake City, Utah 84101
801/355-1756

GENERAL PROJECT DESCRIPTION: Developed interactive graphics magnetic modeling program for specific client interpretational needs.

****

RESUME

DENNIS POTTS

Geophysicist

EDUCATION: B.S. (Geophysics) 1972, University of Utah

SUMMARY: Mr. Potts is currently employed as a field geophysicist with Seismic Exploration, Inc. At the University of Utah his formal education included data acquisition and interpretation of gravity, magnetic and seismic data, as well as an extensive field course in geologic mapping.

3 H

Management and Reservoir Assessment of the Geothermal Resources of The Northern Basin and Range Province

A Proposal Submitted to

The United State Department of Energy

by

California State Lands Commission

Wm. F. Northrop
Executive Officer

D. J. Everitts
Chief, Division of Energy and Mineral Resources

R. G. Paul
Program Manager

R. A. P. Gaal
Co-Principal Investigator

Iraj Ershaghi
Principal Investigator

W 40121

May 26, 1978

Abstract

The California State Lands Commission proposes to participate in the development of the geothermal resources of the Northern Basin and Range Province with the specific responsibilities of management and review function and reservoir assessment. The staff of the State Lands Commission has extensive training and considerable experience in supervising and coordinating leasing development activities on California State-owned lands. These activities include exploration, drilling and production operations on oil, gas and geothermal leases.

No intention of actually drilling the wells or logging is implicit in this proposal. It is envisioned, however, that through our cooperative effort with DOE and other parties who will show interest to implement the drilling phase of the project, a successful reservoir assessment program may be embarked upon for optimum development of the geothermal resources of the Battle Mountain Heat Flow High area.

INTRODUCTION

To expedite the development of the geothermal resources of this nation, we believe there is a need for further integration and coordination of efforts currently underway by various governmental agencies, academic institutions, and industry. These talents, services, and facilities when put together should lead to a more effective applied research program. It is in this spirit that we believe our expertise will be of considerable value to the Department of Energy. Before spelling out the details of our proposal, a brief description of our function, responsibilities, and expertise within the California State government may be in order.

California State Lands Commission is specifically charged with the responsibility of managing all mineral lands owned by the State. Included in this charge is responsibility for supervising all oil, gas, and geothermal operations on State-owned lands in California. In this capacity, the State Lands Commission staff reviews and supervises the exploration, drilling, and production operation on State Leases; conducts reservoir engineering studies to determine reservoir productivity and deliverability forecasts by primary, secondary, or tertiary methods for the short and long-term projection of royalty revenue; prepares and reviews environmental impact studies on various extractive operations; and constantly monitors the field operational procedures of various operators.

The technical staff directly involved in the assessment of oil, gas, and geothermal operations is functionally classified as follows:

1. Engineering and Geological Evaluation

   This group provides services of a reservoir engineer, well log analysts, marine geologists, petroleum geologists, and geothermal engineers.

   Economics of varying methods of operation to the operator as well as to the State are also determined by economic analysts.

2. Drilling Evaluation

   This group consist of drilling and production engineers, and facilities engineers, as well as field inspectors.

3. EIR Preparation

This group consists of specially trained individuals to collect and process data on the environmental impact and mitigating effects of any proposed operation.

4. Electronic Data Processing

This group consist of competent scientific programmers trained to provide services on existing reservoir assessment programs developed for specialized cases.

For this specific proposal it is appropriate to discuss some of our past studies and experiences in the area of geothermal development.

PROJECT PLAN

State Lands Commission (SLC) proposes to participate in the development of the proposed geothermal site as an advisory group to DOE in the following capacities:

Phase 0 - Advisory group during the planning of the drilling operation:

a. well site selection

b. review of drilling plan submitted by the drilling contractor

c. recommend borehole geophysical surveys

Phase 1 - Advisory group specifically recommending and designing pressure transient tests including pulse, interference, pressure buildup and reservoir limit tests.

A subcontractor would be employed to run the proposed tests. SLC staff shall, however, monitor the tests and collect the data.

Phase 2 - Advisory group specifically analyzing and interpreting the borehole geophysical surveys and the pressure transient tests.

The results of the surveys and the tests would be submitted in terms of description of the reservoir configuration and the prospects for alternative modes of reservoir exploitation.

RESERVOIR ASSESSMENT PLAN

There is no unique approach to establish the subsurface reservoir configuration and mechanics. The combination of geophysical logs, core data, and pressure transient and well production tests may be employed to construct pertinent subsurface maps. Data from these maps are utilized to delineate the individual sub-reservoirs, and to provide data on the overall reservoir geometry, boundaries and recharge systems.

In order to construct a useful comprehensive reservoir model, a minimum number of wells must be drilled into the reservoir and logged and tested. Table 1 shows the extent of useful reservoir data which may be obtained based on an increasing number of deep wells.

A relatively comprehensive model, of the subsurface geothermal reservoir, therefore, requires at least two to three wells with a complete suite of geophysical well logs, pressure and flow test data, and core analysis data.

Information Derived from Core Analysis

Identification of the mineral composition of the reservoir rock is a very important step in geothermal reservoir description. The lithology determines the type of expected porosity and permeability. Furthermore, based on the degree of hydrothermal alteration as a function of drilled depth a pattern for subsurface flow and percolation path may be established. The lithological description will also support the quantitative analysis and interpretation of the well logs.

We propose to conduct complete core analyses on the core material obtained from the test wells. The laboratory measurements are proposed to be conducted through a cooperative effort with the departments of petroleum engineering and geology at the University of Southern California. From the core analysis we would furnish the following data on the reservoir rock:

1. X-ray diffraction
2. Porosity
3. Permeability
4. Formation resistivity factor
5. Sonic and elastic properties

Data Obtained From Geophysical Logs

Available published data indicate the subsurface temperature ranges at the project site are estimated at 240° C (464° F), which is considered to be well within the capability of the HEL system (Hot Environment Logging). This system is considered adequate for the expected temperature range. However, through cooperation with the Sandia Laboratories, we propose to make runs with their new and improved tools which can withstand a much higher temperature regime.

The recommended suite of logs to evaluate the reservoir include:

1. Dual Induction Laterolog
2. Gamma Ray and FDC
3. BHC Sonic Log
4. Temperature Log
5. Neutron Log

TABLE 1

No. of Well	Convection Cell	Salinity Profile	Lithology	Reservoir Limits	Productivity	Transmissibility	Heterogeneity	Recharge	Feasibility of Pressure Maintenance
1.	Temp. Log	Well Logs	Coring/ Logs	Pressure Transient (not well defined	Flow Tests	Pressure Transi- ent	Not Well Defined	Not Well Defined	Impractical
2.	Temp. Log	Well Logs	Coring/ Logs	Improved Defini- tion	Flow Tests	Pulse Test	Pulse Test	Better Defined	Better Defined
3.	Tem. Log	Well Logs	Coring/ Logs	Much Better Definition	Flow Tests	Pulse Test	Pulse Test	Improved	Improved

Reservoir Assessment Plan

Since SLC has reviewed many well logs, the services of a company such as the Schlumberger Well Logging Co. would be recommended. We have analyzed their sample work on the wells at the Cerro Prieto Field in Mexico and have found the work to be of excellent quality. From the suite of logs proposed, Schlumberger may provide the Saraband information system, which utilizes the data from the Neutron and the density logs to generate a lithology profile depicting the shale content of the rocks that have been logged.

We further proposed to physically analyze the well logs using the conventional, along with recently developed, correlations to calculate the following reservoir properties:

- Lithology
- Porosity Profile
- Salinity Profile
- Permeability Profile
- Saturation Profile

Data Obtained From the Pressure Transient Tests

Pressure transient tests constitute the backbone of reservoir engineering in petroleum industry. Their use and interpretation in existing geothermal sites to date has not been fully exploited. Recent developments in theoretical analysis of the test data and improvements in sensitive pressure gauges have opened up an exciting frontier in the assessment of geothermal reservoirs. Pressure transient tests such as pressure buildup, drawdown, two rate tests, pulse and interference tests, and deliverability tests may all be used contemporaneously to develop the most comprehensive model of the reservoir configuration. We would recommend a service company to conduct these tests according to our specifications.

We propose to design optimum tests, and interpret the test data, to provide the following reservoir characteristics.

Reservoir heterogeneity.
Reservoir Static pressure
Reservoir Transmissibility
Reservoir Boundaries
Interwell Communication
Vertical Permeability
Fracture Patterns
Wellbore Conditions

Management Plan

The entire participation by the California State Lands Commission staff or their subcontractors would be coordinated by Mr. R. G. Paul, who will serve as the Program Manager. Mr. Paul is currently a Supervising Mineral Resources Engineer with the California State Lands Commission in Long Beach.

The research effort shall be conducted under the supervision of two principal investigators, Drs. R. A. P. Gaal and I. Ershaghi. Dr. Gaal is currently a Senior Marine Geologist with the California State Lands Commission in Long Beach. In his capacity he shall be in charge of coordinating the geological studies as well as the field implementation of formation evaluation procedures. Dr. Ershaghi serves as a Petroleum Reservoir Engineer with the California State Lands Commission in Long Beach. He is also an Assistant Professor of Petroleum Engineering at the University of Southern California. His responsibilities in the project will include the design of well test procedures, recommendation on well logs, and interpretation of the basic well data.

Assisting the principal investigators will be several SLC research associates serving as drilling engineer in charge of reviewing the drilling plan, a field engineer monitoring the field operation, and reservoir engineering consultants to review the interpretation.

The logging and pressure transient tests will be conducted through the use of reputable service companies.

COMPUTER PROGRAMS AVAILABLE

1. Well Log Interpretation
2. Processing of Pressure Transient and flow tests Data
3. Deliverability forecast
4. Economic Evaluation
5. 3-D geothermal simulator
6. Casing Design

California State Lands Commission
Geothermal Reservoir Experience

A- East Mesa Area, California

No. of Wells: 5

Objective: Reserves Evaluation and Deliverability Forecast

Data Available: Well Logs
DST on Most Wells
Flow Test on Two Wells
Temperature Surveys
Heat Flow Map

Methodology and Conclusions:

1. DST data were interpreted to estimate reservoir static pressure and formation transmissibility. Transmissibilities were compared to results obtained from Saraband logs. The validity of Saraband derived permeabilities were ruled out.

2. Net sand thicknesses for individual wells were obtained and contoured. The pore volume of the reservoir in the area of interest was determined using the isopach map, the heat flow map, and the porosity values from the Saraband log.

3. Based on a material balance study it was demonstrated that for straight production and with no pressure maintenance (by reinjection of the produced fluid) the producing life of the reservoir would be less than two years. It was demonstrated, however, that by water injection the economic life may be extended to more than thirty years. In this computation, based on in-situ heat capacity of the reservoir, it was shown that up to two pore volume of the fluid in place may be injected before the reservoir temperature would drop to unacceptable levels.

4. Salinities computed from resistivity logs and the analysis of produced water indicated that the concept of sudden pressure drop to create a vapor dominated system may not be a wise decision for the East Mesa field. Although our hypothetical model studies using

one and two dimensional systems indicate the heat recovery may be maximized by the above process.

5. Economic utilization of a geothermal resource depends heavily on the available temperature level, and the existing technology. At the time the study was done, temperatures in the range of 310° - 330° F were not economical. Therefore, no further action was taken at that time. Recently, however, both TRW and Republic Geothermal are both reconsidering the East Mesa reservoir.

Lawrence Berkeley Laboratory has conducted many pressure transient tests to determine inter-well transmissibilities. Their results have confirmed our initial estimates from the DST analysis.

B - The Geysers Area, California

*(Because of the sensitive nature of the litigation and the fact that the decision made by Superior Court is still subject to appeal, and the confidentiality of the data, only some of the technical aspects of the reservoir study will be discussed here with no reference to specifics of conclusions.)

Objectives: Reservoir and Reserve Evaluation and Deliverability Forecast

Data Available: Pressure transient and some Flow Test; Static Pressure and temperature Surveys; Considerable Past Production Data; No Well Logs.

Methodology:

1. The well head recorded pressure transient test data were converted to bottomhole data by using a computer program utilizing static wellbore temperature surveys.

2. From the bottomhole data, and applying the conventional Horner plots (assuming radial flow), the pressure data were analyzed. It was noticed that the radial flow model may not be suitable for such data. Evidence from drilling and geological information led us to consider the flow regime to be of a semi-spherical rather

than radial system. The behavior of a semi-spherical flow system for a naturally fractured reservoir using the double-porosity model originally proposed by Warren and Root was mathematically modelled and solved both analytically and numerically.

3. From the sperical flow model, we were able to derive improved estimates of reservoir static pressure, fracture capacity, and an average spherical permeability.

4. Also, from the past production data, plots of P/Z vs. cumulative production were made. This information plus a limited amount of back pressure test data on few selected wells enabled us to make deliverability forecast on three distinct portions of the reservoir. A computer program to make the deliverability forecast was developed for this purpose.

   In the absence of well logs, the location of steam entry points compiled from drilling data were used to construct a 3-D peg model illustrating fracture pattern and distribution. Currently, this concept is being considered for modelling on our digital computer. The objective is to generate three dimensional description of fracture orientation and use the information for extrapolation to areas surrounding The Geysers.

5. The shut-in pressure data as they become available are continuously being received by our geothermal operations staff on the Geysers wells and used for updating the P/Z curves and monitoring the reservoir pressure.

6. Our past economic studies on the Geysers area mostly have consisted of estimates of future royalty income from the field and determination of risk weighted optimum bid bonuses on new areas offered for leasing. Computer program to conduct economic evaluation and forecasting and a specific statistical model to digest

past history of the field and make risk-weighted forecasts about the reserves of the unleased areas have been developed by our staff.

C - The Cerro Prieto Field, Baja, California

Objective: Well Log Interpretation

Data Available: The following logs are available on most wells:

a. IES for shallow depths

b. Dual-Induction Laterolog

c. Density Log

d. Neutron

e. Saraband

f. Microlog

In addition, static temperature surveys on some wells are available.

Methodology:

The interpretation of the well logs by our staff has just been started. Based on some preliminary work the following observations have been made:

1. Conventional empirical correlations used in the interpretation of well logs at low temperatures (such as those used in petroleum industry) may have shortcomings at temperature ranges existing in the Cerro Prieto area.

2. The logs indicate the presence of sand-shale series in the producing section of the reservoir. Salinity data are being interpreted to determine the flow path in vertical cross sections of the reservoir.

3. From the physical property measurements currently being made at elevated temperatures (under a separate contract with the U.S. D.O.E.) attempts are underway to interpret the log derived values using the newly developed correlation.

4. Using a novel technique developed by one of our staff members, the permeability profile in individual wells are being determined from well logs. The objective is to compare the results to transmissibility values available from well test data.

CURRICULUM VITAE

Robert G. Paul
5172 Del Sur Circle
La Palma, California 90623

213-590-5202 (Office)
714-828-3375 (Home)

1976-Present STATE OF CALIFORNIA, STATE LANDS COMMISSION

Supervising Mineral Resources Engineer.
Supervisor of Geologic and Engineering Evaluation Section, consisting of multidisciplinary team of professional licensed geologists, engineers and oceanographers. Provide technical analysis and evaluation of all onshore and offshore oil and gas, geothermal and mineral operations for State of California.

1975-1976 U.S. GEOLOGICAL SURVEY, CONSERVATION DIVISION

Staff Geologist.
Technical subsurface studies relative to development of OCS field reserves and tract evaluation for Lease Sale No. 35. Resource potential studies for proposed Lease Sale No. 48. Coordinate preparation of OFR 76-232.

1961-1975 STATE OF CALIFORNIA, STATE LANDS COMMISSION

Engineer and Geologist.
Supervise professional geologic team in evaluation of onshore and offshore oil and gas, geothermal and mineral operations. Provide geological and engineering analysis of oil and gas and geothermal leasing and development to determine the State equity and protect the State's interest.

1959-1960 PETERS FORMATION LOGGING COMPANY

Well site geologist.
Analysis of oil and gas well data and preparation of a continuous log of drilling and geologic data.

EDUCATION	University of California at Los Angeles - B.A. Geology 1959.
	Currently M.S. candidate at University of Southern California in Petroleum Engineering.
	Active in A.I.M.E. and A.A.P.G. continuing education program.
PROFESSIONAL	Registered Geologist No. 855 - State of California.
	Member Pi Epsilon Tau - National Petroleum Engineering Honor Society.
	Member of American Association of Petroleum Geologists - Pacific Section.
	Past member of Society of Petroleum Engineers of A.I.M.E,
	Member of Society of Professional Well Log Analysts - Pacific Section.
BACKGROUND	Health excellect: height 6'0", weight 180 pounds.
	Born December 23, 1933.
	Married with two children. Wife is credentialed elementary school teacher.
	Served two years (1954-56) in U.S. Army; honorably discharged.
PUBLICATIONS	Authored geology and reserves portion of "The Offshore Petroleum Resource", California Resources Agency, 1970.
	Authored Offshore Geology and Mineral Resources portion of "COAP Development Plan", California ICOR, 1971.
	Authored report to California Legislature on "California Offshore Oil Resources", 1974.
	Senior author and editor of OFR 76-232, "Geological and Operational Summary, Southern California Deep Strat Test OCS 75-70 No. 1", 1976.

May 18, 1978

Addendum to the Curriculum Vitae
of
Robert G. Paul

Geothermal Experience

1. Evaluation of permit areas proposed for conversion to lease within known Geothermal Resources Areas in the Geysers area pursuant to Section 6912(b) of the Public Resources Code:

   a) PRC 3708.2, Seghesio property, Mendocino County
   b) PRC 3496.2, Cobb Mountain, Lake County
   c) PRC 4339.2, Horner State, Lake County

2. Extended term of permit for applicant in 1977 in Surprise Valley, Modoc County, based on evaluation of the integrated well data, geology, temperature data, gravity and seismic data.

3. Developed risk-weighted economic program for evaluation of sufficiency of geothermal net profits bidding. This program is currently being expanded to further account for the probability distribution of analog input variables and develop a comprehensive monte carlo simulation program. Reduction of capital and operation cost factors for production scenarios, extrapolated reservoir data, and rate and price variables are necessary to complete the program.

CURRICULUM VITAE

NAME: IRAJ ERSHAGHI, P.E.

DATE OF BIRTH: August 1, 1942

PLACE OF BIRTH: Tehran, Iran

HOME ADDRESS: 1021 Via Ventana
Palos Verdes Estates, CA 90274

EDUCATION

B.S. Petroleum Engineering, 1965, University of Tehran, Iran

M.S. Petroleum Engineering, 1968, Univ. of Southern California

Ph.D. Petroleum Engineering, 1972, Univ. of Southern California

PROFESSIONAL EXPERIENCE

September, 1972 - to present — University of Southern California
Los Angeles, California
Assistant Professor, Petroleum Engineering

Teaching and research on enhanced oil recovery, geothermal reservoirs and pressure transients in wells. Also contributed to departmental administration.

February, 1970 - to September, 1972 — Associate Mineral Resources Engineer, California State Lands Commission, Los Angeles, CA

Responsible for reservoir engineering for the tide and submerged lands of the State of California. Emphasized computer applications to optimize State revenue from unitization of secondary recovery operations.

August, 1966 - to February, 1970 — Full-time graduate student in Department of Petroleum Engineering. Part-time graduate student February, 1970 to February, 1972.

September, 1965 - to June, 1966 — Instructor, Technical Faculty, University of Tehran, Iran

Responsible for petroleum engineering laboratories.

June, 1965 - to September, 1965 — Employed by Society Iranian-Italian Petroleum in Persian Gulf, Iran.

PUBLICATIONS

- "Problems in Estimation of Salinity Profile in Liquid Dominated Geothermal Systems," Paper Scheduled for Presentation at 1978 Annual Meeting of GRC in Hawaii(July 24-29,1978) (with E.L. Dougherty, H. Ucok, and F. Ghassemi)

- "Current Economic Appraisal of Steam and Combustion Drives," SPE 7073 paper presented at SPE Improved Oil Recovery Symposium, April 16-19, 1978, in Tulsa, OK (with T. M. Doscher).

- "Steam-Solvent Stimulation," SPE 7118 paper presented at 48th Annual California Regional Meeting, April 12-14, 1978, in San Francisco, CA (with T. M. Doscher, D. Herzberg and G. Zadi).

- "A Method for Extrapolation of Cut vs Recovery Curves," Journal of Petroleum Technology, February, 1978, p.203 (with O. Omoregie).

- "A Method for Estimating the Interporosity Flow Parameter in Naturally Fractured Reservoirs," SPE 7142 paper presented at 48th Annual California Regional Meeting, April 12-14, 1978, in San Francisco, CA (with D. Uldrich).

- "Permeability Determination in Liquid Dominated Geothermal Reservoirs Using the Dual Induction Laterolog," accepted for publication in 1978 Transactions of the Society of Professional Well Log Analysts (with E. L. Dougherty, Jr. and D. Herzberg).

- "Analysis of Pressure Transient Data in Naturally Fractured Reservoirs with Spherical Flow," SPE 6018 presented at the 1976 Fall Meeting of the SPE in New Orleans, LA (with S. W. Rhee and H. T. Yang).

- "Porosity and Permeability," a contribution to the Encyclopedia of Geochemistry and Environmental Sciences - - Edited by R. W. Fairbridge (1972) p.964-970 (with G. V. Chilingar and C. Beeson).

- "Mobility of Polymer Solutions in Porous Media," SPE 3683 presented at the 42nd Annual SPE California Regional Meeting, November, 1971, in Los Angeles, CA (with L. L. Handy).

- "Mathematical Simulation as a Means of Predicting Offshore Well Blowouts," California State Lands Commission, April, 1971.

- Book Review (G. V. Chilingar) in Eng. Geol, 4 (1970) 89-92

- "Chemistry of Interstitial Solutions in Shales Versus that in Associated Sandstones," SPE 2527 presented at the 1969 Fall Meeting in Denver, CO (with G. V. Chilingar, H. H. Rieke, III, and S. T. Sawabini).

Part Time

September, 1968 to July, 1971 - Lecturer in Department of Petroleum Engineering at USC.

September, 1967 to September, 1968 - Petroleum Engineer, Signal Oil and Gas Company. Responsible for computer application to well log application.

CONSULTING

State Lands Division, State of California
Advises on petroleum reservoir engineering, waterflooding and geothermal operations.

Southern California Gas Company
Screening of potential gas storage reservoirs in Los Angeles Basin.

TRW
Consulting on geothermal operations.

Lawrence Livermore Laboratory
Consulting on physical property measurement of reservoir rocks at elevated temperatures and pressures.

Atlantis Scientific
Consultant on environmental impact reports relative to geothermal and urban drilling.

Addendum to Dr. Iraj Ershaghi Curriculum Vitae

Teaching Experience:

Currently on the teaching staff at the University of Southern California, Dr. Iraj Ershaghi has taught the following courses:

1. Pressure Buildup and flow tests
2. Reservoir Simulation
3. Gas and Gas Condensate Reservoirs
4. Geothermal Energy
5. Improved Oil Recovery Methods
6. Fluid flow through porous media
7. Advanced well testing (scheduled for summer, 1978)

Work Experience:

Log Analysis:

1. Assistant Log-Analyst - Signal Oil and Gas Company
   Developed computerized methods for well log interpretation.

Reservoir Engineering:

1. Consultant to Southern California Gas Co. (Evaluation of prospective depleted or semi-depleted oil and gas reservoirs in the Los Angeles Basins for Gas Storage).

2. Consultant to Atlantic Scientific

   a. Evaluation of Reservoir Data for the Beverly Hills Drill-Site.

   b. Evaluation of Republic Geothermal Reservoir Study on their proposed 10 MW Development Plan in the East Mesa Area.

3. Alberta Oil Sand Authority

   Evaluation of Thermal Recovery Methods for the Viscous crude Reserves of the Alberta Province.

RÉSUMÉ FOR ROBERT A. P. GAAL

PERSONAL:

Dr. Robert A. P. Gaal
4408 Lucera Circle
Palos Verdes Estates, California 90274
Home Phone: (213) 375-5351
Birth Date: March 30, 1929
Birthplace: Hollywood, California
Security Clearance: Secret
Marital Status: Married

EDUCATION:

B.A., UCLA 1953 - M.S., USC 1958 - PhD., USC 1966
Graduate Gemologist, Gemological Institute of America
Currently enrolled in Certificate in Business Degree at UCLA and working toward MSA.

PROFESSIONAL SOCIETIES:

Certified Professional Geologist, State of California (No. 3039), and affiliated with numerous societies including Sigma Xi, SEPM, AIME, AGI, MTS, American Institute for Professional Geologists, and the American Gem Society.
Former President (1972) of the Southern California Section, American Institute for Mining and Metallurgy. Past National Vice President (1971) of the American Society for Oceanography.

EXPERIENCE:

April 1978 - Present — State Lands Commission

1972 - 1978

Name of Organization - Gemological Institute of America
Address - 1660 Stewart Street
Santa Monica, California 90404
Name of Supervisor - Mr. Richard T. Liddicoat, Jr.
President
Address - 1660 Stewart Street
Santa Monica, California 90404

Since joining GIA in 1973 general responsibilities and activities included:

- Provided technical support to GIA Gem Trade Laboratory.
- Supervised the preparation and distribution of Gems & Gemology, various books and correspondence course revisions.
- Coordinated typesetters, layout artist and copy personnel, photographers, and printers.
- Reading and reviewing all books pertaining to gemology, mineralogy, jewelry trade and associated subjects.
- Monitering all gemology and jewelry trade journal and evaluation of these works.
- Establishing and maintaining a file system on all recent data on gemology and the jewelry trade industry.
- Preparing cost estimate associated with publications, preparation of proposals, trade show exhibits, and purchase of scientific instruments and office equipment.
- Determining requirements for the acquisition of new scientific laboratory instruments.
- Performing tests on gem materials using the Electron Microprobe Analyzer, X-ray analyses, cathodoluminescence, infra-red, ultra-violet, and visible spectrophotometry, phase contrast and polarizing microscopy.
- Research on gem materials.
- Lecturing and public information officer functions.
- Supervising Research Library.

1966 - 1972

Name of Organization - TRW Systems, Inc.
Address - One Space Park, Redondo Beach
California 90278
Name of Supervisor - Dr. A. B. Michelwait
Address - One Space Park, Redondo Beach R3/2194
California 90278

Activities at TRW included planning, direction, managing, analysis, and interpretation functions on several studies and projects such as: Geologic and oceanographic study of the Gulf of Tonkin for U.S. Navy; feasibility studies and research in commercial oceanography earth resources satellites; study for the National Academy of Engineering on

1966-1972 TRW Systems, Inc.,...continued

Military oceanography; study of the National Data Program for the Marine Environment; engineering geology missile site selection studies for numerous classified projects; research in VLF, ELF and low frequency electromagnetic prospecting instrumentation with concurrent model and field studies for the exploration of ore deposits, ground water, and determination of physical rock properties and structures; studies in lunar geology and in remote sensing using multi-sensor approach both in laboratory and field. Last assignment (1969-1972) was Chief Geologist of OMAR Explorations, Inc., a subsidiary of TRW, Inc., managing and directing a geologic analysis group on a $3 million worldwide mineral exploration program using the most sophisticated instruments and techniques available. Also, assisting and applying the most recent computer technology to geologic analysis and natural resource studies.

1962-1966

Name of Organization - LA County Museum of Natural History
Address - 900 Exposition Blvd. Los Angeles, Calif.
Name of Supervisor - Dr. Theodore Downs
Address - Chief, Earth Science Division (above address)

Curator of Mineralogy and Geology: Actively engaged in research, display and educational functions of the Museum. Directed extensive studies of rocks and minerals in Mexico and SW U.S. Did structural mapping and petrology/petrography of Pajarita Pk., N. Mexico; worked on origin of the Bottomless Lakes, N. Mexico. Worked on clay minerals in the southern California offshore basins. Prepared, catalogued, identified, and described minerals and rocks in Museum collection. Collected and purchased minerals and gems for exhibits. Prepared traveling geologic and mineral exhibits. Gave public lectures and taught Museum courses in geology and mineralogy. Wrote numerous popular mineral articles. Supervised assistants and museum personnel. Interfaced with the public; mineral clubs, local universities, industry, and governmental agencies.

1963-1966

Name of Organization - Whittier College
Address - 13421 E. Philadelphia Street Whittier, Calif. 90601
Name of Supervisor - Dr. Beach Leighton, Chairman
Address - Dept. of Geology (above address)

Instructor and Lecturer in undergraduate Mineralogy, Petrology, and Structural Geology. Numerous field trips were taken to classic mineral localities in the western U.S. Students did original research on rocks and minerals in the southern California area. Established a working rock and mineral student collection and a Geology Museum collection. Geochemistry and Principles of Ore Deposits were taught as part of the 8 unit mineralogy course. X-ray and optical methods were introduced. Gemology was also taught. Also taught petrology and petrography in Spring of 1971.

1956 - 1962

Name of Organization - U.S. Geological Survey
Address - Ground Water Branch, Albuquerque, New Mexico
Name of Supervisor - Mr. William Hale
Address - Box 4369, University of New Mexico Campus

Ground Water Geologist on WAE status for U.S. Geological Survey in New Mexico. Project Chief of Three Rivers Area, New Mexico, involving detailed and reconnaissance geologic mapping, ground water, and hydrologic study of the area to supplement water for the White Sands Missile Proving Grounds. Reconnaissance geologic mapping, well logging, and ground water study of about 10,000 square miles of SE New Mexico for a basic recharge study. Initiated use of radar to locate storms and potential recharge areas. Ground water study of underground atomic test site for Project Gnome, Operation Plowshare, Carlsbad Area, New Mexico. Worked only during field seasons.

1959 - 1961

Name of Organization - Republic Resources and Development Corporation
Address - Manila, Philippines
Name of Supervisor - Lowell A. Rassmussen
Address - 2120 E. 4th Street, Casper, Wyoming

Petroleum Geologist and supervisor in charge of both on and off shore geological and geophysical surveys for determining subsurface structures in the Philippine Islands. Did geologic field mapping, well-site geology, interpretation of magnetic, gravity, seismic reflection and refraction data, integrated surface, subsurface, paleontological, and geophysical data for well site locations. Taught courses and instructed Philippine trained geologists who were mining geologists and engineers in sedimentary rock geology, petroleum geology, well-site geology, and modern well logging techniques.

1953 - 1955

Name of Organization - U.S. Army
Address - HQ JQMPD - Yokohama, Japan

U.S. Army Petroleum Branch, Far East Headquarters, Japan, Chief Yoshira Petroleum Quality Control Testing Laboratory. Member of four-man team establishing the Chinese Nationalist Military Petroleum System, Formosa. Project leader of loss-gain studies involving ship and ship-shore petroleum transmission, storage, and handling problems. Author of U.S. Standard Operating Procedures for Military Petroleum Storage, Sampling, and Testing for Far East, 1955. Recipient of U.S. Army Commendation Ribbon. Mapped detailed geology of underground petroleum storage areas in Japan. Petroleum Liaison for HQ JQMPD in Far East.

PUBLICATIONS:

Establishment & Analysis of Chinese Nationalist Military Petroleum System, Formosa, 1954, Military Assistance Advisory Group, U.S.A.F., Tapei, Formosa (250 pages).

Standard Operational Procedures for Sampling, Testing & Storage of Military Petroleum Products for Joint Forces in Far East, 1955, U.S. Army Headquarters Japan Quartermasters Petroleum Depot, Yokohama, Japan (300 pages).

Geology and Hydrology of the Three Rivers Area, New Mexico, 1959, U.S Geological Survey (48 pages).

Preliminary Report on the Geology of the Pajarito Mountain Area, New Mexico, 1960, with W. S. Motts, in AAPG Bulletin, Vol. 44, No. 1, pp 108-120.

Geological Map of the Green Springs Quadrangle, Nevada, 1962, in Webb & Wilson "Progress Geologic Map of Nevada, "Nevada Bureau of Mines Map 16.

The Marine Geology of the Palos Verdes Shelf, California, 1963, with E. Uchupi, in Emery Commemorative Volume, Allan Hancock Foundation, Los Angeles, Calif., (22 pages).

Gems of Geology, 1963, Los Angeles County Museum of Natural History Quarterly, Vol. 3, No. 1, pp 21-30.

Geologic Map of the Central Portion of the Green Springs Quadrangle, Nevada, 1965, in "Preliminary Geologic Map of Nevada, "U.S. Geological Survey.

Geologic Map of the Three Rivers Area, New Mexico, 1965, in Dane and Bachman "Geologic Map of New Mexico," U.S. Geological Survey.

Marine Geology of the Santa Catalina Basin, California, 1966, Dissertation, University of Southern California; Abst, University of Michigan.

Oceanography & Marine Geology of the Santa Catalina Basin, California, 1966, in the Proceedings of the Pacific Science Congress, Tokyo, Japan.

Electromagnetic Depth Sounder, 1970, with G. Inouye, H. Bernstein, in the Proceedings of the International Conference on Geoscience Electronics, IEEE, Washington, D.C. (35 pages).

Military Oceanography, with S. Rothman, for National Academy of Engineering, Committee on Oceanography (46 pages).

North Slope - Past, Present and Future for the 1970 National Marine Science in Education Conference, Catalina Island, California, Sea Grant, Abst.

Oceanography, 1973, Chapter 14, pp. 318-334, in California-Past, Present, Future, Information Almanac, published by California Almanac Co. Long Beach, Ca.

PUBLICATIONS:

Turquoise - Stone of the Ages, 1974, Terra, Vol. 13, No. 2, Fall, The Natural History Museum Alliance of Los Angeles County, Los Angeles, California.

Diamonds...Famous, Notable and Unique, 1st Edition Revised, 1974, by L. Copeland, et al., Revised by R. Gaal and J. Taylor, 252 pages.

Book Review, 1973, Minerals of Brazil, Ribeiro Franco, et al., (1972), Man-made Crystals, Joel E. Arem, (1973), "Gems & Gemology", Fall Issue, Vol. XIV, No. 7.

Book Review, 1974, An Illustrated Dictionary of Jewelry, Anita Mason, (1974), "Gems & Gemology," Spring Issue, Vol. XIV, No. 9.

Book Review, 1974, The World's Finest Minerals and Crystals, Peter Bancroft, (1973), "Gems & Gemology," Summer Issue, Vol. XIV, No. 10.

Book Review, 1974-75, The Diamond Magnates, Brian Roberts, (1972), Gemstone & Mineral Data Book, John Sinkankas (1974), Gems and Minerals of America, Jay Ellis Ransom, (1975), Hunting Diamonds in California, Mary Hill, (1972), Gems and Minerals in Color, Rudolph Metz, (1974), Pebble Collecting and Polishing, Edward Fletcher, (1973), "Gems & Gemology," Winter Issue, Vol. XIV, No. 12.

Quenstedtite from California, 1975 with D. Weber, "The Mineralogical Record," Vol. 6, No. 3, p. 105.

Book Review, 1975, Minerals of the World, Charles A. Sorrell, (1973), Working with Gemstones, V. A. Firsoff, (1974), "Gems & Gemology," Spring Issue, Vol. XV, No. 1.

Book Review, 1975, Diamonds Eternal, Victor Argenzio, (1974), Gemstones and Minerals, Paul Villiard, (1974), "Gems & Gemology," Summer Issue, Vol. XV, No. 2.

Book Review, 1975, The Retail Jeweler's Guide, Kenneth Blakemore, (1973), "Gems & Gemology," Fall Issue, Vol. XV, No. 3.

Recent Research at the Gemological Institute of America, 1976, Mineralogical Society of America-FOM Symposium on the Chemistry and Paragenesis of Gem Minerals, Tuscon, Arizona (Abstract).

Cathodoluminescence by the Luminoscope[R], 1976, "Guilds - Conclave Issue," Boston, Massachusetts, p. 13-15.

Cathodoluminescence in Gemology: A Short Review, 1976 - 77, "Gems & Gemology," Winter Issue, Vol. XV, No. 7, p. 234-244.

The Diamond Dictionary, 2nd Edition, 1977, Gemological Institute of America, Santa Monica, California, 352 p.

The Geology, Origin & Ground Water Conditions of the Bottomless Lakes Area, New Mexico, with W. S. Motts of the USGS and University of Massachusetts, for the Bull. Geol. Soc. Am.

Marine Geology of the Emery Seaknoll, California with G. Schaefer of NAVOCEANO, Chief PACSUPGP, for Journal of Marine Geology.

Foraminfera of the Gulf of Tonkin with K. Green of Shell Research, for Journal of Micropaleo.

Statistical Analysis of Foraminfera of the Santa Catalina Basin, California, with K. Green, presently Cypress College.

Study of the Space Group for the Mineral Langite.

- Authored 10 technical reports for TRW (exclusive of contractual documentation), and participated in preparation of 8 major proposals. Supported many classified programs in remote sensing, geologic and oceanographic analysis.

- Numerous proprietary worldwide economic geology reports for OMAR Explorations, Inc.; these reports included all aspects of mineral exploration, mining geology, mining engineering, as well as economic, legal and political analyses of prospects and countries.

- Proposal Manager of:

  Study on a National Data Program for the Marine Environment, 1967, for National Council on Marine Resource and Engineering Development, ONR RFP No. N00014-67-R-0011.

  Study of Brine Disposal from Large Desalination Plants in the Gulf of Calif., 1967, for Office of Saline Water, U.S. Dept. of Interior.

- TRW Reports pertinent to Oceanography and Environment:

  Applications of an Orbiting Satellite to Oceanography, for NASA study, 1967.

  Continuous Recording Oceanographic Densitometer, 1966

  Significance of Remotely Sensed Parameters to Fisheries, for U.S. BCF study '67.

  Status Report on the Geology, Geochemistry & Geophysics of the Moon, for NASA '68.

  Acoustical Properties of the Gulf of Tonkin Bottom Sediments, U.S. NAVY, 1967

  The Oceanography & Marine Geology of the Mouth of the Gulf of Tonkin, for U.S. Navy study, 1967.

  Oceanographic Pollution Studies in the Coastal Zone, 1968

  Engineering Geology and Environmental Impact Site Analysis Project Sanguine, for U.S. Navy study, 1970.

  Systematized Natural Resource Study for Brazil, 1971

  Environmental Study (EIS) of the Outer Channel Islands, Santa Barbara Channel, California, 1972

ROBERT GAAL

Resume Addendum

GEOTHERMAL EXPERIENCE

1. Hot Spring geochemistry (Coso H.S., California).

2. Hot Spring mineralization studies using X-ray, XES, SEM, and microscopic analyses (Coso H.S., California).

3. Remote Sensing - detection of geothermal areas with various sensors, e.g. thermal IR, VLF.

4. Feasibility and field studies of offshore California hot springs for beneficial use.

5. Review and analysis of geothermal, geophysical and well log data for State Lands Commission on research and litigation projects.

6. Continuation of State Lands Commission underwater abnormal heat flow project on State-owned lands. Redesigning thermal probe designed and fabricated by the Lawrence Berkeley Laboratory for State Lands Commission.

7. Presently preparing a temperature gradient hole drilling and geochemical program for State Lands Commission to confirm the anomaly found with the State Lands Commission underwater probe at Mono Lake.

8. Developing analog data for State Lands Commission monte carlo simulation program.

CHARLES P. FRIDDY
21872 Kiowa Lane
Huntington Beach, CA 92646

Telephones:
Office: 213-590-5211
Home: 714-968-2252

RESUME

1963 - Present CALIFORNIA STATE LANDS DIVISION

Responsible for leasing and development of geothermal resources on State land. Devised geothermal regulations, lease provisions and operating procedures. Preparation of environmental impact reports covering geothermal operations on State land. Evaluation of State land for classification as KGRA land. Review and approval of drilling and producing operations. Supervision of professional and technical staff consisting of engineers, geologists, inspectors and administrative analysts.

1962 - 1963 BAROID DIVISION, NATIONAL LEAD COMPANY

Gulf Coast, Mexico, and California. Drilling Mud Engineer. Examination and maintenance of clay base and oil base drilling fluids in areas of high pressure, lost circulation, and heaving shales. Evaluation and recommendation of drilling programs.

1959 - 1961 PETROLERA DOMINICANA, C. por A.

Dominican Republic. Surface geology in the Azua and Enriquillo basins--structural mapping, photo interpretation, basin evaluation, and stratigraphic studies. Subsurface work included electric log interpretation and correlation, analysis of ditch samples, testing and coring, and mapping from geophysical data. Located potential oil prospects and drill sites. Directed contract seismograph crew.

1956 - 1958 CREOLE PETROLEUM CORPORATION

Venezuela. Well site geologist on Lake Maracaibo - electric log interpretation and correlation, analysis of ditch samples, and isopach studies. Surface geology in eastern Venezuela, measuring sections, photo geology, and structural interpretation. Office geologist in Caracas - writing well summaries and compiling a yearly summary of industry developments.

EDUCATION Texas Technological College, Lubbock, Texas. Master of Science Degree in geology with a minor in mathematics, 1956. Thesis "A Sedimentary Analysis of the Cox Formation of Trans-Pecos Texas". B.S. in geology, 1952. Graduate study in Geology, University of Texas. Graduate study in Petroleum engineering, University of Southern California. Information and Computer Science courses, University of California, Irvine.

BACKGROUND Born June 10, 1931. Married. Read, write and speak Spanish. Served with the Korean Military Advisory Group. Member American Association of Petroleum Geologists, Sigma Gamma Epsilon and Society of Petroleum Engineers. E.I.T. Certificate No. 24056, Registered Geologist No. 806, State of California.

ADDENDUM

C. P. Priddy

Environmental Impact Reports covering geothermal operations in the following areas:

1. Boggs Mountain State Forest, Lake County
2. Randsberg Area, San Bernardino County
3. Niland Area, Imperial County
4. Surprise Valley, Modoc County
5. Owens Lake, Inyo County
6. Wendel-Amedee Area, Lassen County
7. Mono Lake, Mono County

Approval of all geothermal wells proposed for State land.

1. Site inspection and field study of potential geologic hazards.
2. Review of location to insure proper spacing.
3. Review of drilling program to determine whether it follows good engineering practice.
4. Determine if BOP equipment, choke manifold and mud monitoring equipment comply with State Lands Commission procedures.
5. Calculate pressure overbalance of mud program.
6. Review casing design and calculate safety factors.
7. Determine cement fill-up.
8. Review testing procedures.
9. Review completion program.
10. Make revenue predictions.
11. Inspection of drilling operation.

Analysis of production tests and pressure build-up tests to determine State equity in wells producing from both State and other land.

Analysis of drilling and production costs to assist Attorney General in Pariani case. Also made analysis of this type of data to develop provisions for determining allowable costs in net profits type bid lease.

Evaluation of geologic data, geophysical data and well tests to classify State lands as being Known Geothermal Resources Lands.

1. PRC 5206, Davies Estate, 130 acres

2. PRC 5213, Wildhorse Ranch, 440 acres

Evaluation of net profits bids on geothermal leases to predict future income and to determine if bids are acceptable.

Review of unitization procedures and submission to Geothermal Task Forces of policy paper covering recommended position on unitization.

RESUME

Leonard C. Smith
114 Loma Vista Avenue
Taft, CA 93268

Telephone: (Area Code 805) 765-6602

CURRENT POSITION — State of California - State Lands Commission
June 1973 to date — Petroleum Drilling and Production Engineer — Long Beach, CA

Review all operators' proposals for drilling, remedial and abandonment operations on State oil and gas leases to determine technical competence and compliance with State Lands Commission Procedures and good engineering practice, with particular attention to blowout prevention equipment, casing and cementing programs, drilling fluids programs and completion programs.

Monitor drilling and production practices of operators of State oil and gas leases to assure compliance with State Lands Commission Procedures and accepted good oil-field practice, particularly regarding safety shut-down systems and pollution control. Make field inspections.

Participate in special projects for management such as assisting in formulating governmental procedures and regulations, participating in A.P.I.-W.O.G.A. Subcommittee on Safety and Training, etc.

Supervisor: C. F. Eaton (213) 590-5209

PRIOR POSITIONS - GENERAL Twenty-five years experience in engineering and related assignments with crude oil production for the Standard Oil Company of California, Western Operations, Inc., detailed as follows:

Dec. 1972 - July 1971 — Petroleum Production Engineer — Carpinteria, CA

Proposed work to improve well performance, prepared programs, cost estimates, pay-out calculations, etc., covering stimulation, well pulling, survey, etc., for Carpinteria Offshore oil field, North Gaviota and Caliente Offshore gas fields and Fillmore Unit oil field. Prepared reports, correspondence, etc. for joint venture operations.

Supervisor: G. H. Thomas (415) 894-7700

July 1971 - Oct. 1970 — Petroleum Production Engineer — Inglewood, CA

Duties similar to Carpinteria assignment, but relating to City of Inglewood zone of Inglewood oil field, and El Segundo gas field and storage zones. As member of

Engineering Committee for nonoperated Joughin Unit in Torrance oil field, handled appropriation and budget requests.

Supervisor: R. L. Schmidt (213) 691-2251

Oct. 1970 - June 1970 Petroleum Production Engineer Taft, CA

Made comprehensive review proposing fuller development of Shallow oil zones in four section area of Cymric oil field. Correlated well logs, constructed sections and maps, reviewed histories, production records, etc. Estimated additional oil and costs; prepared memoranda.

Supervisor: G. N. Buttram (415) 894-2435

June 1970 - Feb. 1970 Analyst-Engineer Taft, CA

Member of 2 - 3 man team which reviewed: (1) Field operating personnel group to determine results of recent reorganization; (2) company testing laboratory to determine its economic justification compared to contract laboratories.

Supervisor: R. E. McCann (415) 894-7700

Feb. 1970 - June 1968 Project Engineer - U.O.N.P.R. #1 Tupman, CA

Headed three-man team of Operational Readiness Program for Naval Petroleum Reserve 1, which forecasted maximum production from Elk Hills Shallow Oil zone. Reviewed pressure data and mechanical conditions and established maximum possible drawdowns; calculated maximum production rates for each well. Studied possibility of fluid migration from east end of N.P.R. 1 to North Coles Levee oil field.

Supervisor: R. A. Kollehner (415) 894-7700

June 1968 - Dec. 1964 Lead Secondary Recovery Engineer Taft, CA

Supervised four-man engineering team (plus technicians) on secondary recovery operations, involving four waterflood, two gas injections, and two cyclic steam injection projects in the Buena Vista Hills and Midway Sunset oil fields. Assisted in budget preparations and made presentations. Was chairman of two Unit Engineering Committees and represented Standard Oil Company on three other Unit Engineering Commitees.

Supervisor: A. M. Cooper (415) 894-7700

Dec. 1964 - June 1962 Lead Development Engineer Taft, CA

Supervised five-man engineering team (plus technicians) on development drilling operations in Buena Vista District, covering the Buena Vista Hills and a portion of the Midway Sunset oil fields. Carried out program of infill drilling and continued step-out development drilling; drilled over 250 wells. Engineered exploratory wells drilled in area. Assisted in budget preparations and made presentations.

Supervisor: R. H. Adams (707) 526-1000

June 1962 - Aug. 1955 Petroleum Production Engineer Bakersfield, CA

Handled engineering in Greeley Unit oil field operations, including gas injection and waterflooding. Prepared well programs for remedial work, stimulation, etc., together with cost estimates and justifications. Requested and interpreted depth pressure and thermometric data. Constructed isobaric maps and production maps. Prepared and made presentations at Unit Engineering Committee meetings.

Supervisor: D. C. Roberts (deceased)

Aug. 1955 - Aug. 1953 Secondary Recovery Engineer Taft, CA

Made study for expansion of pilot waterflood in East Coalinga oil field. Recorrelated logs, redrew structure cross sections and contour maps. Made sand count and drew isopach maps. Prepared preliminary report.

Supervisor: J. C. McKinnell
U. S. Navy staff, Elk Hills, CA

Aug. 1953 - Oct. 1952 Petroleum Production Engineer Coalinga, CA

Responsible for engineering of well stimulation work in East Coalinga and West Coalinga and Jacalitos oil fields. Prepared programs and evaluated results. Programmed and witnessed perforating operations, water entry surveys and plugging operations. Scheduled depth pressure operations.

Supervisor: V. A. Isaacs (805) 832-2342

Oct. 1952 - Nov. 1948 Petroleum Development Engineer Avenal, CA

Programmed drilling, redrilling and repair of wells in Kettleman Hills, East and West Coalinga, Northeast Coalinga Unit, Jocalitos and Guijarral Hills oil fields. Prepared cost estimates and requests for approval. Correlated logs, drew structure cross-sections and contour maps. Designed casing strings. Did field work, witnessing logs, drill-stem tests, cementing operations, etc., and prepared supplementary programs.

Supervisor: D. C. Roberts (deceased)

Nov. 1948 - Feb. 1947 Engineering Trainee Taft and Avenal, CA

Worked twelve months in oil fields as roustabout, well puller, gauger, pumper, and meterman. Assisted in cathodic protection survey (1 month). Worked with development engineers (7 months in Kettleman Hills).

Supervisor: J. J. Higginbotham
Reno, Nev.

EDUCATION: Louisiana State University 1939-1940
Ohio State University 1940-1943: Bachelor of Mechanical Engineering degree.
Various short courses in petroleum engineering field and company seminars.

PROFESSIONAL AFFILIATIONS:

Society of Petroleum Engineers of A.I.M.E. (former Chairman, San Joaquin Valley Section).

OTHER SKILLS: Speak, read and write French fluently. Served six years as Director (including three years as President) of Sovale Credit Union (Standard Oil Valley Employees).

PERSONAL DATA:

Date of birth: September 14, 1922
Place of birth: San Antonio, Texas
Height: 5' 6"
Weight: 159 pounds
Married since June 26, 1949.
One son, born August 7, 1952

BACKGROUND: As a boy, lived in Panama Canal Zone; Paris (France); Illinois; Louisiana; Ohio. Father was regular U. S. Army Officer and mother was French.

Served as officer in Corps of Engineers, U. S. Army, April 1943 to January 1947 in the United States (The Engineer School - training publications) and in Europe (construction operations).

Leonard C Smith

CURRICULUM VITAE

John D. Messer
Senior Mechanical Engineer

B.S. Mechanical Engineer, University of Washington

Registered Mechanical Engineer, States of Washington and California

Professional experience includes design, inspection and testing of steam generating plants, distribution systems, turbines and condensing systems. Familiar with thermodynamics of various cycles and heat balances associated with geothermal electrical generating plants. Have made field inspections of the Mexican government geothermal steam plant at Cerro Prieto and San Diego Gas and Electric Co. - ERDA Geothermal Loop Experimental Facility at Niland, CA.

My present involvement with geothermal operations is a study of the methods being used at the Geysers to measure steam quantities produced from approximately 100 wells which supply 12 generating units. The equable distribution of revenue among the various leaseholders in proportion to the production from separate wells depends on the accuracy of the individual flow meters at each well and in cross connecting lines which commingle steam from various leases. This report will deal with the inherent degree of accuracy of the flow meter and recorder system, the effect of steam pressure, quality and temperature on accuracy and a maintenance and renewal program required to maintain dependable flow measurement.