8 H

SOUTHERN UTAH STATE COLLEGE

WATER ANALYSIS LABORATORY

PROPOSAL TO

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE

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

Geothermal Reservoir Assessment Case Study
Northern Basin and Range Province

Submitted May 30, 1978

SOUTHERN UTAH STATE COLLEGE
WATER ANALYSIS LABORATORY

PROPOSAL FOR

GEOCHEMICAL DATA OF HOT SPRINGS AND HOT WATER WELLS

A. Proposer's Name and Address

Dr. Joseph L. Comp
Science Center
Southern Utah State College
Cedar City, UT 84720

Telephone: (801) 586-4411, X 244, X 221, X 442

B. Technical Proposal

1. Investigation Area. Battle Mountain Heat Flow High Northern Basin and Range Province.

2. Program Data. Geochemical data of hot springs and existing hot water wells.

3. Program Description. The Southern Utah State (SUSC) Water Analysis Laboratory proposes to sample on a monthly basis and chemically analyze water from sixty (60) sites in the Battle Mountain Heat Flow High Northern Basin and Range Province to develop basic geochemical data to support new surface and/or sub-surface investigations. This project will also monitor water system interactions and variations over a one-year period of time. In addition, the project results will identify areas of potential difficulty for other technical investigations.

4. Schedule. A proposed Schedule of Assessment Activities is presented on the following page. The geochemical data will be available for publication each month and could be released by the Department of Energy immediately. At the end of the project term, the data will be summarized in a Final Report.

Schedule of Assessment Activities

Month 1

Identification of sample sites
Train sampling personnel and collect first samples
Analyze samples

Month 2

Prepare and submit report for Month 1
Continue sampling and analysis

Month 3

Same as Month 2

Month 4

Visit sample sites and sampling personnel
Prepare and submit report for Month 3
Continue sampling and analysis

Months 5-12

Continue monthly sampling and analysis
Continue monthly reporting
Continue quarterly site visits and personnel supervision

Concluding Activities

Prepare, publish, and submit to DOE Final Project Report

5. Environmental Evaluation. There will be no environmental impacts on the area as a result of sampling the existing wells and springs and there is no potential for conflicts with existing land patterns and programs.

C. Estimated Cost

The estimated costs of this project have been based on the collection and analysis of sixty (60) samples each month for twelve (12) months. The samples will be collected from the total study area. The estimated costs include program planning, administration, implementation, data analysis, and the completion of a Final Report. The estimated cost is specified in Form 60, which follows this page.

D. Business and Management

1. Experience. The SUSC Water Analysis Laboratory has been in existence for three years and has provided numerous and varied services to the Five County Association of Governments, the U.S. Forest Service, the Bureau of Land Management, local municipalities, and many public and private water systems.

The laboratory is certified by the State of Utah and the U.S. Environmental Protection Agency.

The Water Analysis Laboratory has access to a computer facility and has prepared and has in operation a program to analyze all of the data that will be collected under this project. The program will flag all parameters which exceed a predetermined limit, will identify maximumx and minimumx, and will compute averages and standard deviations.

2. Vitae. Vitae for laboratory personnel are attached.

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: SOUTHERN UTAH STATE COLLEGE	SUPPLIES AND/OR SERVICES TO BE FURNISHED: GEOCHEMICAL DATA OF HOT SPRINGS AND HOT WATER WELLS
HOME OFFICE ADDRESS: 351 West Center, Cedar City, Utah 84720	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED: School of Science, Water Analysis Laboratory	TOTAL AMOUNT OF PROPOSAL: $164,380
	GOV'T SOLICITATION NO.

DETAIL DESCRIPTION OF COST ELEMENTS

			EST COST ($)	TOTAL EST COST	REFERENCE
1. DIRECT MATERIAL *(Itemize on Exhibit A)*					
a. PURCHASED PARTS			N/A		
b. SUBCONTRACTED ITEMS			N/A		
c. OTHER—(1) RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS 20.50 x 720			14,760		
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				14,760	
2. MATERIAL OVERHEAD[1] *(Rate % X $ base =)*					
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/ HOUR	EST COST ($)		
Project Director			3,570		
Asst. Director			2,380		
720 Analyses @ $79			67,680		
Date processing & recording			7,200		
TOTAL DIRECT LABOR				80,830	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[1]	O.H. RATE	X BASE =	EST COST ($)		
HEW negotiated indirect rate 51.2%	51.2%	80,830	41,385		
TOTAL LABOR OVERHEAD				41,385	
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			1,330		
b. PER DIEM OR SUBSISTENCE			1,575		
TOTAL TRAVEL				2,905	
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST ($)		
Sample collectors 720 x $25			18,000		
Training collectors 15 x $100			1,500		
TOTAL CONSULTANTS				19,500	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)* Final Report				5,000	
10. TOTAL DIRECT COST AND OVERHEAD					
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate % of cost element Nos.)*[1]					
12. ROYALTIES[1]					
13. TOTAL ESTIMATED COST				164,380	
14. FEE OR PROFIT					
15. TOTAL ESTIMATED COST AND FEE OR PROFIT				164,380	

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

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
Joseph L. Comp, Director SUSC Water Analysis Laboratory	Joseph L Comp
NAME OF FIRM Southern Utah State College	**DATE OF SUBMISSION** May 30, 1978

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST ($)

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)*

3. Management Plan. The SUSC Water Analysis Laboratory proposes to sample, on a monthly basis, and chemically analyze water from sixty (60) sites in the "Battle Mountain Heat Flow High Northern Basin and Range Province" to provide and offer basic geochemical data to support new surface and/or sub-surface investigations. Sample sites are ilustrated in Enclosure 1, Figure 2 of the Request for Proposal No. ET-78-R-08-0003, and are:

Alvord	Wendel Amedee	Stillwater
Lake View	Beckwourth Peak	Brady
Baltazor	Reno Hazen	
Crump Geyser	Carson City	Walti Hot Springs
Lake City	Ruby Lake	Wabuska Hot Springs
Suprive Valley	Elco Hot Hole	Salt Wells Basin
Soldier Meadow	Beowawe	Steamboat
Pinto Hot Springs	Hot Springs Point	Moapa Springs
Souble Hot Springs	Leach Hot Springs	Wilson Hot Springs
Fly Ranch Northeast	Winnemucca	Darrough Hot Springs
Fly Ranch	Kyle	Dixie Hot Springs
Gerlach	Rye Patch	Tego
Gerlach Northeast	Colado	Locklock

There are many areas listed in the DOE Report for which there are several water sources. It appears from the topographical maps that there are approximately 60 water sampling sites present in the 39 thermal areas listed.

It is proposed that the water in the hot springs and existing wells of the Battle Mountain Heat Flow High Northern Basin and Range Province be sampled monthly and chemically analyzed for the following parameters:

General Parameters

Alkalinity
Conductivity
Hardness
pH
Silica
Total Dissolved Solids

Cations

Aluminum
Antimony
Arsenic
Barium
Beryllium
Boron
Cadmium
Calcium
Chromium Total
Copper
Iron Total
Lead
Magnesium
Manganese
Mercury
Potassium
Selenium
Silver
Sodium
Zinc

Anions

Bicarbonate
Carbonate
Chloride
Fluoride
Nitrate
Sulfate

In addition to the parameters listed, the laboratory could also perform the following analyses not included in budget, if there were an interest in them:

General Parameters

CO_2
Surfactant
Suspended Solids
Turbidity
Votalite Acids

Cations

Ammonium
Chromium +6
Cobalt
Germanium
Iron Filtered
Molyebdium
Nickel
Vanadium

Anions

Cyanide
Hydroxide
Kjel N
Nitrate
Nitrite
Phosphate Ortho
Phosphate Total

The sampling and analysis of the water under investigation can begin immediately with the results being submitted to the Department of Energy monthly.

The Final Report will identify any changes in the composition of the water throughout the project year. An important result of the project will be the identification of areas of potential difficulty for other technical investigations.

Potentially, the project results could form the basis for hypothesizing as to relationships, or interconnections, between water systems in the geological range.

4. Business and Technical Contacts.

Dr. Joseph L. Comp
Science Center
Southern Utah State College
Cedar City, UT 84720

(801) 586-4411, X 221

Dr. Harl E. Judd
Dean, School of Science
Southern Utah State College
Cedar City, UT 84720

(801) 586-4411, X 411

5. Draft Contract. The provisions of the draft contract as a basis of contract negotiations is acceptable to the proposer.

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

7. Proposer's Capability. The Water Analysis Laboratory is operated within the School of Science, Southern Utah State College, and is supported and maintained by the College.

8. Proposal Time Period. This proposal will remain in effect for 120 days from the date of submission.

9. Signature Sheet. The following page contains the signatures of the chief administrative officer of the College, the Dean of the School of Science, and the Director of the Water Analysis Laboratory.

Signature Page

The following authorized representatives of Southern Utah State College, Cedar City, Utah, give their approval to the submission of this proposal to:

U.S. Department of Energy

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

Geothermal Reservoir Assessment Case Study
Northern Basin and Range Province

Signed this 30th day of May, 1978.

Royden C. Braithwaite
President Royden C. Braithwaite

Harl E. Judd
Harl E. Judd, Dean, School of Science

Joseph L. Comp
Joseph L. Comp, Director
Water Analysis Laboratory

JOSEPH L. COMP

Age: 48
Married: 4 children
Home Address: New Harmony, Utah
Telephone: 586-9102

Degrees Earned

Simpson, 1950, B.A.
Major: Chemistry
University of New Mexico, 1956, Ph.D.
Major: Chemistry
Minor: Math

Teaching Experience

1961 - 1965 Assistant Professor, Southwest Texas State College
1965 - 1968 Assistant Professor, Southern Utah State College
1968 - Associate Professor, Southern Utah State College
1968 - Tenure - Southern Utah State College

Special Training

Monsanto Chemical Company, Texas City, Texas - 5 years research chemist
University of Arizona - Post Doctoral research with Dr. Marvel in plastics

Publications

Synthesis of 7-Methyl, 10-methyl, 6, 7-Dimethyl, and 7, 10-Diethyl 3, 4 Benzapyrene Homoploymerezation of hydronopyl vinyl ether and 2-Hydroxy noposyethyl vinly ether.
Preparation and polymerization of vinyl esters of cholors-and hydroxy-steric and Eicosanoati acids. Preparation and Ploymerization of the vinyl esters of Nonhydroxy carnuba wax acids & the Acrylic Esters of carnuba Wax Alcohols.
Cyclic Ester Copolymers.

Research Experience

Five years research chemist with Monsanto. Fifteen months research with Dr. Marvel at the University of Arizona.

Harl E. Judd
Professor of Engineering and Mathematics
Southern Utah State College

Birth Date

October 16, 1932

Degrees

B.S. Utah State University, 1955
Ph.D. Utah State University, 1964

Teaching Experience

1957-60 Southern Utah State College
1963-present Southern Utah State College

Experience

1952-53 Assistant City Engineer, Cedar City (parttime during school, full time summers).
1955 Civil Engineer, U.S. Bureau of Reclamation.
1955-57 Planning and Programming Engineer, U.S. Air Force.
1954 Chief of Party, U.S. Bureau of Land Management (summer).
1958 Inspector, Green's Lake Flood Control Project, Soil Conservation Service.
1961 Engineer, Porcupine Dam , Utah Water and Power Board (summer).
1971-present Dean, School of Sciences, Southern Utah State College

Research Experience

1954-55 Agricultural Research Service
1963-65 Utah Water Research Laboratory
1969-present Chief Attendant, SUSC Seismograph Station (CCU)

Publications

A Study of Bed Characteristic in Relation to Flow in Rough, High-Gradient, Natural Channels. Ph.D. Dissertation, Utah State University, 1964.

Judd, Harl E. and Peterson, Dean F. 1969, Hydraulics of Large Bed Element Channels. Utah Water Research Laboratory PRWY 17-6, College of Engineering, USU, Logan, Utah 84321.

Judd, Harl E., Overton, D.E., and Johnson, C.W. 1972, Optimizing Resistance Coefficients for Large Bed Element Streams. Utah Water Research Laboratory PRWG 59a-1, College of Engineering, USU, Logan, Utah 84321.

Scientific and Professional Societies

American Society of Civil Engineers
Society of Phi Kappa Phi

Dr. E. Blair Maxfield
(Paleontologist, Geologist)

Education
B.S. Brigham Young University, 1955
M.S. Brigham Young University, 1957
Ph.D. Brigham Young University, 1975

Professional Experience
1955-1965 - Exploration Geologist and Paleontologist, Shell Oil Co.
1967-1968 - High School Science Teacher, Richfield, Utah
1969-1976 - Assistant Professor of Geology and Chemistry, Southern Utah State College
1969-1971 - (Summers) Instructor in National Science Foundation Secondary Education - Earth Science Inservice Programs.
1969-1971 - Instructor and Field Guide in National Science Foundation Four State Secondary Education Earth Science Field Conference
1970 - Consulting Geologist, Union Oil Company of Canada
1972 - Research on Cretaceous Foraminifers of Eastern Utah at Louisiana State University
1973-1974 - Geological Consultant on Environmental Impact Studies, Utah State Highway Department
1975-1976 - Geological Consultant, South East 208 Project - Water Quality Planning Task, Five County Association
1976- - Associate Professor of Geology and Chemistry, Southern Utah State College

Professional Organizations
American Association of Petroleum Geologists
American Paleontological Society
Society of Economic Paleontologists and Mineralologists

Papers and Publications
1957 Sedimentation and Stratigraphy of the Morrowan Series in Central Utah, Brigham Young University, Research Studies, Geology Series, Vol. 4, No. 1.

1973 Environmental Impact Study, Anderson Junction to LaVerkin Junction. Utah State Highway Department.

1974 Environmental Impact Study Harrisburg Junction to Zion National Park Entrance. Utah State Highway Department.

1975a (Co-editor) Symposium for Coal Geology Division, Geological Society of America, Brigham Young University, Geology Studies, Vol. 22 pt. 1.

1975b (Co-editor) Field Guide and Road Log to Western Book Cliffs, Brigham Young University, Geology Studies, Vol. 22, pt. 2.

1975c Five County 208 Project - Water Quality Planning Task C-1.

1976 Five County 208 Project - Water Quality Planning Task C-1.

Dr. Brent C. Palmer
(Botony)

Education
B.S. Utah State University, 1961
M.S. Utah State University, 1963
Ph.D. Oregon State University, 1972

Professional Experience
1962-63 - Instructor of Botony, Weber State College
1963-72 - Assistant Professor of Botony, Southern Utah State College
1972- - Associate Professor of Botony, Southern Utah State College
1964-65 - Naturalist, Zion National Park
1972- - Environmental Consultant for Terracor on Stansbury Park Development
- Field work on Biological Study of LaVerkin Hot Springs for Bureau of Lang Management

Administration
1975 - Assistant Director, Bacteriology Section, Southern Utah State Water Lab

Professional Organizations
Mycological Society of America

Papers and Publications
1966 "Flora of Horse Ranch Mountain, Zion National Park." On file at Zion National Park Headquarters.

1971 "Comparison of Plant-pathogenic Pseudomonads by Disc-Gel Electrophoresis," Phytopathology 61:984-986.

1975 "Vegetation Studies on the Warner Valley Power Plant Site." Quarterly and summary reports on file with Bureau of Land Management, Salt Lake City, Utah.

RESOURCE ASSESSMENT PROPOSAL

FOR LAKEVIEW, OREGON

Submitted to

U. S. DEPARTMENT OF ENERGY

For

GEOTHERMAL RESERVOIR ASSESSMENT

CASE STUDY, NORTHERN BASIN

AND RANGE PROVINCE

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

By

NORTHWEST GEOTHERMAL CORPORATION

123 N.W. Flanders St.

Portland, OR 97209

NORTHWEST NATURAL GAS COMPANY

SUITE 1900
200 SOUTHWEST MARKET STREET, PORTLAND, OREGON 97201

PAUL H. HOWE
Senior Vice President

May 25, 1978

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

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

Gentlemen:

Enclosed herewith is a proposal pursuant to Request No. ER-78-R-08-003 made by Northwest Geothermal Corporation, a wholly-owned subsidiary of Northwest Natural Gas Company.

You may already be aware of the Company's well known interest in geothermal energy as an alternative to fossil fuels and our current exploration project near Mt. Hood. In keeping with the well-recognized national need to develop alternative forms of energy, and because of our status as a long-time (since 1859) distributor of energy in the State of Oregon, now involving the operation of 11,000 miles of underground system, it appears particularly appropriate for our Company and its geothermal subsidiary to look at known geothermal energy sources within the State.

While our Mt. Hood project is likely to require several years to complete, we are interested as a concurrent activity in the possible development of a smaller geothermal system for Lakeview which might be accomplished in a relatively short period of time. We are particularly fascinated by the potential of a complete end-use development there.

Please let us know if any further information is needed.

Yours very truly,

Paul H. Howe

Paul H. Howe

Encl.

RESOURCE ASSESSMENT PROPOSAL

FOR LAKEVIEW, OREGON

Submitted to

U. S. DEPARTMENT OF ENERGY

For

GEOTHERMAL RESERVOIR ASSESSMENT

CASE STUDY, NORTHERN BASIN

AND RANGE PROVINCE

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

By

NORTHWEST GEOTHERMAL CORPORATION

123 N.W. Flanders St.

Portland, OR 97209

INDEX

ABSTRACT

Northwest Geothermal Corporation (NGC), a wholly owned subsidiary of Northwest Natural Gas Company (NNG), is proposing to continue investigations for possible direct application of geothermal resources to serve the city of Lakeview, Oregon and portions of Lake County. The immediate objective of NGC is to evaluate the resource potential. Our full objective is to develop a hot water resource, build and operate a model utility system designed to serve domestic, commercial, agricultural and industrial requirements capable of directly utilizing hot water. In addition to becoming one of the Nation's few geothermal direct-use district heating systems, the project would serve as a model for the design, construction ~~and a model for the design, construction~~ and management experience that would be desirable for a larger project, such as currently being appraised for the Mt. Hood-Portland area.

The projected costs for the resource analysis summerization is:

1.	Drilling	$179,880
2.	Well Performance Testing	57,000
3.	Contract Scientific Services	10,000
4.	Management Cost	61,075
5.	Transportation	4,500
6.	Housing	5,430
		$317,885

Proposed Cost Distribution

Department of Energy	$238,414
Northwest Geothermal Corporation	$ 79,471

B. TECHNICAL PROPOSAL

B1a Northwest Geothermal Corporation proposes to test the structures north of Lakeview underlying Sections 32 & 33 T38S, R20E and Sections 4 & 5 T39S, R20E (See Exhibit A). The proposed locations are described in Exhibit B, Geological Descriptions and the Technical Reasons are covered in a report prepared by J.W. Hook and H.J. Meyer (Appendix A).

B1b The area to be tested is predominantly under geothermal resource lease by Gulf Oil Company. They have been contacted by phone and letter for permission to test on their leases. Conditions for an agreement would be resolved prior to any testing. The other primary interest holders in the area to be tested is the Oregon Desert Farms Corporation and the Favell-Utley Corporation. A letter of proposal is presently being prepared by them for us concerning their rights or ownership of the hot water resource on their lands.

B1c GEOLOGIC DESCRIPTION

The project area covers four square miles around Hunter Hot Springs on the north side of Lakeview, Oregon. The hot spring area is on the basin side (west) of the Lakeview Fault, a major normal fault with perhaps 5,000 feet (1,524 m) of normal displacement between the Goose Lake graben and the Warner Mountain horst.

A more detailed description and geologic maps are attached in Appendix A. A Preliminary Report on the Geothermal Potential of Lakeview, Oregon by J.W. Hook and H.J. Meyer, May, 1978.

B1d TECHNICAL REASONS FOR SITE SELECTION

1. The site has hot springs, wells and geysers with temperatures near 100°C (212°F).
2. The resource is very close to a potential market, i.e., Lakeview, Oregon, which has a high degree day deficiency.

B1d (Cont.)

3. There is potential for present and future industrial development.

4. The reservoir is believed to be shallow.

5. Water samples from springs indicate that water is of good quality.

6. Geothermometry indicates a minimum reservoir temperature of 140°C (284°F).

7. There is a high probability that reservoir rock of good porosity and permeability exists under a clay cap rock (silica cap?).

PROGRAM DATA OFFERED

B2a SUBSURFACE

The subsurface data offered in this proposal originates from three sources: 1. water well logs, 2. a deep geothermal test well and 3. communications with local users of geothermal water. The geologic description of the rock units is from a report by N. V. Peterson and J. R. McIntyre, 1970, published by the Oregon Department of Geology and Mineral Industries as Bulletin 66, The Reconnaissance Geology and Mineral Resources of Eastern Klamath County and Western Lake County, Oregon.

Table 1 is a summary of the thermal data from the water wells in the project area. This data was compiled from drill logs on file in the Oregon Department of Water Resources Office in Salem, Oregon.

The Gulf Oil Company drilled a deep geothermal test well, Favell Utley #1, in Sec. 17 T39S, R20E, to a total depth of 5,440 feet (1658 m). This well is approximately two miles (3.22 km) south southeast of Hunters Hot Springs and about the same distance northwest of the Barry Ranch Hot Springs south of Lakeview. The lithologic log of the first 1,000 feet (305 m) of the well (Plate 1) indicates that potential reservoir rock exists from at least 140 feet (43 m) to 350 feet (107 m); from 520 feet (158 m) to 540 feet (165 m) and from 590 feet (180 m) to 610 feet (186 m). The drillers log also showed potential reservoir rock at 980 feet (299 m) to 1,150 feet (351 m); 1,260 feet (384 m) to 1,480 feet (451 m), 1,540 feet (469 m) to 1,600 feet (488 m) and 4,680 feet (1426 m) to 5,440 feet (1658 m). The sediments in the first 930 feet (283 m) are unconsolidated Pleistocene to recent fluvial and lacustrine deposits which represent delta deposits of an expanded and possible fluctuating Goose Lake. As such,

there will be local facies changes and the sediments which are expected to provide the reservoir rock in Hunters Hot Springs area may differ from Favell Utley #1. The proximity of the Hot Springs to the west side of the Warner Mountains and a resultant high energy depositional environment should enhance the chances of potential reservoir rocks in the first 1,000 feet (305 m).

Another geothermal test well was drilled in the SE 1/4 of Sec. 33, T38S, R20E by Magma Power in 1960. This well is located on the eastern boundary of the proposed study area. While there are no records of this hole, discussions with Andy Parker, Manager of Oregon Desert Farms, which utilizes the well to heat greenhouses, revealed that the well is plugged at a depth of 500 (152 m) feet and can produce water at a temperature of 180°F (82°C). It was learned from Parker that there was a reversal of the temperature gradient at about 500 feet (152 m). From the location of the well relative to the Lakeview Fault (fig. 6 Hook & Meyer 1978), it is quite likely that the fault would have been crossed at about that depth and the cooler formations of the horst block would have been encountered. Andy Parker also pointed out that a durable clay zone exists in the Hunters Hot Springs area at a depth from 100 (30.5 m) to 150 feet (46 m). This clay zone acts as a cap to the geothermal reservoir and is well known to local well drillers. "Old Perpetual Geyser" at Hunters Hot Springs is a well that was drilled in 1928 and has been blowing steam and hot water about 50 feet (15 m) into the air three times a minute ever since. Other geysering wells in the area have been plugged or controlled and utilized.

From the above information, the unstabilized temperature log of the Gulf Well, and reported temperatures of water wells, it is our interpretation that two convective cells exist, one north (Hunter Hot Springs) and one south (Barry Ranch Hot Springs) of Lakeview. These cells are along the Lakeview fault at junctions with northwesterly trending faults.

PROGRAM DATE OFFERED

B2b SURFACE

The surface data offered is a portion of the geologic map from Bulletin 66 (Peterson and McIntyre 1970) (fig. 1 Hook & Meyer 1978) and a report by Hook and Meyer 1978 entitled A Preliminary Report on the Geothermal Potential of Lakeview, Oregon which includes a discussion and maps on structural lineations, chemical analyses and temperature measurements (Appendix A).

The geologic map gives the general geology of the Lakeview area on a scale of 1:250,000 (fig. 1 Hook & Meyer 1978). From this map it may be noted that Lakeview is in an alluvial filled graben at the foot of a major fault scarp forming the west side of the Warner Mountains. The major horsts and grabens (Basin and Range Province) of southeast Oregon have a northerly trend. A second set of faults appear to have predominantly strike-slip movement and trend in a northwesterly direction (Eugene-Denio fault zone). The Basin and Range faulting is believed to be the younger of the fault systems (Peterson and McIntyre 1970). However, the lineation analyses show both directions of faulting prevalent in the Quaternary alluvium of the graben (Hook & Meyer 1978), illustrating the youthfulness of the movement.

PROGRAM DATA OFFERED

B2c RESERVOIR ENGINEERING STUDIES

There has been no reservoir engineering studies of the Lakeview area. It is reported that Hunters Hot Springs flow at the rate of 600 gpm (Bowen, R. G., Peterson, N. V., 1970. Thermal Springs and Wells in Oregon. State Dept. of Geol. and Min. Indust. Misc. pap. 14.). It has also been reported that a thermal water well (70°F) (21°C) located about 1 mile west of Hunters Hot Springs, drilled to a depth of 480 feet (146 m), has been tested at a rate of 4,000 gpm (15142 lpm) (personal communication R. Utley). In Bulletin 66 Peterson and McIntyre (1970) state: "It is estimated from the surface heat flow that there is enough heat available to provide much of the space heating required for the City of Lakeview." The reservoir is obviously more than adequate for existing uses. The goal of our proposed study is to do reservoir engineering studies which will yield estimates of production capabilities of the Hunter Hot Springs area.

GEOTHERMAL STUDY PLAT NO. 1

LITHOLOGY FROM SURFACE TO 1050'

Lakeview, Oregon
Favell Utley #1

Plate 1

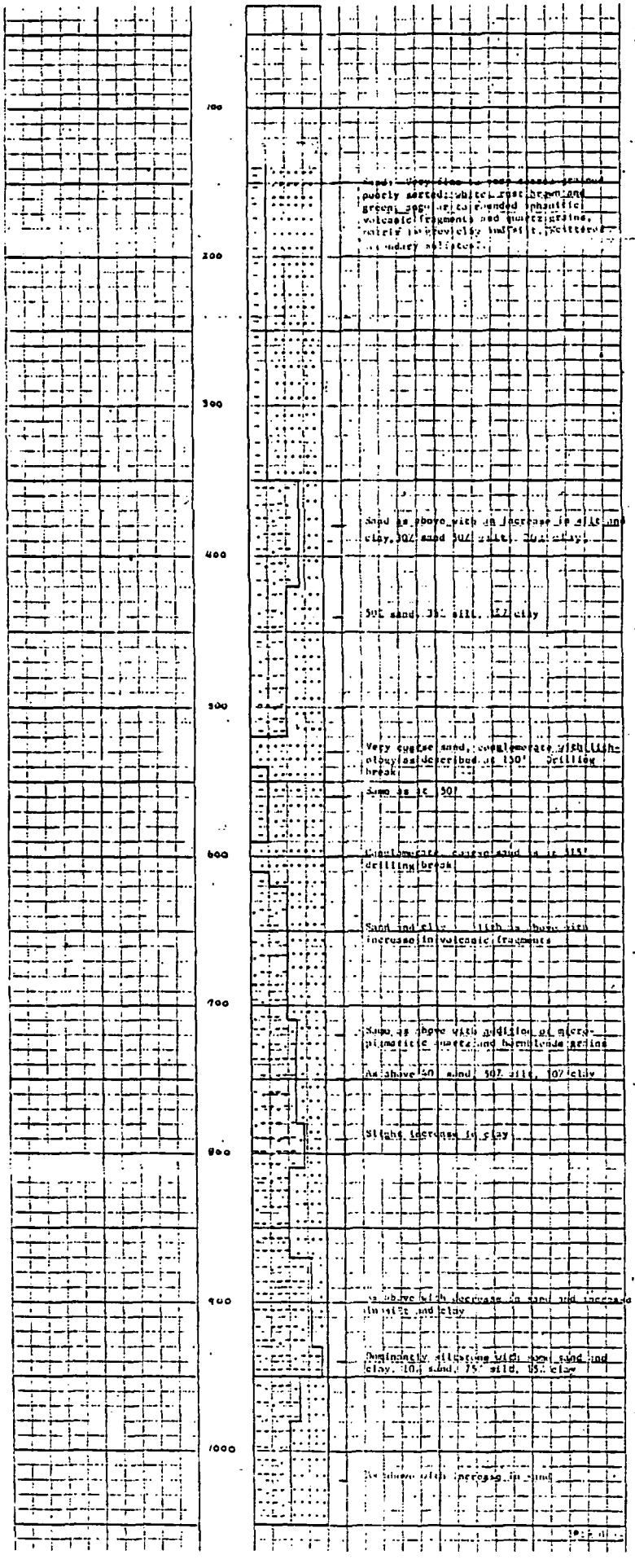


TABLE 1. THERMAL WATER WELLS T39S, R20E LAKEVIEW COUNTY, OREGON

LOCATION	NAME	DEPTH		TEMPERATURE	
		FEET	METERS	°F	°C
39S-20E-4	Lutheran Church	260	79	Warm	---
39S-20E-4	Tremont Logging Company	560	171	63	17
39S-20E-4d	Jim Olson	95	29	80	27
39S-20E-4aa	Doug Tatro	180	55	60	16
39S-20E-4	Wm. Strawn	100	30.5	92	33
Tract 3 Goldmore Tr.					
39S-20E-4ab	Jess Faha	80	24	80	27
39S-20E-4ab	Robert Utley	100	30.5	72	22
39S-20E-4dbd	Lakeview Mining	509	155	98	37
39S-20E-4	Lasley & Michelson Inc.	155	47.2	43	6
1500' SW of NE Corner Sec. 4					
39S-20E-9a	Lakeview Mining	800	244	98	37
790' NE Corner Sec. 9					
39S-20E-10cb	Eastern Oregon Pine Company	360	110	78	26
39S-20E-15cbb2	Town of Lakeview	405	123	62	17
39S-20E-16bc	Town of Lakeview	360	110	58	14
39S-20E-16bb	Town of Lakeview	330	100.5	72	22
39S-20E-20bb	Town of Lakeview	400	122	58	14
39S-20E-22	Ester Cogar	63	19.2	58	14
39S-20E-22bd	Thomas Elliot	147	45	53	12
39S-20E-27bb	George Jackson	387	118	52	11
39S-20E-35b	Jim Cye	220	67	64	18
39S-20E-35b	Wm. Hamilton	275	84	68	20

PROGRAM DESCRIPTION

B3a(2) SUBSURFACE

The drilling program will include nine (9) shallow temperature gradient test holes drilled to the top of the "silicated" clay cap or closure that exists over the resource prospect. The depth anticipated will be between 100 and 400 feet. Core samples are anticipated for the first one or two test holes in the "silicated" clay zone and the clay structure directly above. The core samples would be used for correlation of cutting samples in subsequent drilling. The hole size would be between four (4) and six (6) inches in diameter. Mud would be used as a drilling fluid. The hole would be completed with a 2" steel observation pipe closed at the bottom and run to the total depth. Heavy mud and cutting would be used to pack the anulus between the pipe and the hole wall. Cement would be used around the upper ten (10) feet to surface. A street box would be placed over the observation pipe at ground level. Observation pipe would be closed and locked.

Three (3) one thousand foot holes will be drilled for stratigraphic, temperature gradient, water chemistry and production analysis. The holes will be drilled into the "silicated" clay cap with an 11-7/8" bit. 8-5/8" welded casing will be run and cemented to surface. Blowout prevention equipment would be installed. The hole would then be continued with a 7-7/8" bit to 1,000 feet and geophysically logged. The hole would be cased to total depth or to an intermediate casing point dependent upon logs and structures encountered with drilling. The well head would be left available for hydrology studies and eventually used for production.

A geologist would be present during all drilling operations for mud logging and analysis.

Coring will be done only if correlation is required.

B3a(2) (Cont.)

Flow testing and injection testing will be done as required to prove production capabilities.

Fluid chemistry tests will be performed to evaluate the quality of the water.

No well bore treatment is anticipated unless casing is set through production zones and cemented. Perforating and acidization may be required for cleanup.

B3b SURFACE INVESTIGATIONS

(1) The surface investigations will be a continuation of the air photo analyses, coupled with field checking and detailed geologic mapping. This work will be done concurrently with the work on the shallow temperature gradient holes by John Hook and Jack Meyer.

(2) A network of bench marks will be established on and around the reservoir area to monitor changes in elevation. This is needed to determine if the unconsolidated alluvial sediments are undergoing natural subsidence, as well as for baseline data to monitor future subsidence, if any, due to geothermal production. This work will be scheduled as early in the program as possible and performed by Barry Norris, P.E., the County Engineer for Lake County.

B3c RESERVOIR ENGINEERING STUDIES

All studies will be based upon new information to be obtained from tests on the proposed deep holes. Measurements will be standard water well tests which would allow for volume, drawdown and injection capabilities. Offsetting wells would be monitored during all tests. Hydrology evaluations would be made under advisement of qualified consultants.

B5a DESCRIPTION OF ENVIRONMENT

The four square mile project area is at the north edge of Lakeview and is predominantly farm land with some industrial, commercial and residential development. The area is in the Goose Lake basin at an elevation of about 4,800 feet (1463 m), at the base of the Warner Mountains. U. S. Highway 395 parallels the mountain along the eastern part of the area and most of the residential development is between the highway and the escarpment. The Desert Farms Greenhouse is also east of the highway, including the geothermal well which supplies heating (plate 2).

The Hunter Hot Springs Motel is west of Highway 395 and near the center of the four square mile area. The motel uses geothermal heating. "Old Perpetual", a geysering well, is at the motel and most of the hot springs are nearby. Waterfowl, especially Canadian geese and wild ducks, are abundant at the warm ponds around the motel. Other commercial uses in the area are a drive-in theater and a radio tower.

The Louisiana Pacific Lumber Mill is at the south edge of the project area. An industrial roadway cuts diagonally across the project area to deliver timber to the Louisiana Pacific Mill. A previous industrial use was an uranium mill which had about 100 acres of settling ponds in the southwest quarter of Section 4. These ponds still hold water in the winter months and with a little repair would serve as reservoirs for flow testing the geothermal wells.

Farming operations cover about two thirds of the project area, including all of Sections 32 and 5 and the west 1/2 of Section 33. Hay and pasture for cattle are the dominant crops. High water tables and alkalinity, as well as severe climate, limit the agricultural uses.

B5b ANALYSIS OF POTENTIAL ENVIRONMENTAL IMPACT

The natural hot springs, the associated warm ponds, and the "Old Perpetual" Geyser attract both wildlife and people. It is very unlikely that the shallow temperature gradient tests or the three 1,000 foot (305m) tests would significantly add to or detract from this situation. Any long-term impact of this project would be related to the possible stimulation of greater utilization of the geothermal resource.

The temporary impacts of drilling would involve noise, minor surface disturbance, minor air pollution, and the possible use of surface reservoirs of discharge areas for flow testing the 1,000 foot (305 m) wells.

NOISE. Truck-mounted water well drills would be used for both the temperature gradient and 1,000 foot (305 m) wells. The noise levels would be comparable to trucks on the highway or farm equipment in the fields.

SURFACE DISTURBANCE. The disturbance at the shallow temperature gradient holes will do little more than mash down the grass around the hole sites with a small mud sump near the collar. The 1,000 foot (305 m) tests will require larger mud sumps during drilling and extended site occupation for testing. These sites may be reclaimed and abandoned or developed for future production or reinjection.

AIR POLLUTION. Air pollution will be limited to dust from traffic to and from the drill and exhaust from the engines.

WATER DISCHARGE. The flow testing of the wells will require disposal of the water. This can be by pumping to reservoirs (the settling ponds of the old

uranium mill), to irrigation, to a reinjectin well or disposal to the surface drainage, depending on the heat and quality of the water and permitting by regulatory agencies.

LONG TERM IMPACTS. If the test wells are plugged and abandoned, the site will be reclaimed and there would be no long-term impact from the drilling. It is, of course, the objective of this drilling to assess the reservoir potential with the expectation that it will be good enough to encourage additional development. Such additional development, which may include a district heating system for the town, industrial uses, and expanded agricultural uses, would be a separate project with long-term environmental implications. It would be an exercise in futility to attempt to describe all of the possible uses of all of the possible types of geothermal resource which may be found in this area. It is therefore recommended that environmental studies related to development projects be made for the specific proposed uses of the specific resources found. Thus, while the presently proposed reservoir testing project may lead to long-term development, the reservoir testing per se will have no long-term environmental impacts.

B5c POTENTIAL FOR CONFLICTS WITH EXISTING LAND USE PATTERNS AND PROGRAMS. The reservoir testing drilling program will have no conflicts with existing land use patterns and only minor conflicts with farm management programs.

The real potential for conflicts would lie in the subsequent geothermal development which the reservoir testing may spawn. Such uses are likely to be greenhouses, industrial plants, pump stations, reservoir tanks, and possibly heat exchanger facilities to supply a district heating system. As discussed in the previous section (b) on environmental impacts, these are concerns which should be addressed when a specific use is proposed. However, the proposed study area already has existing greenhouse, commercial and industrial facilities and the potential for conflicts seem minimal.

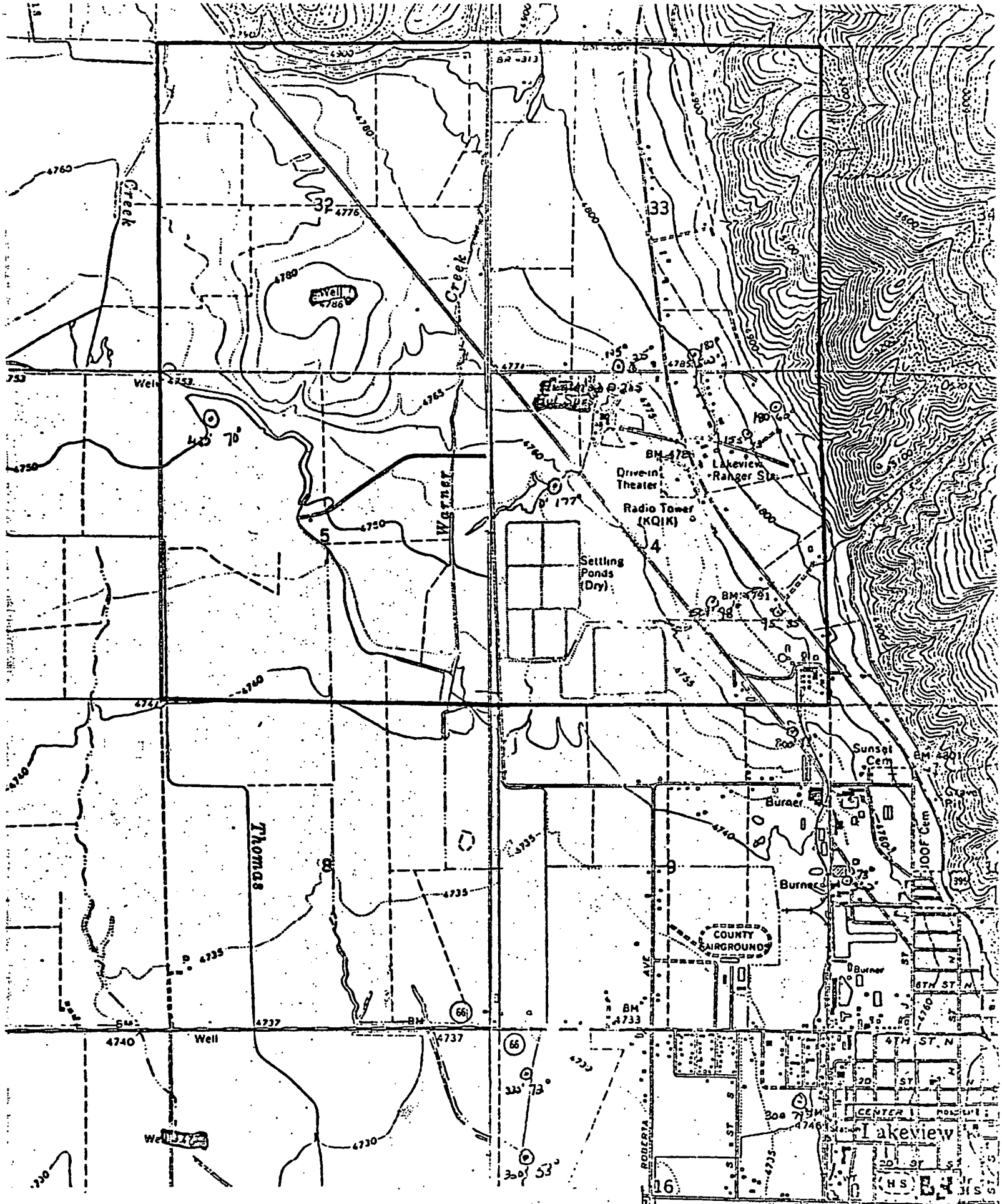


Plate 2 Topographic Map of Hunter Hot Springs Geothermal Area, Lakeview, Oregon.

C. COST ESTIMATES FOR THE LAKEVIEW GEOTHERMAL PROPOSAL

1.	Drilling	$179,880
2.	Well Performance Testing	57,000
3.	Contract Scientific Services	10,000
4.	Management Cost	61,075
5.	Transportation	4,500
6.	Housing	5,430
	TOTAL	$317,885

Cost breakdown on following pages

Optional Form 60 - EXHIBIT E

1. Drilling

a. Shallow test holes - nine to be drilled to an estimated average depth of 350 feet

Average cost per hole

Drilling contractor	$3,500
(To provide all materials footage contract rate)	
Site restoration and abandonment	1,000
	$4,500

Nine hole cost estimate: $ 40,500

b. Intermediate depth test holes - three to be drilled to a depth of 1,000 feet. Driller to provide service at a daily rate. Bits, mud and miscellaneous supplies to be furnished by NGC.

Drilling contractor

Estimated operating time:		
96 hours x $185/hr.	=	$17,760
Standby for cement & testing		
26 hours x $150/hr.	=	3,900
	Total	21,660

Cementing services

Surface pipe	=	$ 3,000
Production pipe	=	5,000
	Total	$ 8,000

Materials

Surface 8-5/8" pipe		
350 ft. @ $8/ft.	=	2,800

Materials (Cont.)

Production - 5-1/2"

1,000 ft. @ $6/ft.			6,000
		Total	$ 8,800

Tools and supplies

Mud	$3,000		
B.O.P.	500		
Bit	3,000		
Miscellaneous	1,500		
		Total	$ 8,000
TOTAL DRILLING COST/WELL =			$46,460
THREE WELL TOTAL =			$139,380

Excluding Management, Supervision and Site Restoration

2. Well Performance Testing

For three 1,000 foot wells - estimates would include pump test and injection test separately or between wells and other production evaluations. Material and labor requirements are estimated to be:

3,000 ft. 4" conductor between holes			
3,000 ft. x $10	=	$30,000	
Labor for surface installation			
200 hours @ $10/hr.	=	2,000	
Pumps and Misc. well equipment	=	25,000	
	Total		$ 57,000

3. Contract Scientific Services

Well logging for at least one 1,000 foot hole to include electric, sonic and other determined from drilling data.

Well logging	=	$ 6,000	
Water testing services	=	4,000	
	Total		$ 10,000

4. Management Costs

a. Geological observations and reports

(1) Geologist field time

640 hours @ $30/hr. = $19,200

(2) Reports and summarization

210 hours @ $30/hr. = 6,300

b. Drilling and testing supervision

400 hours @ $35/hr. = 14,000

c. Miscellaneous labor

200 hours @ $10/hr. = 2,000

d. Management overhead (including labor under testing)

45% x $43,500 = 19,575

	Total		$ 61,075
5. Transportation	=		$ 4,500
6. Housing and Expenses	=		$ 5,430
	TOTAL		$317,885

C2 Proposed Cost to Government

75% x 317,885 = $238,413.75

D. BUSINESS AND MANAGEMENT

1. Northwest Geothermal Corporation is presently engaged in geothermal resource exploration on the west slopes of Mt. Hood. The objective is to develop resources for direct use in the Portland, Oregon area. We have been working with the assistance of the Oregon Department of Geology and Minerals Industries (DOGAMI) in the assessments. We are proposing to continue our testing in 1978 with an expanded drilling program, some of which will include participation in the Mt. Hood assessment program being conducted by DOGAMI in cooperation with the Department of Energy, U.S. Geological Survey and the U.S. Forest Service. While the scope of the Mt. Hood project is much greater, the objective is the same as the Lakeview proposal.

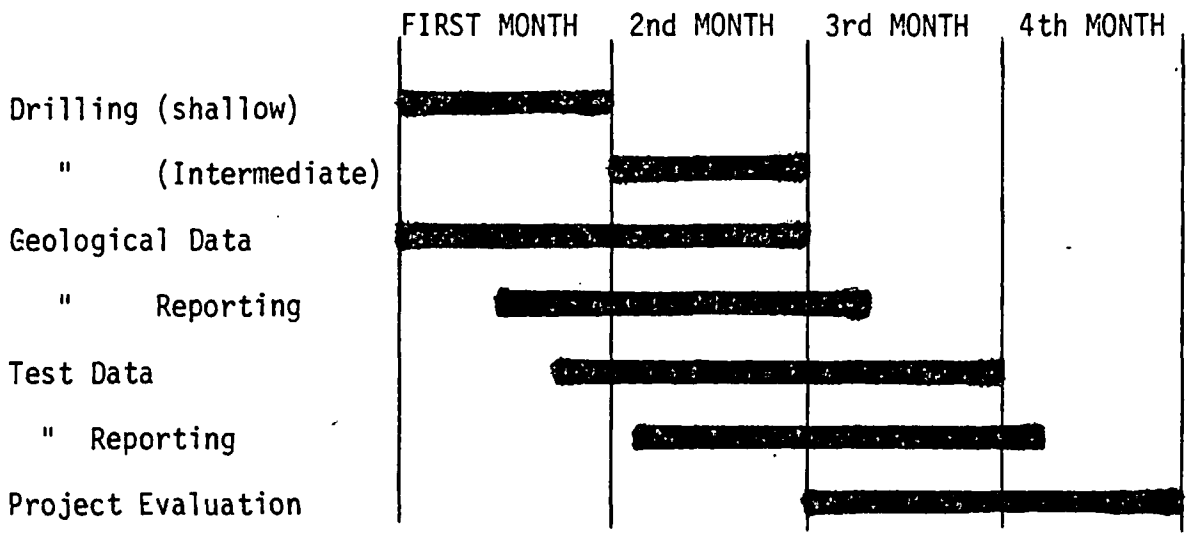
2. The principal program personnel for the project will be E. Rowan, General Manager, W.F. Covert, Supervisor of Exploration and Development, and H.J. Meyer, NGC Geologist and J.W. Hook, Consulting Geologist. The resumes are enclosed as Exhibit C.

3. MANAGEMENT PLAN

The NGC will provide the management and supervision needed to provide all drilling, testing, permits, land acquisition, labor and materials needed to evaluate the resource area named in this proposal. The General Manager, E. Rowan, will monitor the Lakeview project and provide supportive engineering as required to maintain the Lakeview Task Force. W.F. Covert, Supervisor of Exploration and Development, will initiate contracts with drillers, service companies, and suppliers as required. He will supervise all field activities. H.J. Meyer, NGC Geologist and J.W. Hook, Consulting Geologist, will monitor all drilling and testing through the project and report to W.F. Covert. THey will maintain all records and provide reports and

summaries of the complete project.

The project time frame estimate would be:



4. Persons and agencies available for discussion of this proposal would be:

Don Hull - State Geologist 229-5580

Andy Parker - Desert Farms, Lakeview 947-7745

City of Lakeview - City of Lakeview

5. The draft contract is acceptable as a basis for contract negotiations.

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

7. Northwest Natural Gas Company annual report for 1977 (Exhibit D).

8. NGC Proposal will be in effect until October 1, 1978.

9. Mr. P.H. Howe, Vice President of NGC and Senior Vice President of NNG is authorized to commit NGC or NNG to a contract with DOE.

10. GSA Form 19B "Representations and Certifications" is enclosed as Exhibit F.

RESUMES OF

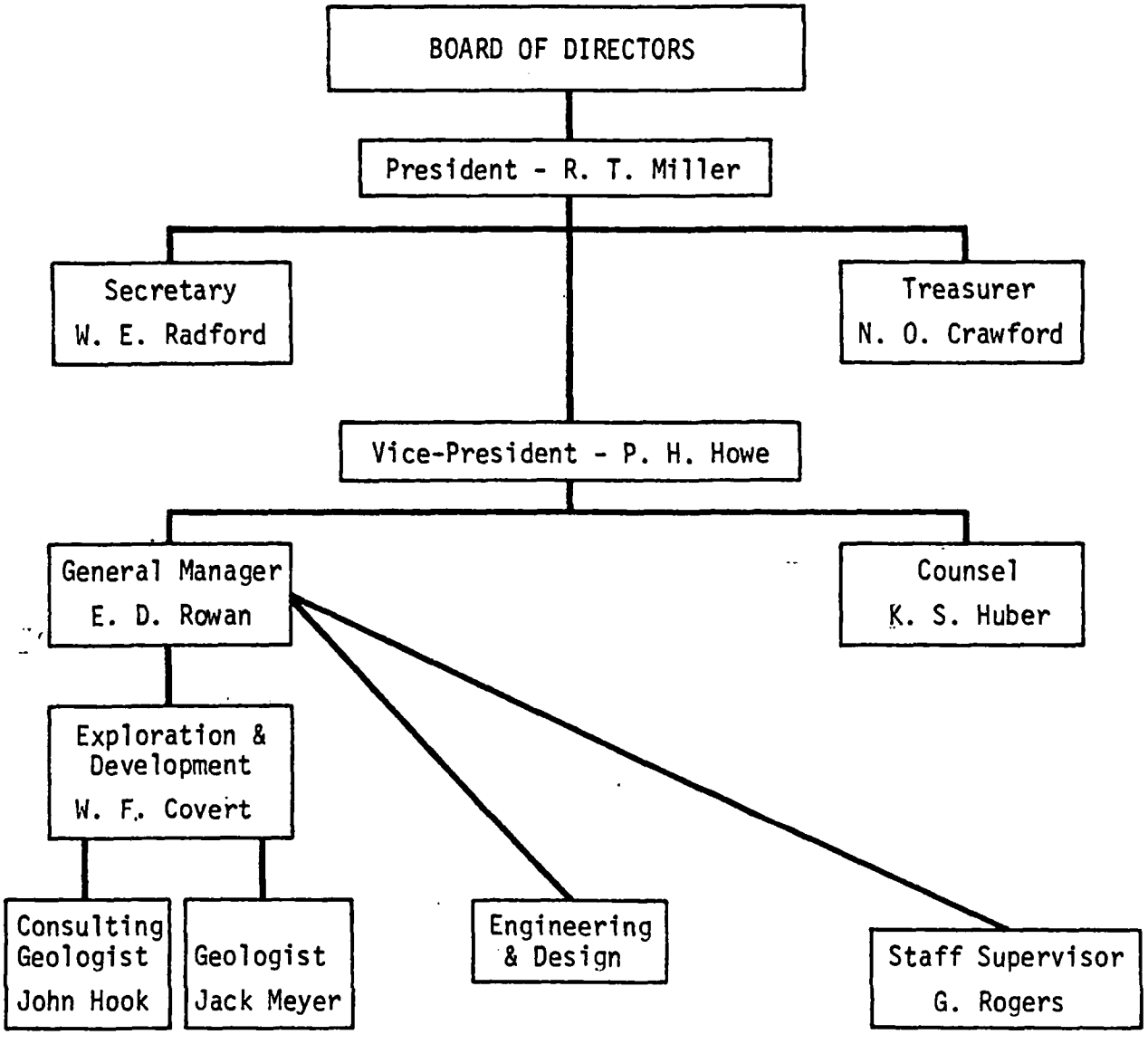
PRINCIPLE PROGRAM PERSONNEL

OF

NORTHWEST GEOTHERMAL CORPORATION

EXHIBIT C

NORTHWEST GEOTHERMAL CORPORATION



R E S U M E

Edward D. Rowan, P.E.

Education:	Oregon State University 1940 B.S. Mechanical Engineering
	Registered Professional Engineer May 1947 #2684
Member:	American Society Mechanical Engineers 1937 Professional Engineers of Oregon 1947 National Society Professional Engineers 1947 Oregon State Board of Boiler Rules 1961 - 1978 Oregon State Board of Engineering Examiners 1967 - 1979 Engineers and Architects Council of Oregon 1949 - 1967
Experience:	Northwest Natural Gas Company 37 years Construction Engineer Plant Engineer Supt. of Production Conversion Coordinator Sr. Staff Engineer Project Manager Project Manager for two liquefied natural gas plants, one completed in 1977 at $17.5 million.
Honors:	ASME National Undergraduate Award, New York, 1940 President - 1963 Engineers and Architects Council of Oregon Chairman - 1949 Oregon Section, ASME
Papers:	ASME, Gas Journal, ASCE, Washington, D.C.
Teaching:	Oregon State Extension, Engineers Registration Exam Course
Military Service:	South Pacific, United States Navy 1944 - 1946 USNR - 1959 LT (jg)
	Private Pilot's License 1962 - #1613544

RESUME'

Wilford F. Covert
Born: March 22, 1925
Malden, Indiana

Education:

1. Military Schools 1-1/2 years for Electronics Techanical Training
2. Texas College of Arts & Industries - B.S. Petroleum & Natural Gas Engineering (considered double degree)

Military Service: U.S. Marine Corp. 1943 - 1946 T/Sgt.

Exploration and Production Experience:

1. El Paso Natural Gas Company 1955 - 1958. Drilling and Completions Engineer, completed over 200 gas wells in San Juan Basin.
2. Northwest Natural Gas Company 1958 - present. Company Coordinator and observer on 4-hole wildcat gas exploration in Northwest Oregon. Drilling was in cooperation with Reichold Energy Company.

   Supervised drilling and testing on the west slopes of Mt. Hood for geothermal resources.

Reservoir and Resource Projects as Research and Development Supervisor:

1. Underground Gas Storage Project
2. Mt. Hood - Old Maid Flat Geothermal Resource Project
3. Portland, Oregon Geothermal Utility Proposal
4. Lakeview, Oregon Geothermal Utility Proposal
5. Klamath Falls, Oregon Geothermal Utility Proposal

Major Supervisory Positions held with Northwest Natural Gas Company:

1. Gas Control Supervisor
2. Pipeline Construction Project Engineer
3. Industrial Service Supervisor
4. Economic & Area Development Supervisor
5. Coordinator of Facility Planning
6. Energy Research and Development Supervisor

W. F. Covert

R E S U M E

John W. Hook, Consulting Geologist
7315 Battle Creek Road, SE
Salem, Oregon 97302

Telephone: 503-581-5493

Education: A. B. Degree in Geology University of Tennessee 1947
Graduate studies at University of Tennessee 1948 - 1950

Military: Army Air Corps Bombardier - Navigator 1942 - 1945

Experience: American Zinc Company Exploration Geologist 1947 - 1954
Reynolds Metals Company Exploration Geologist 1954 - 1974
Consulting Geologist 1974 - Present

My experience has been primarily in the exploration of hydrothermal deposits of lead, zinc and fluorspar. These deposits were formed by geothermal systems. I have also directed exploration drilling projects for bauxite, high alumina clay, and coal. I developed new structural theories in the East Tennessee zinc district and in the Illinois - Kentucky fluorspar district, both of which proved useful in making major ore discoveries.

I have been interested in the geothermal resources of the northwest since the late 1960's and resigned my position with Reynolds to pursue this interest. I have made many studies and field examinations of geothermal resources, attended conferences and presented papers on this subject. I have filed geothermal lease applications on federal land in Clackamas, Marion and Harney counties, Oregon. I am consulting for the Northwest Natural Gas Company on the Mt. Hood-Portland geothermal project.

Professional Organizations:
Society of Economic Geologists
Geological Society of America (Fellow)
Geothermal Resources Council
Society of Miscellaneous Oregon Geologists
Northwest Mining Association

Publications

Oder, C. R. L., and Hook, J. W., 1950, Zinc deposits of the southeastern states, Symposium on mineral resources of the southeastern United States, University of Tennessee Press.

Hook, J. W., 1974, The structure of the fault systems in the Illinois-Kentucky fluorspar district, Symposium on the geology of fluorspar, Kentucky Geological Survey Special Publication 22.

Hook, J. W., 1976, Ferruginous bauxites of the Pacific Northwest, Oregon Dept. of Geology & Mineral Industries Open File Report O-76-3, 26 p.

Hook, J. W., 1976, The possibility of geoheat for Portland, Geo-Heat Utilization Center Quarterly Bull., Jan. 1976, p. 4-5.

R E S U M E

Harry J. Meyer, Registered Professional Geologist

Education: 1968 B. S. Geology Portland State University
1972-1978 Graduate Study Portland State University, Candidate for Masters Degree in Geology. Partially completed thesis titled: Geology of Old Maid Flat and Zig Zag Area, Clackamas and Hood River Counties, Oregon.

Experience: Spring 1968-Employer: Dr. R. E. Thoms, Portland State University
Duties: Isolated and mounted foraminifera from oil and gas wildcat drill cores.

Oct. 1968 - Oct. 1971 Military Service - U. S. Army

Oct. 1971 - Feb. 1972-Employer: Tom Beard Consulting Geologist, El Paso, Texas. Duties: Stakes mining claims, assisted in field magnetometer survey; assisted in field geology of portions of West Texas and Central New Mexico; prepared base maps from air photos.

May 1973 - Present Employer: Northwest Natural Gas Co.
Geologic studies of Northwest Oregon for natural gas prospects and/or underground storage of natural gas; observed four wildcat wells. Geologic and geothermal studies of western Mt. Hood, Oregon. Observed the drilling of one deep temperature gradient hole. Reconnaissance geologic and geothermal study of Lakeview, Oregon.

A PRELIMINARY REPORT ON THE GEOTHERMAL POTENTIAL OF LAKEVIEW, OREGON

By J. W. Hook & H. J. Meyer

May 24, 1978

Introduction

Lakeview is in a Known Geothermal Resource Area (KGRA) with thermal wells in town and hot springs to the north and south of the city limits. While reservoir testing is needed for confirmation, the existing thermal manifestations seem to indicate a more than adequate resource to heat the city and provide energy for new industry. The Hunter Hot Springs area 2 miles (3.2 Km) north of town, known for its geyser "Old Perpetual" , has the highest temperatures (205°F) (96°C), largest discharge (600 gpm) (2,271 lpm), and best quality resource. Here, boiling water found under a shallow "silica cap" is being used for heating a large greenhouse, a motel, and several homes. For these reasons the Hunter Hot Springs area appears to be the most likely prospect to develop a geothermal resource for space heating, industry, and agriculture.

Geology

Stratigraphy

The stratigraphy of the region surrounding Lakeview is comprised of five unnamed mappable units (Fig. 1). The oldest unit (1) consists of andesitic tuffs, tuff breccias, tuffaeceous sedimentary rocks and local flows of andesite and basalt. It is early Oligocene to late Miocene in age. The unit is conformably overlain and locally interfingers with a more siliceous volcanic unit. This unit (2) consists of rhyolitic and dacitic tuff, tuffaceous sedimentary rocks, subordinate basalt and andesite flows and palagonitic tuffs. The nearly continuous sequence of volcanism ceased in the early Pliocene. A period of erosion followed and ended in mid-Pliocene with the outpouring of extensive (3) olivine basalt flows.

The last two map units are sedimentary in nature and are limited to the present topographic basins. The oldest unit (4), about mid-Pleistocene in age, consists of fluvial terrace and lacustrine deposits. The sediments range from silts to conglomerates. These deposits are found along the north and northwestern boundary of the Goose Lake depression. They represent stream and delta deposits at the margin of an earlier expanded Goose Lake. The youngest map unit (5) is alluvium. It is the sand, silt and mud deposits left by a receding Goose Lake.

Rhyolitic domes are part of two well-defined belts of intrusive-extrusive rocks in southeastern and south central Oregon that become progressively younger to the west. In the Lakeview area they are approximately 8 million years in age, which probably is too old to be the heat source for the thermal manifestations near the town.

Structure

The dominant structural feature in the Lakeview area is normal faulting (Basin and Range Structure). The mapped faults can be subdivided into two groups: 1. Those that strike northwesterly (Eugene-Denio fault zone); 2. Those that strike northerly (Basin and Range). Both groups are regional in extent (Fig. 2).

The northwesterly striking group is characterized by close spacing, a nearly parallel strike pattern and vertical displacement of generally less than 500 ft. (152 m). Peterson and McIntyre (1970) believe that the faulting started sometime in the Pliocene and decreased in the Pleistocene.

The northerly striking group of which the Lakeview fault is one, is characterized by widely spaced horst and graben type faulting with irregular strike and vertical displacement of as much as 5,000 feet (1,524 m). The northerly trending group show the ragged tearing of extensional tectonics as opposed to the

relatively straight nearly parallel strikes of the northwesterly group which have a strong strike-slip type pattern. The northerly group is part of the Basin and Range fault system of Nevada, Western Utah and Eastern California. In most cases the northerly trending "range" faults seems to displace the northwesterly ones. The northerly faulting is believed (Peterson and McIntyre 1970) to have started in the early Pleistocene and diminished quite recently. They also noted two stages of major movement along the Lakeview fault as indicated by the bench in the Warner Mountains escarpment above Lakeview.

A lineation analysis of northern Goose Lake depression from U-2 high altitude infrared air photos (Fig. 3) demonstrates that both fault patterns are present in the Quaternary valley sediments, indicating that some lateral as well as vertical movement to the faults is quite young and may still be intermittently active. However, the lineations in the valley sediments die out rapidly south of Lakeview, indicating that either faulting has not been active since the lake receded or that area lies outside of an active fault zone.

Regionally there is an anticlinal structure that parallels the northwesterly fault zone. The axis of this structure passes into and quite probably through the Goose Lake Depression. It appears to be older than or contemporaneous with the northwesterly fault trend (Peterson and McIntyre 1970). If it is contemporaneous with the faulting, it could represent rotation of the fault blocks rather than actual folding.

Geothermal Analysis

Resource Location

There are strong surface manifestations of geothermal energy at both the north and south ends of the city of Lakeview. Hunter Hot Springs, about 1 mile north of the city (1.6 Km), has spring temperatures that range from 195°F (90.5°C) to 205°F (96°C) and a geyser temperature of 210°F (99°C). Barry Ranch Hot Springs, about 1 mile (1.6 Km) south of the city has a maximum temperature of 193°F (89°C). In between these two locations shallow water wells encounter thermal waters ranging from 52°F (11°C) to 98°F (37°C) (Fig. 4).

Geologically, the hot springs are located adjacent to the Lakeview fault on the downdropped block.

Hunter Hot Springs seem to be the better geothermal prospect for the following reasons: 1. They appear to reflect a larger and hotter reservoir; 2. the reservoir is probably more than adequate to supply Lakeview and may be capable of supporting substantial new industrial applications; 3. Hunter Hot Springs is practically odorless whereas there was a distinct hydrogen sulfide smell at Barry Ranch Hot Springs.

The report will deal exclusively with the hot water potential. The steam potential of the two hot spots has not been tested. The well being used by Oregon Desert Farms was orignally a thermal test well drilled in the Hunter Hot Springs area by Magma Power in 1960. It has no records, but it is rumored that the thermal gradient reversed when it crossed the Lakeview fault zone at about 500 feet (152 m). In 1973 Gulf Oil Company drilled a deep test a little west of the center of the two hot spots (Fig. 4). Despite encountering a temperature of 125°F (52°C) at 1,000 feet (304 m), the unstabilized thermal

gradient was in the neighborhood of 56°C/Km (133°F). These two holes do point out that the heat source is localized and apparently associated with faulting. A study (Mariner and others, 1974) by the United States Geological Survey of the mineral constituents that have been shown to be geothermometers indicate a minimum aquifer temperature in both reservoirs of at least 140°C (284°F).

Heat Source

In southeastern and south central Oregon there are three major northwesterly fault zones; the Brothers fault zone, the Denio fault zone and the McLaughlin fault zone (see Fig. 2). Crossing these fault zones at oblique angles are the large normal faults of the Basin and Range province (Fig. 2). These faults have such large displacement that they tend to mask the age of the northwesterly faults. A lineation analysis of infrared U-2 photographs of Goose Lake Valley (Fig. 3) demonstrates that there has been Quaternary movement to both fault systems. Relatively unweathered fault scarps indicate the faulting is quite recent, likely still on-going. Further, a study of the hot spring locations in southeastern and south central Oregon leads to the conclusion that the areas of high heat flow are generally along the three northwesterly fault zones where they intersect with the Basin and Range faults. Possibly the mantle of the earth is upwelling along these fault zones or that the continent has rotated over a convective cell in the mantle.

The point of this discussion is that Lakeview is situated near the junction of the Denio-Eugene lineament and the Goose Lake graben and that the heat source is probably deep seated magma fueling convection cells along the faults. Interpretation of high level and low level aerial photography (Figs. 3 and 6) reveals the existance of a relatively small fault block just north of Hunter Hot Springs and to the west of the major fault along the Warner Mountains.

Perhaps the intersection of this fault and the fault along the east side of Goose Lake graben has localized the convection cells.

Figure 5 is a conceptual model of the possible reservoir at Hunter Hot Springs. In this model the water is heated by deep circulation in the Lakeview fault zone and rises by convection along the fault. Near the surface, cooling causes precipitation of the silica and other minerals in the water to form a "silica cap." This seals the upper part of the fault zone and deflects the water to the permeable formations of the graben, extending the silica cap as it moves outward. The silica cap is shallow (100 ft.) (30.5 m) and thin (5-10 ft.) (1.52-3 m). Wells drilled through this cap tap the superheated water below and blow as geysers unless contained. "Old Perpetual" is such a well and has been blowing about three times per minute since 1928. It should be emphasized here that the potential resource is shallow, probably less than 600 feet (183 m).

Water Quantity and Quality

Groundwater seems to be in abundant supply. A 480 foot (146 m) well drilled about 1-1/2 miles (2.41 Km) west of Hunter Hot Springs has been tested at 4,000 gallons/minute (15,142 lpm).

Volumes of this magnitude are not surprising because of the clastic nature of the Pleistocene lake sediments that underly the surface. As stated before, the sediments consist of silts, sands and gravels. The sands and gravels have very high porosity and permeability. The test well drilled by Gulf Oil Company logged in the first 620 feet (189 m) a sand body extending from at least 140 feet (43 m) to 300 feet (91 m) and two 20 foot (6 m) thick gravel beds below the sand unit at 520 feet (158 m) and 590 feet (180 m).

Recharging of the aquifers occurs vertically and horizontally. Vertical downward migration of water is related to the surface runoff from the mountains to the east and the west of the valley. Horizontal recharge of the aquifers comes from Goose Lake which is approximately 60 feet (18.3 m) lower in elevation than Lakeview. These two sources of water should be adequate for a town of Lakeview's size and allow for substantial additions including industrial and agricultural uses.

The quality of the geothermal water now produced at Hunter Hot Springs is good yet it has some aspects that may require that the water be treated before distribution. It does not appear to be excessively corrosive. Oregon Desert Farms which uses a 4-inch (10.2 cm) steel pipe loop as a down-hole heat exchanger, expects the pipe to have a life of at least 15 years. The water contains a fairly high concentration of silica (see Table 1, Hunter Hot Springs). The potential for silica scaling is not known, as every user of thermal water employs a down-hole heat exchanger. The water has not as yet been completely tested to determine if it meets the E.P.A. standards for public drinking water (Table 2). The E.P.A. only tests for heavy metals, pesticides, herbicides, radioactive minerals and biologic contaminants. The other dissolved solids come under separate regulation governing the esthetics of drinking water (Table 3) which the E.P.A. says it will never enforce. As indicated in Tables 1 and 2, the concentration of 1. Fluorine is well above, 2. Arsenic barely exceeds, 3. Selenium approaches, and 4. Mercury is well below the E.P.A. limits. A complete analysis (perhaps several) will have to be done and a plan formulated for dealing with each excessive element.

The geyser water from the northern hot springs (Table 1, Hunter Hot Springs) exceeds the E.P.A. esthetic criteria for sulfate content and total dissolved

solids. If it can pass "the taste test", the E.P.A. would not object to it being used in a public water system.

One potentially detrimental element in the thermal water is sodium (Table 1). Its high concentration is ideal for softening water and cleaning clothes "whiter than white" but if not balanced with calcium it kills plants and ruins the soil. If the hot water analyses that have been used as reference are representative, the water most likely could not be used directly on the soil. The Soil Conservation Service recommends analyzing soils and the water to determine compatibility and the type of crops that could be grown under the conditions present. The soils that are now suitable for farming are generally in the northwest portions of the valley. The harsh climate is one of the limitations for this area and thermal water may be a way to ameliorate some of the effects of the cold climate.

Evaluation

Positive Factors

1. A hot water resource (boiling) is present and located.
2. The resource is shallow.
3. There appears to be an abundant supply of groundwater.
4. There are known large aquifers in the valley.
5. The water is of good quality.
6. The resource is close to a population center.
7. Non-thermal water is in abundant supply.
8. Land subsidence should not occur as reservoirs are expected to have adequate recharge.

9. The subsurface is quite favorable for laying pipelines. Lake bed material consists of silts, sands, and an occasional gravel bed.
10. Steam capabilities may be present.

Negative Factors

1. Some inorganic chemicals (fluorine and arsenic) may exceed E.P.A. contaminant levels.
2. Esthetically, the water may not be potable.
3. There is a high sodium content vs. calcium content.
4. The high silica content may lead to scaling problems.
5. Heat exchange system may be required if thermal water cannot be used directly.
6. Water may have to be reinjected.
7. Most valley soils unsuitable for farming.
8. Most valley soils unsuitable for dwellings, septic tank fields and sewage lagoons (Fig. 7).

Recommendations for Next Phase of Study

1. Detailed location of faults and possible faults.
2. Drill shallow (less than 150 ft. [45.7 m]) temperature gradient holes to define boundary of resource.
3. Drill two or three deeper holes (about 1,000 ft. [305 m]) to test for temperature gradient, reservoir rock, water quality and production capability.
4. Use water from one of the deeper holes to conduct experiments for scaling and corrosion.
5. Have soils and water from deeper test holes analyzed for compatibility.
6. Analyze waters from deeper test holes for E.P.A. requirements.
7. Analyze water from Goose Lake for comparison to thermal water.

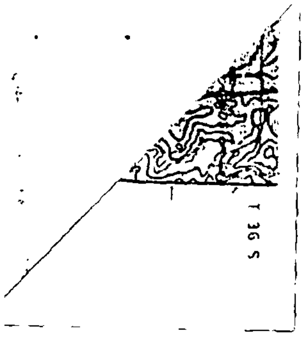
References:

Mariner, R.H., Rapp, J.B., Willey, L.M., and Presser, T.S., 1974, The Chemical Composition and Estimated Minimum Thermal Reservoir Temperatures of Selected Hot Springs in Oregon: U.S. Geol. Survey, Open-File Report, 27p.

_____, 1975, Minor and Trace Elements, Gas and Isotope Compositions of the Principal Hot Springs of Nevada and Oregon: U.S. Geol. Survey, Open File Report, 27p.

Peterson, N.V., and McIntyre, J.R., 1970, The reconnaissance Geology and Mineral Resources of Eastern Klamath County and Western Lake County, Oregon: Oregon Dept. of Geology and Mineral Industries Bull. 66, 70p.

Walker, G.W., 1963, Reconnaissance Geologic Map of the Eastern Half of the Klamath Falls (AMS) Quadrangle, Lake and Klamath Counties, Oregon: U.S. Geol. Survey Mineral Inv. Field Studies Map, MF-260.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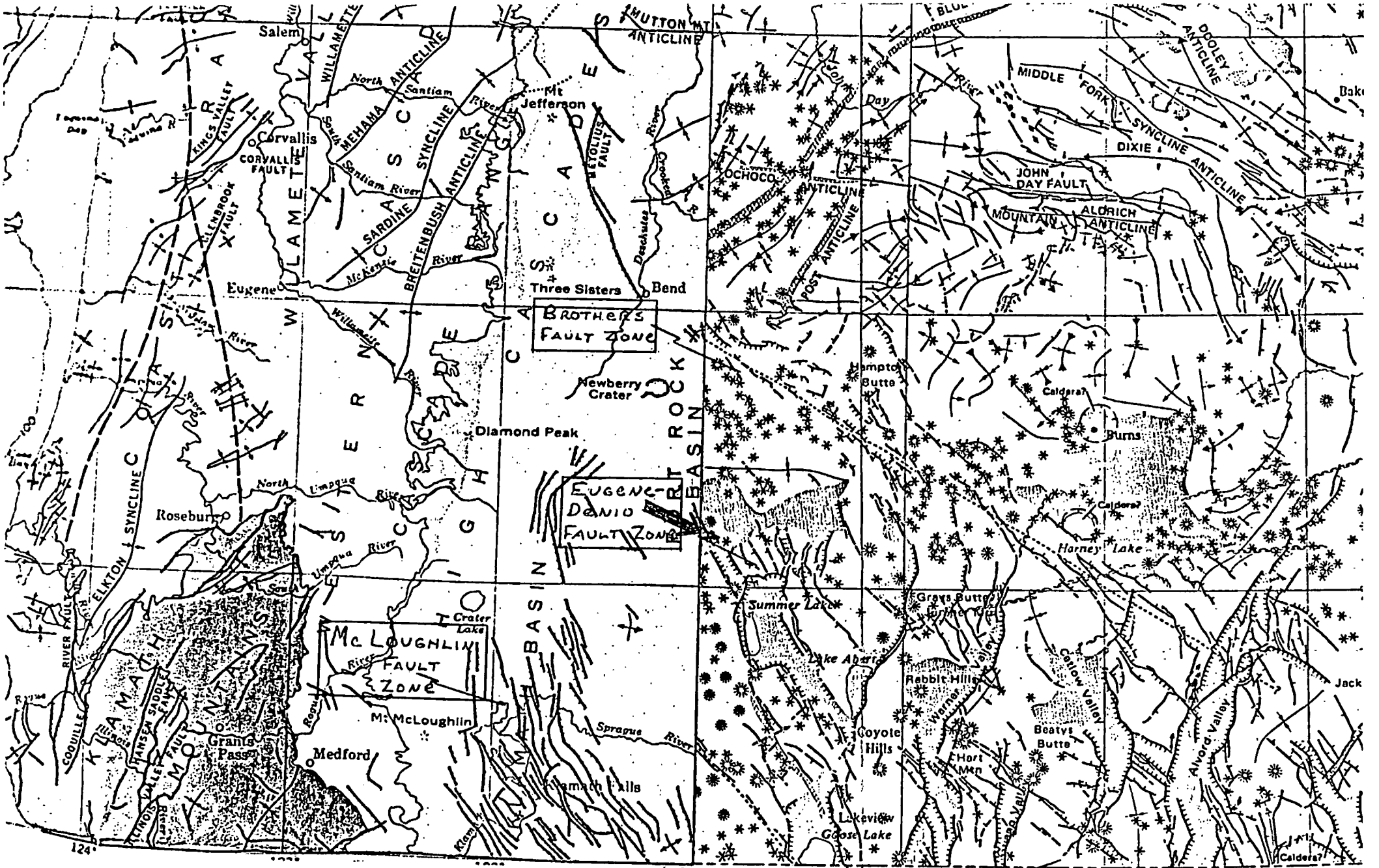
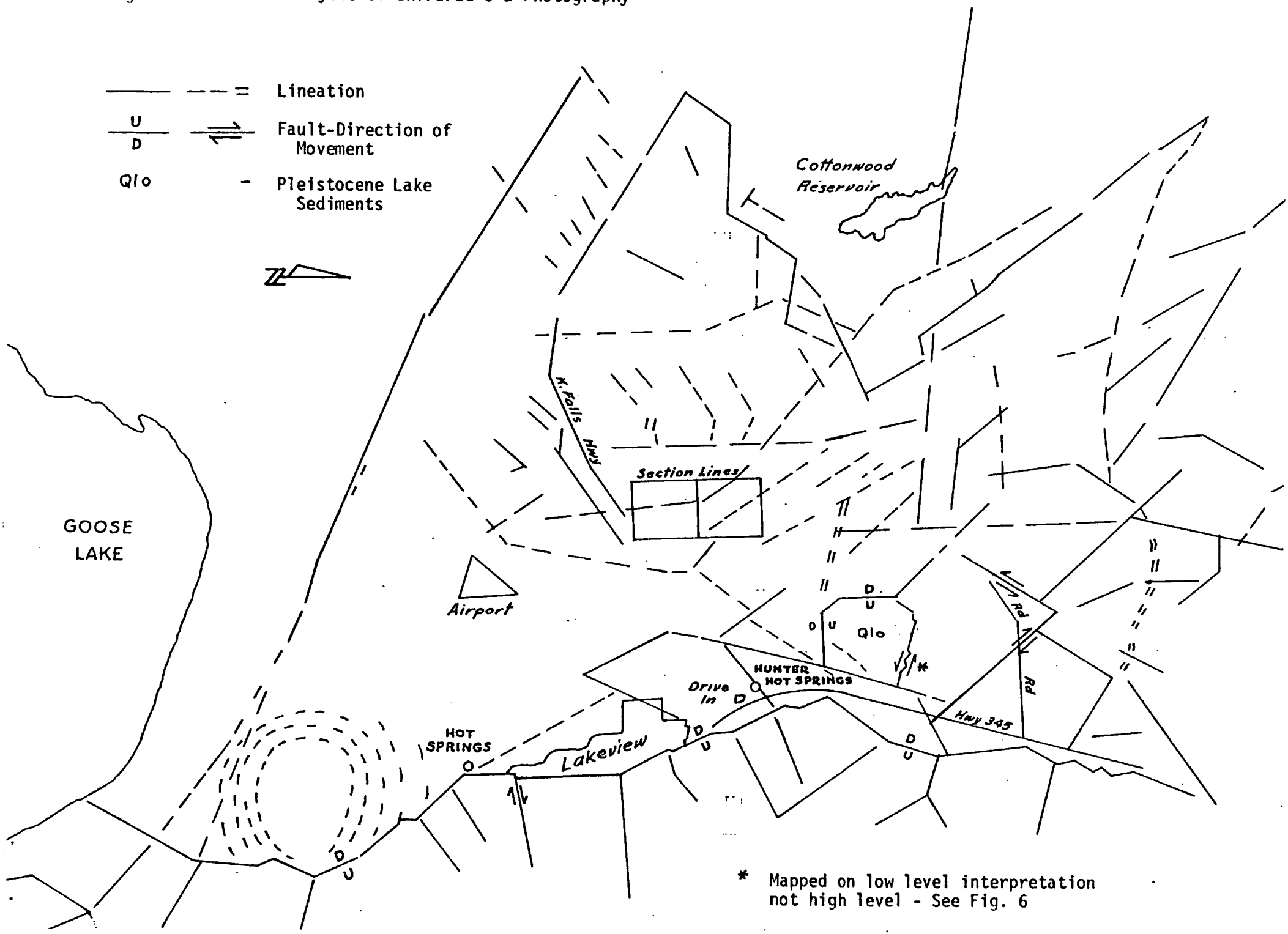


MAJOR NORTH - SOUTH FAULTS

FIGURE 2

Fig. 3 Lineation Analysis of Infrared U-2 Photography



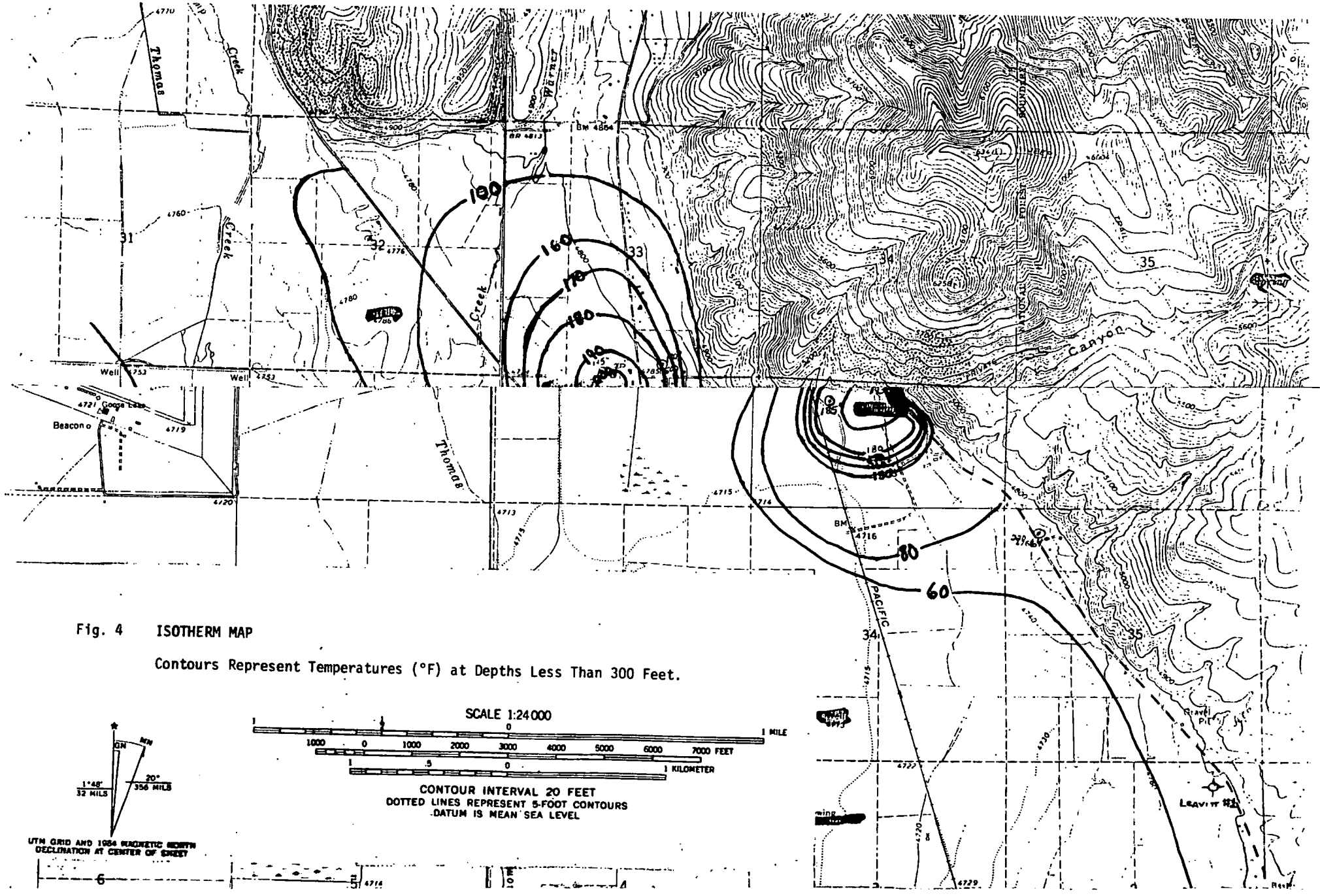


Fig. 4 ISOTHERM MAP

Contours Represent Temperatures (°F) at Depths Less Than 300 Feet.

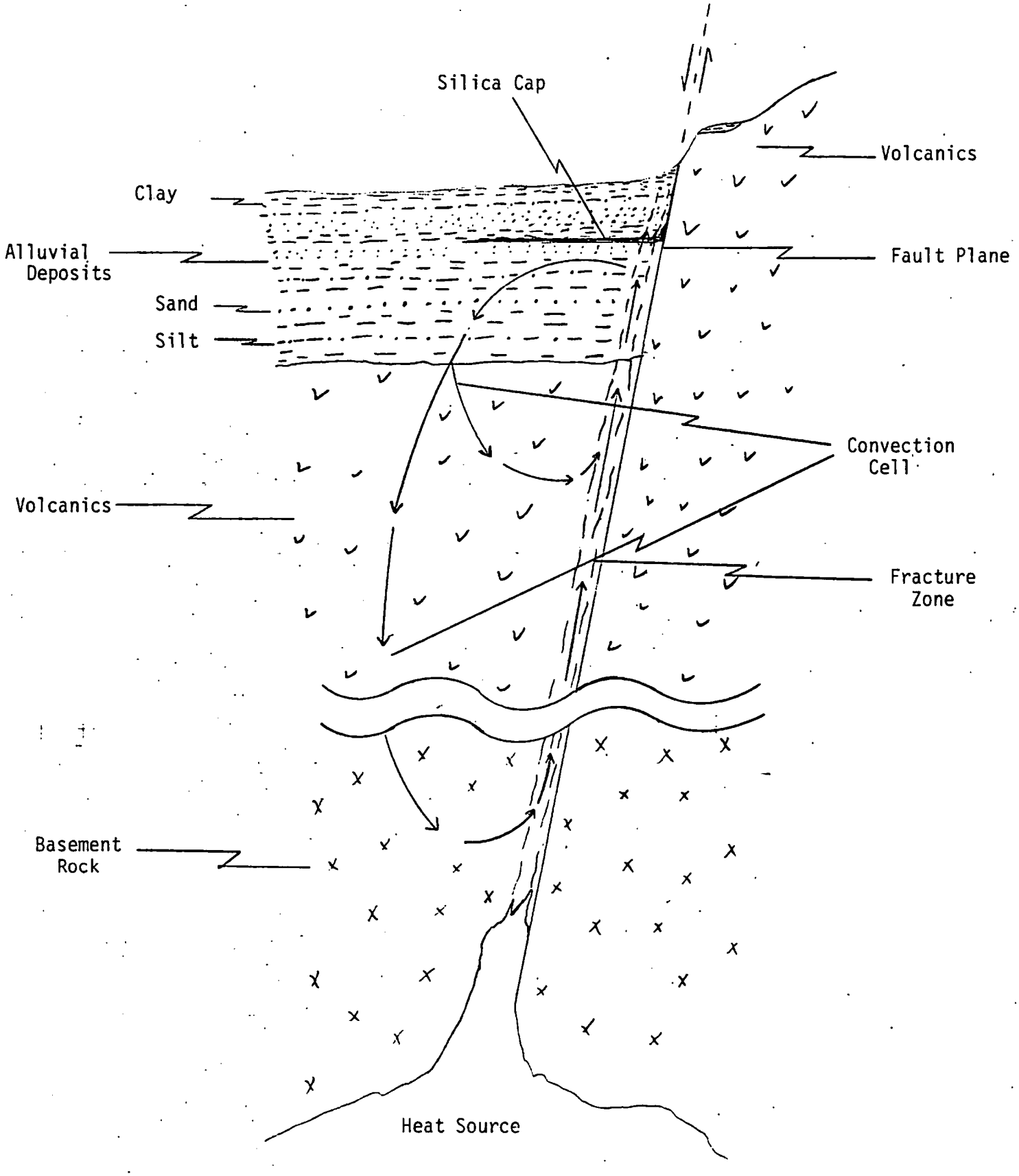
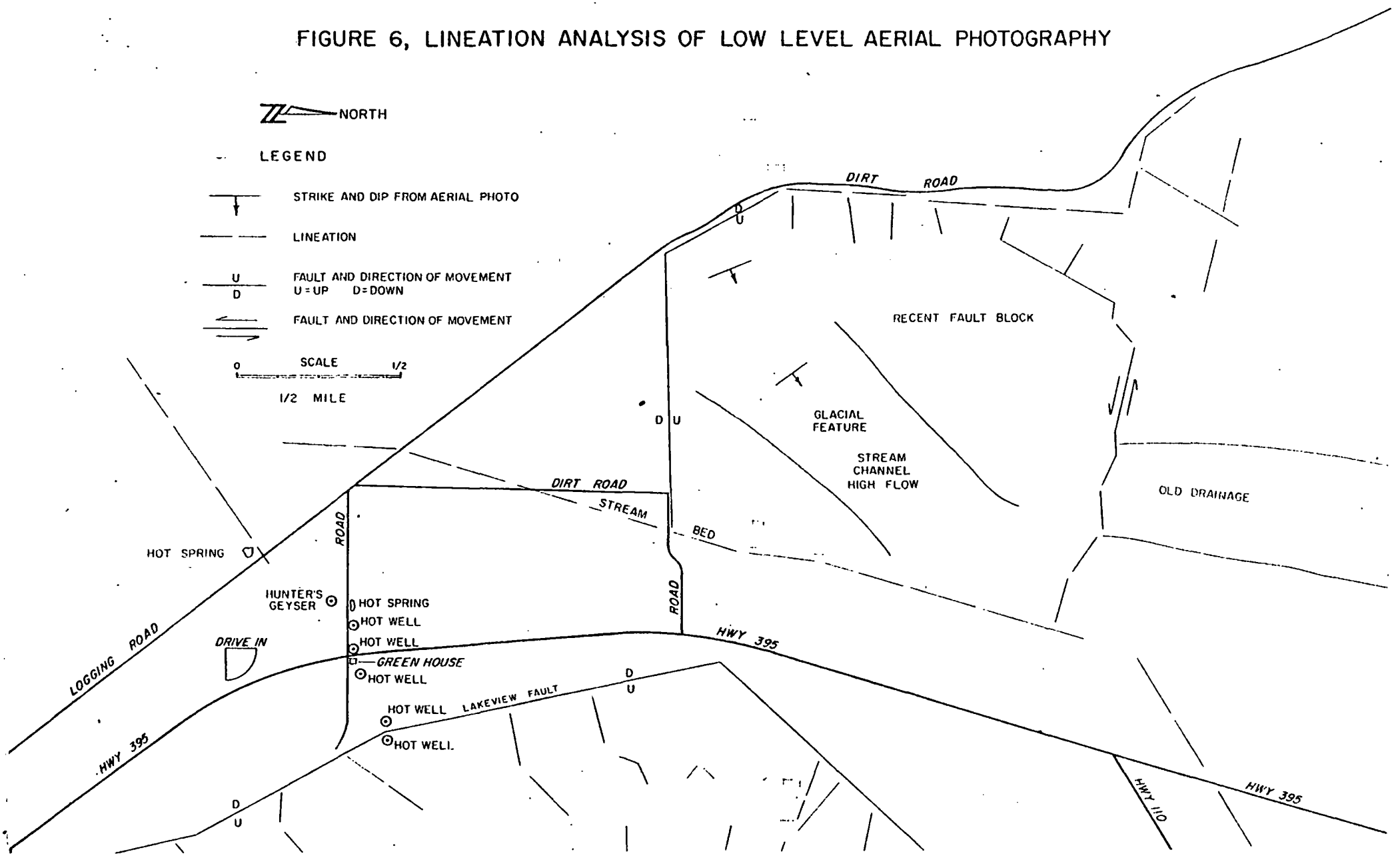


Fig. 5 Idealized Thermal Convective System Associated with Normal Faulting and Deep Seated Magma

FIGURE 6, LINEATION ANALYSIS OF LOW LEVEL AERIAL PHOTOGRAPHY



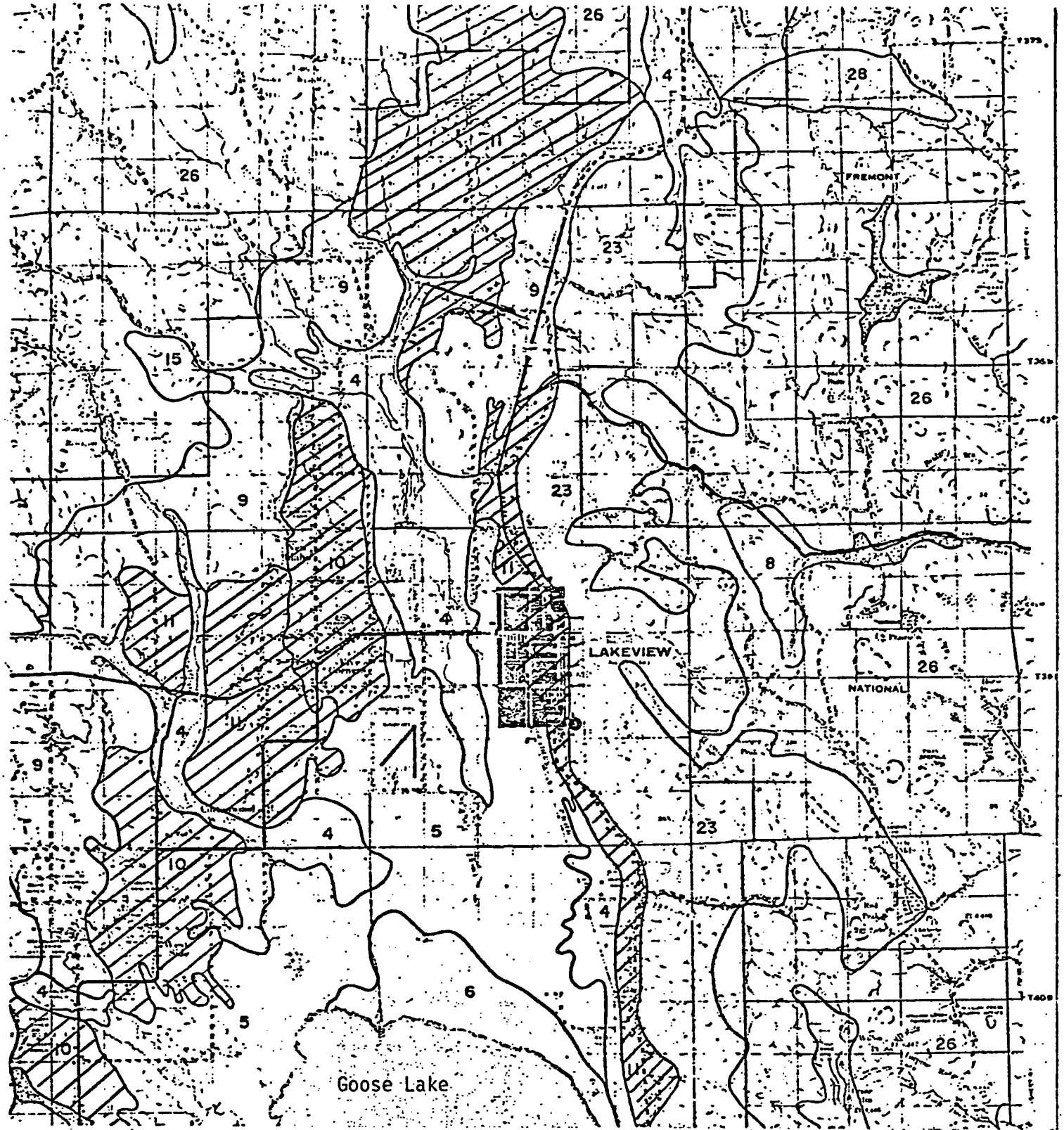


Fig. 7 General Soil Map

Soils suitable for dwellings, septic tank fields and sewage lagoons.

Soil Nos. 4, 10 & 11 suitable for farming with limitations of wetness for No. 4 and climate for Nos. 10 & 11.

TABLE 1 CHEMICAL ANALYSES OF THERMAL WATER

Lakeview, Lake County, Oregon

(ppm Peterson & McIntyre - mg/l, USGS)

Location	Data Source	pH	Solids Total	Hardness ($CaCO_3$)	Ca	Mg	Fe	As	Cl	Na	K	F	SO_4	SiO_2	B	Hg	Se	°F Temp.
Hunters Hot Springs 39-20-4C	Peterson & McIntyre	--	886	56	15	4.4	0.07	--	132	236	6.6	4.6	289	145	--	--	--	212
Hunters Hot Springs 39-20-4C	USGS	7.77	--	--	13	.1	.02	0.06	120	210	8.5	4.4	260	140	6.9	.0004	.008	205
City of Lakeview 39-20-16A	Peterson & McIntyre	--	191	6	1.1	0.8	0.05	--	3.2	45	2.0	0.6	1.4	77	--	--	--	79
Leo Hanks 39-20-27B	Peterson & McIntyre	--	531	39	15	0.4	0.06	--	99	152	2.2	3.1	152	66	--	--	--	157
Gus Allen 39-20-27L	Peterson & McIntyre	--	905	27	8.5	1.4	0.02	--	146	268	8.8	6.9	223	140	--	--	--	185
Barry Ranch Hot Springs 39-20-27L	USGS	7.76	--	--	8.8	.1	.02	0.07	170	280	9.0	5.4	240	130	11.2	0.0017	--	190

TABLE 2 E.P.A. Maximum Contaminant Levels

141.23

(b) The following are the maximum contaminant levels for inorganic chemicals other than fluoride:

Contaminant	Level, milligrams per liter
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05

(c) When the annual average of the maximum daily air temperatures for the location in which the community water system is situated is the following, the maximum contaminant levels for fluoride are:

Temperature Degrees Fahrenheit	Degrees Celsius	Level, milligrams per liter
53.7 and below	12.0 and below	2.4
58.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

141.12 Maximum contaminant levels for organic chemicals.

The following are the maximum contaminant levels for organic chemicals. They apply only to community water systems. Compliance with maximum contaminant levels for organic chemicals is calculated pursuant to 141.24.

	Level, milligrams per liter
(a) Chlorinated hydrocarbons:	
Endrin (1,2,3,4,10, 10-hexachloro-6,7-epoxy-1,4, 4a,5, 6,7,8,8a-octa-hydro-1,4-endo, endo-5,8 - dimethanonaphthalene).	0.0002
Lindane (1,2,3,4,5,6-hexachloro-cyclohexane,gamma isomer).	0.004
Methoxychlor (1,1,1-Trichloro-2, 2 - bis [p-methoxyphenyl] ethane).	0.1
Toxaphene ($C_{10}H_{10}Cl_8$- Technical chlorinated camphene, 67-69 percent chlorine).	0.005
(b) Chlorophenoxys:	
2,4-D, (2,4-Dichlorophenoxyacetic acid).	0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid).	0.01

Table A. --Average annual concentrations assumed to produce a total body or organ dose of 4 mrem/yr.

Radionuclide	Critical organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

TABLE 3 E.P.A. Secondary Maximum Contaminant Levels

143.3 Secondary Maximum Contaminant Levels.

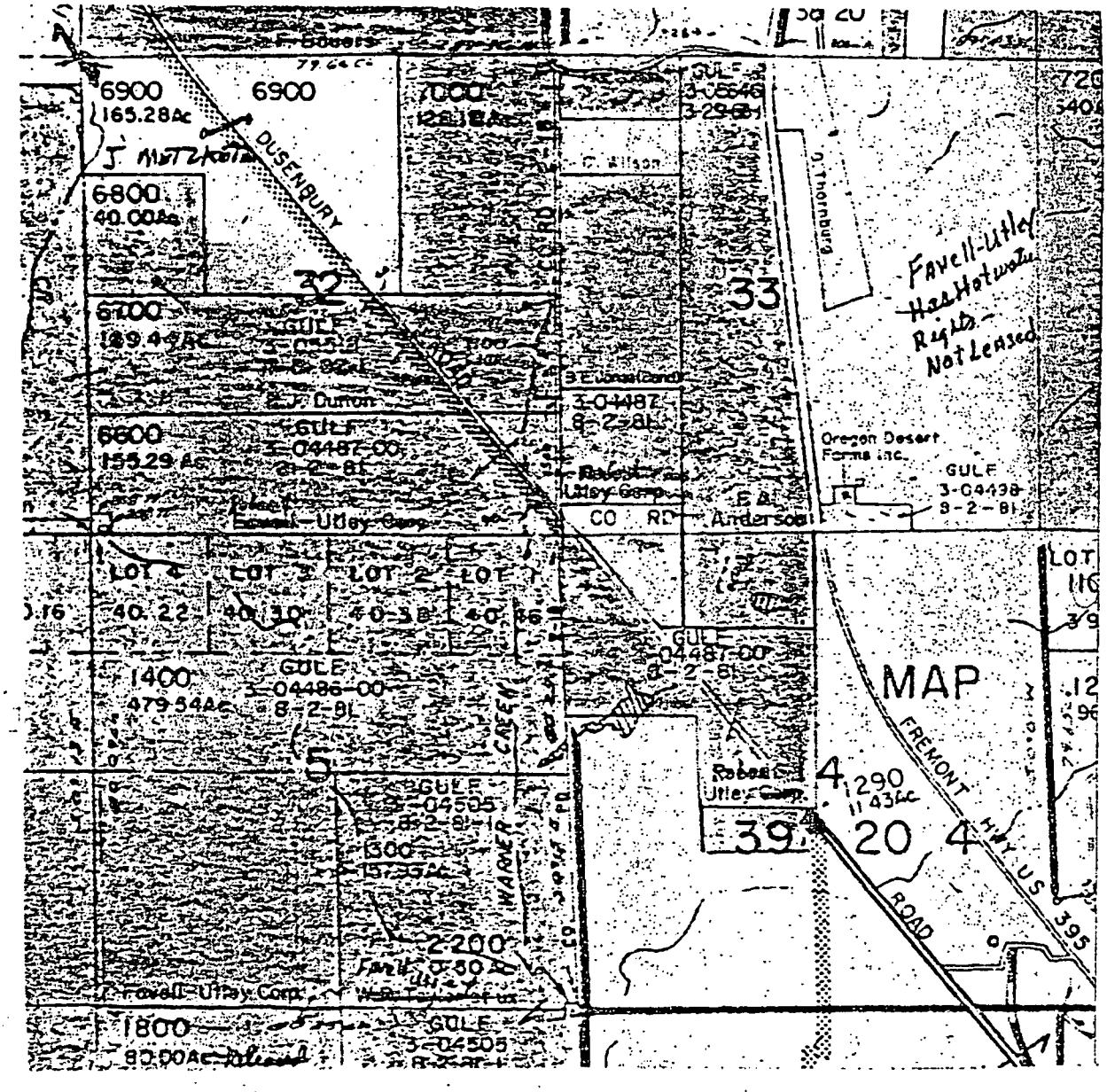
The Secondary Maximum Contaminant Levels for public water systems are as follows:

Contaminant:	Level
Chloride	250 mg/l.
Color	15 Color Units
Copper	1 mg/l.
Corosivity	Non-corrosive
Foaming Agents	0.5 mg/l.
Hydrogen Sulfide	0.05 mg/l.
Iron	0.3 mg/l.
Manganese	0.05 mg/l.
Odor	3 Threshold Odor Number
pH	6.5-8.5
Sulfate	250 mg/l.
TDS	500 mg/l.
Zinc	5 mg/l.

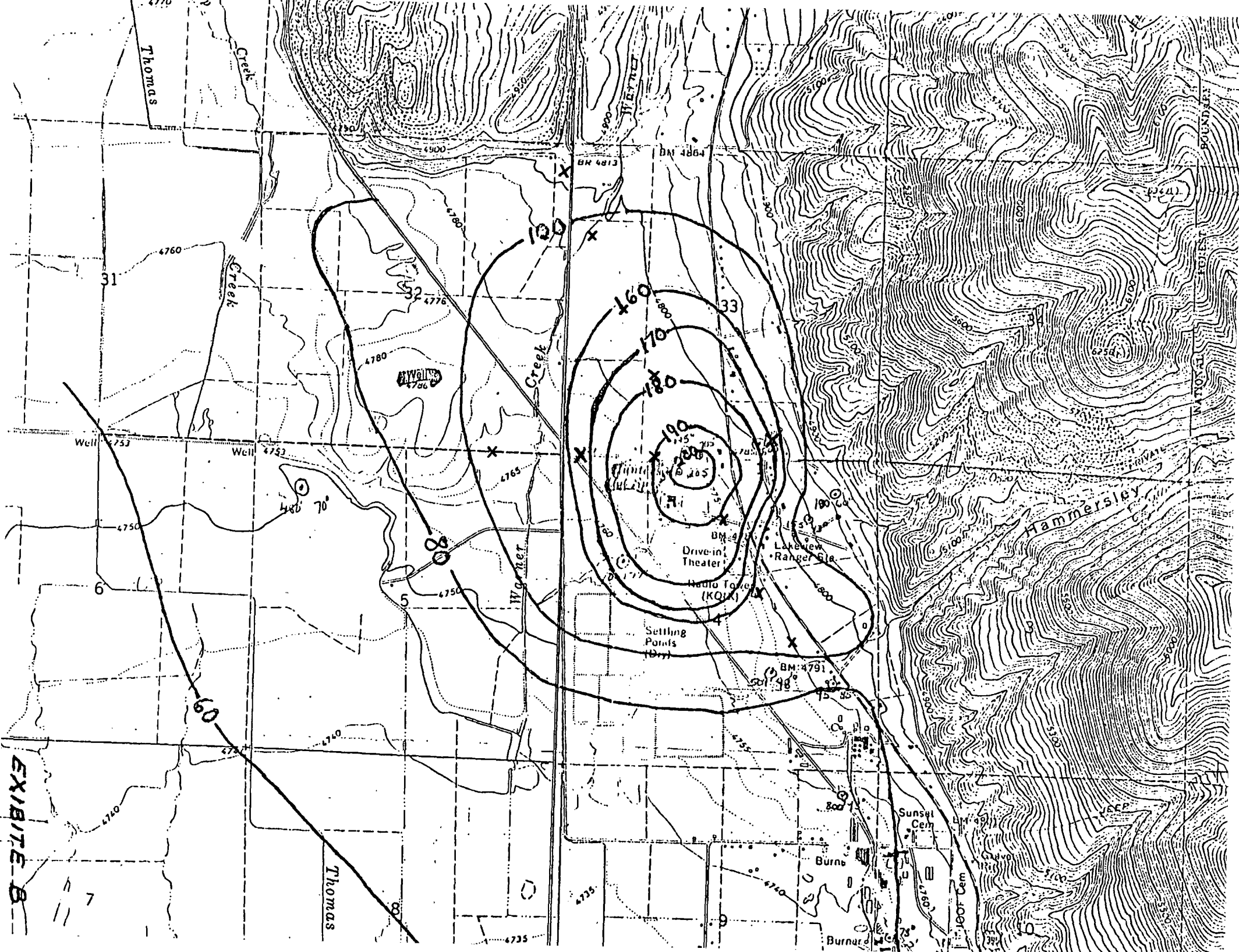
NORTHWEST GEOTHERMAL CORPORATION

LAND MAP OF AREA OF INTEREST

LAKE COUNTY, OREGON



Exibit A


Thomas Creek
Tierney
Warner Creek
Hammersley
Drive-in Theater
Lakeview Ranger Sta.
Radio Tower (KQIK)
Settling Ponds (Dry)
Sunset Cem.
Burns
Thomas
100
160
170
180
190
200
60
80
BM 4813
BM 4864
BM 4791
Well
EXHIBIT B

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	SUPPLIES AND/OR SERVICES TO BE FURNISHED
Northwest Geothermal Corporation	Drilling and Testing of Geothermal Resources at Lakeview, Oregon, Northern Basin and Range Province
HOME OFFICE ADDRESS 123 N.W. Flanders St. Portland, OR 97209	
DIVISION(S) AND LOCATION(S) WHERE WORK IS TO BE PERFORMED Lakeview, Oregon	TOTAL AMOUNT OF PROPOSAL $ 317,885
GOV'T SOLICITATION NO. ET-78-R-08-0003	

DETAIL DESCRIPTION OF COST ELEMENTS

1. DIRECT MATERIAL *(Itemize on Exhibit A)*			EST COST *($)*	TOTAL EST COST[1]	REFERENCE[2]
a. PURCHASED PARTS			105,400		
b. SUBCONTRACTED ITEMS			129,480		
c. OTHER—*(1)* RAW MATERIAL					
(2) YOUR STANDARD COMMERCIAL ITEMS					
(3) INTERDIVISIONAL TRANSFERS *(At other than cost)*					
TOTAL DIRECT MATERIAL				234,880	
2. MATERIAL OVERHEAD[3] *(Rate % X $ base =)*					
3. DIRECT LABOR *(Specify)*	ESTIMATED HOURS	RATE/ HOUR	EST COST *($)*		
Geologists	850	30	25,500		
Drilling & Testing Supervision	400	35	14,000		
Misc. Labor	400	10	4,000		
TOTAL DIRECT LABOR				43,500	
4. LABOR OVERHEAD *(Specify Department or Cost Center)*[3]	O.H. RATE	X BASE =	EST COST *($)*		
Payroll Overhead (Includes Administration Exp.)	45	43,500	19,575		
TOTAL LABOR OVERHEAD				19,575	
5. SPECIAL TESTING *(Including field work at Government installations)*			EST COST *($)*		
Electronic Well Logging			6,000		
Water Test Services			4,000		
TOTAL SPECIAL TESTING				10,000	
6. SPECIAL EQUIPMENT *(If direct charge) (Itemize on Exhibit A)*					
7. TRAVEL *(If direct charge) (Give details on attached Schedule)*			EST COST *($)*		
a. TRANSPORTATION			4,500		
b. PER DIEM OR SUBSISTENCE			5,430		
TOTAL TRAVEL				9,930	
8. CONSULTANTS *(Identify—purpose—rate)*			EST COST *($)*		
Consultant Fees & NGC Direct Labor Handled Under Direct Labor Due to Undetermined Ratio at This Time.					
TOTAL CONSULTANTS				317,885	
9. OTHER DIRECT COSTS *(Itemize on Exhibit A)*					
10. TOTAL DIRECT COST AND OVERHEAD					
11. GENERAL AND ADMINISTRATIVE EXPENSE *(Rate % of cost element Nos.)*[4]					
12. ROYALTIES[5]					
13. TOTAL ESTIMATED COST					
14. FEE OR PROFIT					
15. TOTAL ESTIMATED COST AND FEE OR PROFIT					

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

EXHIBIT E

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

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

TYPED NAME AND TITLE	SIGNATURE
W. F. Covert Research and Development	W. F. Covert

NAME OF FIRM	DATE OF SUBMISSION
Northwest Geothermal Corporation	5/25/78

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

COST EL NO.	ITEM DESCRIPTION *(See footnote 5)*	EST COST *($)*
1.a.	Casing (Surface & Production) 3 Holes	26,400
	Drilling Tools & Supplies	24,000
	Well Test Conductor Pipe	30,000
	Pumps & Misc. Well Equipment	25,000
		105,400
1.b.	Drilling Contractor (Shallow Tests)	31,500
	Drilling Contractor Intermediate	64,980
	Contractor - Site Restoration	9,000
	Cementing Services	24,000
		129,480

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

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

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

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

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

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

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

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

☐ YES ☒ NO *(If yes, identify.):*

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

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

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

INSTRUCTIONS TO OFFERORS

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

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

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

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

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

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

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

FOOTNOTES

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

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

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

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

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

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

REPRESENTATIONS AND CERTIFICATIONS

(Construction and Architect-Engineer Contract)

(For use with Standard Forms 19, 21 and 252)

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

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

NORTHWEST GEOTHERMAL CORPORATION

DATE OF BID

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 Oregon ....

5. INDEPENDENT PRICE DETERMINATION

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

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

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

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

(b) Each person signing this bid certifies that:

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

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

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

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

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

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

6. EQUAL OPPORTUNITY

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

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

7. PARENT COMPANY AND EMPLOYER IDENTIFICATION NUMBER

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

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

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

NAME OF PARENT COMPANY	MAIN OFFICE ADDRESS *(No., Street, City, State, and ZIP Code)*
NORTHWEST NATURAL GAS COMPANY	200 S.W. Market Street, Suite 1900 Portland, OR 97201

(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
➔	93-025-6722	Applied for

8. CERTIFICATION OF NONSEGREGATED FACILITIES

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

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

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

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

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

9. CLEAN AIR AND WATER

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

The bidder or offeror certifies as follows:

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

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

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

SUPPLEMENT TO REPRESENTATIONS AND CERTIFICATIONS

10. BUY AMERICAN CERTIFICATE

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

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

11.* AFFIRMATIVE ACTION PROGRAM

The following paragraphs are added:

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

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

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

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

* Northwest Natural Gas Company, controlling parent of Northwest Geothermal Corporation, is in full compliance with the affirmative action program requirements of the rules and regulations of the Secretary of Labor (41CFR).

NAME OF CONTRACTOR	DATE	FEDERAL AGENCY
(include known first-tier sub-contractors)		

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 solicitation (see I. below) unless (i) the offeror, together with all divisions, subsidiaries, and affiliates under common control, did not exceed the monetary exemption for disclosure as established by the Cost Accounting Standards Board (see II. below); (ii) the offeror exceeded the monetary exemption in the Federal Fiscal Year immediately preceding the year in which this proposal was submitted but, in accordance with the regulations of the Cost Accounting Standards Board, is not yet required to submit a Disclosure Statement (see III. below); (iii) the offeror has already submitted a Disclosure Statement disclosing the practices used in connection with the pricing of this proposal (see IV. below); or (iv) postaward submission has been authorized by the Contracting Officer. See 4 CFR 351.70 for submission of copy of Disclosure Statement to the Cost Accounting Standards Board.

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

Check the appropriate box below:

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

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

Date of Disclosure Statement(s): _____

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

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

[✓] II. CERTIFICATE OF MONETARY EXEMPTION

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

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

[ ] III. CERTIFICATE OF INTERIM EXEMPTION

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

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

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

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

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

Date of Disclosure Statement(s):_____

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: Northwest Geothermal Corporation

Name: Paul H. Howe Paul H. Howe

Date: 5/25/78

Title: Vice President