

Lead to clay over

also thru Botelle & DNR in Wash. State

6L015419

19 Oct 77

DOE-USGS-BLM-USFS-STATE OF WASHINGTON AGREEMENT

Washington Geothermal Reservoir Assessment Cooperative Project

The purpose of this document is to develop a basis of understanding between the principal participants in a proposed project to assess and confirm potential geothermal reservoirs within the State of Washington. The principal participants are expected to be the Division of Geothermal Energy of the U.S. Department of Energy (DOE-DGE); the Geothermal Research Program of the U.S. Geological Survey (USGS); the U. S. Forest Service (USFS); the U.S. Bureau of Land Management (BLM); and the Geology and Earth Resources Division of the Washington Department of Natural Resources. In recognition of the economies to be gained and the benefits of multi-disciplinary, integrated technical projects applied to reservoir assessment and confirmation efforts, the parties will plan and execute a coordinated project employing the technical and financial resources available. It is the intention of the parties involved in the principles of agreement to implement the project through DOE contracts with the Washington Department of Natural Resources and letters of agreement among the USGS, USFS, BLM, and DOE. Detailed planning will be accomplished by a Working Advisory Group composed in part of representatives of the five parties.

The objective of the proposed program is to assess and characterize the geothermal resources in the State of Washington -- low-temperature reservoirs suitable for direct heat applications and certainly higher-temperature resources, if found to be present. It is expected, at this time, that any reservoirs of exploitable size will be of low-temperature character.

The State of Washington contains five large andesitic strato-volcanoes of the Cascade Range, three of which have hot springs associated with them. All of these volcanoes are within 50 to 100 miles of the major population centers of western Washington, thus any geothermal resource would be extremely valuable. This proposed project then is in accord with the general goals of the DOE-DGE program to assess the potential of geothermal systems that are not being explored by industry. This project will lay the foundation for more intense evaluation of the Cascade strato-volcanoes, and hence is logically supportive of the Mt. Hood, Oregon

studies. If the assessment of Mt. Hood is positive, then the Washington volcanoes will become of even greater interest. If the initial Mt. Hood assessment is not positive or is terminated due to environmental or institutional barriers, then further development of the knowledge of the thermal regime of the Cascade system of volcanoes will be needed.

The project will be funded by DOE through its Direct Heat Applications Reservoir Confirmation Program. The Program Manager for this project will provide technical management of the program for DOE and the Washington Geology and Earth Resources Division, maintain liaison with the USGS and the USFS, BLM, and be responsible to the Working Advisory Group.

Although the main emphasis of the project is resource assessment, all parties will support a substantial effort devoted to dealing with environmental, legal and institutional requirements, and barriers to development of the resource. Each of the volcanoes is in an environmentally sensitive area and every effort will be made to protect them from abuse.

The project in FY78 will focus on providing a review of existing data on the geophysics, geology, hydrology, chemistry and structure of the Washington Cascades. This review would indicate the need for additional reconnaissance in late FY78 and FY79. Detailed investigations would begin as soon as the most appropriate site and methods had been chosen; possibly as early as the end of FY78. Although the prime interest is to be directed toward the strato-volcanoes, deep well data from the basalt flows of eastern Washington will be examined for the possibility of blind geothermal areas.

The Division of Geology and Earth Resources of the Washington Department of Natural Resources will be responsible for geology, geochemistry, heat flow, geohydrology, and geologic input to geophysical investigations and will provide research library facilities and publication facilities, as well as coordinating the surface activities with the appropriate Federal and State agencies.

The U.S. Forest Service and U.S. Bureau of Land Management activity will initially be as an aid in the coordination of surface activities, environmental issues and use regulations on land managed by the USFS and BLM.

The USGS Geothermal Research Group at this time will act in an advisory capacity and aid in obtaining existing basic data.

Level of participation is dependent upon funding of the program by DOE and details of each participants obligations will be included in the actual funding contracts.

Page for Signatures:

1. State

2. DOE-DGE

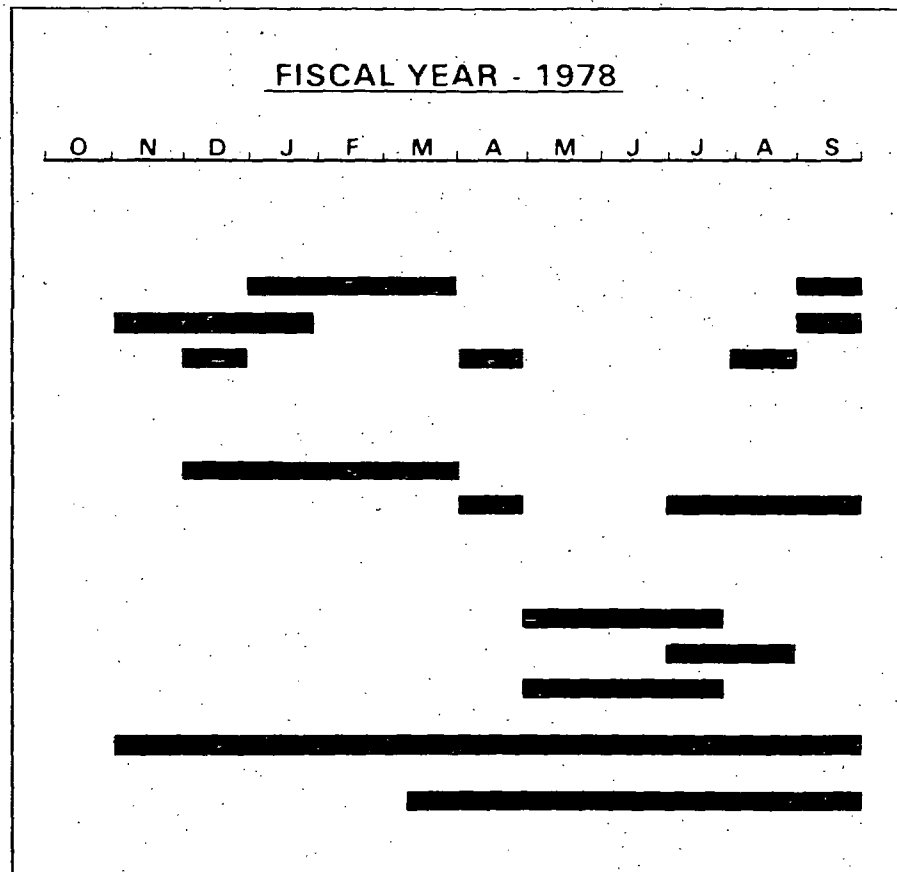
3. USFS

4. USGS

5. BLM

TASK

- 1.0 ANALYTICAL STUDIES - *what is known*
  - 1.1 GEO-HYDROLOGICAL STUDIES
  - 1.2 GEOPHYSICAL STUDIES
  - 1.3 STUDY OF THE CASCADE RANGE  
*milestone - try to figure out what to do next.*
- 2.0 INSTITUTIONAL RELATIONSHIPS
  - 2.1 IN-FORMAL APPROACH TO OBTAIN APPROVALS
  - 2.2 OBTAIN INSTITUTIONAL APPROVALS
- 3.0 FIELD WORK - *min to fill in gaps*
  - 3.1 TAKE ADDITIONAL WATER SAMPLES
  - 3.2 CHEMICAL ANALYSIS
  - 3.3 RESISTIVITY SOUNDINGS  
*Geophysical Surveys*
- 4.0 CORRELATE WITH OTHER STUDIES
- 5.0 GENERATE TOTAL ASSESSMENT PLAN



*\$ requested first year \$150K - day's figure includes state + PLN*

Washington

19 Oct 41

Eric Hunter

Ted

WJ - Jimmy J J & Upton - Brehely -

1. Letter of agreement

day reviewed, also Washington people  
day says buzz work @ low temp.

2. JJJ's capt. Saw Bob Chamberlain  
yesterday, gave him a copy -

3. All jobs will be Project for you  
for PNL

4. Proj. Coordinator - day<sup>said</sup> should be  
Belle - Upton -

Christ said OK

State said OK - yes -

State Agency seems to be super  
shut out re directions or orders from  
field re any project -

State performs  $\$$  work  $\Rightarrow$  PCN  $\Rightarrow$  state  
state will be PT.

Mike Wright



STATE OF  
WASHINGTON

Dixy Lee Ray  
Governor

WASHINGTON STATE ENERGY OFFICE

400 E. Union-1st floor, Olympia, Washington 98504 (206) 754-0700

June 25, 1980

SUBJECT: Budgetary Cuts - Hydrothermal Resources Program

As was indicated to you in a telephone conversation with our office, we are extremely concerned about the budgetary cuts which have been proposed in the House of Representatives Science and Technology Subcommittee and Appropriations Committee regarding the FY 1981 hydrothermal resource program. The hydrothermal program is a major and vital part of the overall U.S. Department of Energy geothermal program.

DOE has indicated to our office that if the proposed cuts are accepted, it would have the following impact on programs:

- 1) no new direct heat projects would be funded;
- 2) the state planning projects would be eliminated;
- 3) market assessment would be cut by 80 percent;
- 4) work on institutional barriers would be cut by two-thirds;
- 5) no new feasibility studies would be undertaken; and,
- 6) resource definition would be cut by approximately 50 percent.

Hydrothermal resources, unlike hot dry rocks and geopressured resources, show great near term potential in Washington State, and we urge that sufficient funding be made available so as to ensure the timely development of the state's hydrothermal resources.

The state of Washington only recently became engaged in a well coordinated effort to assess the geothermal potential of the state and to initiate commercialization of those resources.

The assessment program, which is in its second year, is funded by DOE at the \$300,000 level and is coordinated by the Department of Natural Resources, Division of Geology and Earth Resources. Commercialization activities are coordinated by the Washington State Energy Office (WSEO) which received a grant from DOE in the amount of \$110,000. In order to ensure coordination of the two programs, as well as the activities of other agencies and organizations, the Washington State Interagency Development Council was established in 1978.

Representative Mike McCormack  
June 25, 1980  
Page 2

The resource assessment program has succeeded in identifying several areas with high geothermal potential (Figure 1). The continuation of the assessment program is essential in order that the state be able to establish the quantity and quality of geothermal resources available for development.

Presently, commercialization activities are progressing in Yakima, Ephrata, and North Bonneville.

The city of North Bonneville will be receiving \$10,000 from WSEO and the city has applied to DOE for an additional \$90,000. The funding, if approved, will be used in further resource characterizations with the goal of establishing a geothermal district heating system for the city.

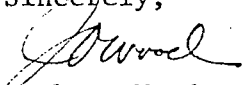
In Yakima, Saint Elizabeth Hospital has applied for and received \$541,000 from WSEO for energy conservation. The sum has been matched by the hospital. Plans are now underway to drill one or possibly two wells in hopes of obtaining geothermal fluids which will, in conjunction with a heat recovery system, cut the hospital's consumption of conventional energy by a minimum of two-thirds. Similar programs are being considered by Davis High School and by Yakima County.

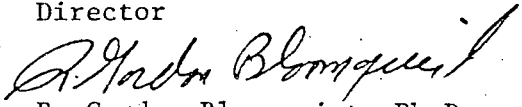
The city of Ephrata, which has a domestic water supply with a temperature of ca 80°F, will submit together with Grant County, a preapplication in the amount of \$468,000 under HUD's Innovative Community Energy Conservation Grant Program by June 23, 1980. The goal of the Ephrata program is to provide a nationally innovative approach to meeting community heating needs by demonstrating the feasibility of municipal district space heating, using an existing municipal water system which carries water warm enough (50 - 90°F) for heat pump applications.

These programs are designed to help establish geothermal as a technically and economically viable additional energy resource in the state of Washington.

A continuation of the DOE hydrothermal resource assessment and commercialization programs at existing budgetary levels is vital if we are to carry on these programs and meet the state's goal of providing a minimum of four percent of the total energy needs of the state with energy derived from geothermal resources by the year 2000.

Sincerely,

  
Jack O. Wood  
Director

  
R. Gordon Bloomquist, Ph.D.  
Chairman, Interagency Geothermal  
Development Council

RGB/JOW/jc

Enclosures



Figure 1

### Geothermal Resources of Washington



WASHINGTON STATE ENERGY OFFICE

10 E. Union-1st Floor

Olympia, WA 98504

Senator Warren G. Magnuson  
Attention: Mr. Ed Sheets  
127 Russell Senate Office Building  
Washington, D.C. 20510

Senator Henry M. Jackson  
Attention: Mr. Joel Merkel  
137 Russell Senate Office Building  
Washington, D.C. 20510

Representative Norman D. Dicks  
Attention: Ms. Creigh Agnew  
1508 Longworth House Office Building  
Washington, D.C. 20515

Representative Mike McCormack  
Attention: Mr. Jack Bagley  
2352 Rayburn House Office Building  
Washington, D.C. 20515

PROPOSED WASHINGTON STATE GEOTHERMAL RESOURCE  
ASSESSMENT PROGRAM FOR CALENDAR 1980

by

J. Eric Schuster and Michael A. Korosec

Washington State Department of Natural Resources

Division of Geology and Earth Resources

Olympia, WA 98504

December, 1979

INTRODUCTION

The Washington Division of Geology and Earth Resources (DGER) has conducted <sup>a</sup> geothermal assessment program under contract to the U.S. Department of Energy for the past year. Activities conducted under that contract have included the drilling of heat-flow holes in the southwestern Cascades; measurement of temperature gradients in existing wells in southwestern Washington; acquisition of temperature gradient data sets from Southern Methodist University, the U.S. Geological Survey, and Washington State University; gravity measurements in the south Cascades and at Camas by the University of Puget Sound; geologic mapping in the White Pass area by the University of Washington; sampling, analysis, and description of thermal and mineral springs; a resistivity survey at Camas; compilation of data for public and scientific geothermal resource maps and a geothermal bibliography; and coordination with other geothermal investigators in the Pacific Northwest.

Proposed activities for calendar 1980 include heat-flow drilling in the south Cascades, measurement of temperature gradients in existing wells in the southeast Cascades and southwest Columbia Basin, support of a thermal-gradient-hydrologic thesis project by Washington State University in the Columbia Basin, support of a geological thesis project on Mount Baker or Mount Adams by the University Washington, continuation of gravity studies in the central and north

Cascades, continued sampling, analysis, and description of thermal and mineral springs, and production of a carefully documented and field-checked lineament-fault map for a portion of the Cascades.

Overall objectives are 1.) to assess geothermal resources in Washington by a) conducting regional exploration activities in order to identify geothermal target areas, b) reporting the results of these exploration activities in a series of open-file and published maps and reports, c) performing confirmatory surveys in the target areas as necessary in order to reach a level of knowledge of the resource sufficient to draw the private sector in to complete the assessment and development, and 2.) to involve local university and consulting personnel in the assessment effort whenever practical in order to develop a "reservoir" of local geothermal experience and expertise.

#### PROPOSED ACTIVITIES

Heat-Flow Drilling--We proposed to drill eight heat-flow holes in the south Cascades during the summer months of 1980. These holes will be six inches in maximum diameter and 500 feet in depth.

Three holes will be located between White Pass and the city of Yakima for the purpose of extending the Cowlitz Valley heat-flow traverse of 1979 to the east, and providing a preliminary test of heat flow in the vicinity of the young dacitic and basaltic volcanic area to the northeast of White Pass.

Two holes will be drilled to the north-northeast and east of Mount Saint Helens for the purpose of completing a preliminary temperature-gradient and heat-flow assessment of the volcano. The three holes drilled during 1979 are located around the southwest one-half of the mountain and one of these holes appears to be adversely affected by local hydrology.

One hole will be located in the Cowlitz Valley between Randle and Morton for the purpose of more clearly defining the location and nature of the transition between "Puget Lowland" type gradients which are typically less than 30°C/km and "High Cascade" type gradients ~~which~~<sup>which</sup> are typically 50°C/km or higher. Two holes will be drilled in as yet unspecified locations, possibly on the Wind River near St. Martins Hot Spring and in the North Bonneville area.

We are proposing to spend \$96,000 to drill eight 500 foot holes during 1980. This is a proposed cost of \$24 per foot. During 1979 we drilled a total of 5,259 feet of hole at a cost of \$94,697.79, or \$18.01<sup>8</sup> per foot. Due to difficult drilling conditions encountered during the 1979 drilling project, including heavy artesian water flows and numerous caving zones, more time and money were required to complete the drilling than was originally anticipated. Because the contractor worked under a footage contract, extra costs are only partially reflected in the payment (\$94,697.79) made to the drilling company. The company reports that their costs were approximately \$145,000, or about \$27.50 per foot. Considering that 1.) a larger drilling rig with more capabilities will be specified for the 1980 drilling, 2.) the holes will be more widely spaced, 3.) actual costs for the 1979 drilling were about \$27.50 per foot, and 4.) inflation, we feel that an estimated 1980 drilling cost of \$24 per foot is quite conservative and may even require that we omit one or two low priority drill holes.

Drilling will take place during the summer months of 1980. Reduction of the data will be accomplished by D. D. Blackwell of Southern Methodist University. We are assuming that Dr. Blackwell will have support from the U.S. Department of Energy in the form of a separate contract which will include the reduction and processing of the Washington State temperature-gradient and heat-flow data. If not, we will have to provide such support through the Washington State resource assessment contract.

Drilling Supervision--A larger sum (\$12,200) is allocated for this task than in 1979 because our 1979 experience shows that drilling programs encounter unexpected difficulties and often extend well beyond their expected completion dates. The drilling supervisor will be an outside consultant who is familiar with drilling practices. He will be expected to direct the day-to-day drilling operations, monitor drilling costs, select alternate drilling sites when necessary, collect and catalog drill cuttings samples, compile a history for each hole, describe the lithology of each hole, and measure temperature gradients in holes drilled.

In the event that all goes well and drilling supervision does not require the full \$12,200, we plan to use the excess funds to support additional measurements of temperature gradients in existing wells.

Temperature Measurements In Existing Wells--A larger sum is allocated for gradient scrounging (\$18,460) than in 1979 for several reasons: 1.) The area of interest during 1980, namely the southeastern Cascades, Yakima Valley, and southwestern Columbia Basin is larger in area than the 1979 area of interest (southwest Cascades), 2.) the area has a large number of wells that are used for irrigation and some of the wells have reported temperatures that are high enough ( $\pm 30^{\circ}$  C) to be of possible interest for heat-pump and direct-use applications, 3.) we hope to put a person in the field early enough in the spring of 1980 so that we can benefit from measured gradients for the siting of holes to be drilled in the White Pass - Yakima area, and 4.) the thesis project we intend to support at Washington State University will involve study of temperature gradient data in the Columbia Basin, and we want to be in a position to supply additional gradient data to that investigation if necessary.

Temperature measurements in existing wells will be made between April and

September, 1980. Resulting data will be interpreted by Dr. D. D. Blackwell and the Washington State University graduate student.

Thesis Support--A significant number of relatively shallow warm water wells are scattered throughout portions of the Columbia Basin in eastern Washington. Under the guidance of Professor J. Crosby, a hydrologist at Washington State University, a graduate student will study existing well logs (including temperature logs) and aquifer flow data to identify thermal anomalies. Through additional well logging and temperature gradient determinations, models will be constructed on the basis of stratigraphy and hydrology which will lead to a better understanding of these anomalies.

The project will continue through two academic years and one summer field season (three months). The budget for the first year will cover the first academic year and the first summer of field work. A progress report will be prepared for the end of calendar 1980. At the end of the two-year project, a final project report will be prepared, complete with maps and models, which will lead to the final thesis report. The 1980 progress report and 1981 final report will be incorporated into the Division of Geology and Earth Resources year-end reports to the Department of Energy, and will be available through the Division as open-file reports.

Site Specific Geology--Under the guidance of Professor J. Vance, University of Washington, a detailed geologic investigation of a specific area within the Cascade Range will be initiated by a University of Washington graduate student as a thesis project. The study will center on one of the stratovolcanoes (most likely Mount Adams or Mount Baker), and will contribute to the understanding of this feature as a potential geothermal system.

The 1980 budget includes expenses for the first academic year and a three month summer field season. The project is expected to take an additional academic year to complete. Detailed geologic mapping, rock analysis, and age dating will lead to a 1980 progress report and a final report at the end of 1981, both of which will be included in the Division of Geology and Earth Resources year-end reports to the Department of Energy and open-filed by the D E division. The reports will include maps and models which will examine the stratigraphy, structure, and volcanic history of the feature, using a geothermal framework when applicable.

If Mt. Adams is the final target selected, this work will tie in directly with projects by the U. S. Geological Survey (D. Swanson and W. Hildreth), and work being carried out by Dr. P. Hammond throughout the South Cascades. We expect the graduate student to work closely with these investigators.

Budget and Schedule--It may not be realistic to plan for graduate students to be at work on the above projects before the fall of 1980. If that is the case the planned level of support (\$15,000 per year at each university) will not be required during calendar 1980. Provision will then need to be made to either extend the 1980 contract at no additional cost or write the 1930 contract initially with only 8 total months of graduate student support included, instead of 24 months.

Gravity Measurements--During 1979 Drs. Z. F. Danes and Al Eggers made gravity measurements at 743 stations in the south Cascades (from the Columbia River on the south to the latitude of the Cowlitz valley on the north, and from 121° W. on the east to 122°30' on the west). Except for a few inaccessible areas which will be covered next spring, regional gravity coverage of the south Cascades has been finished. Determination of spot elevations from aerial photographs by the U.S. Geological Survey remains to be done for a number of gravity stations



before the data reduction and construction of a gravity map can be finished. A gravity map to be open-filed is expected by June 1, 1980.

During the 1980 and 1981 field seasons, the central and north Cascades will be covered on the same basis as the south Cascades (at least one gravity station per five square miles). The 1980-1981 study area is much larger than the 1979 study area, but it will be covered as a unit rather than part by part so that the investigators have the freedom to work the area as weather conditions in the high country permit.

We expect field work to begin in the spring and extend through the summer months. Data reduction will extend through the 1980-1981 winter, with a progress report on central and north Cascades gravity to be included in the 1980 year-end report to U.S. Department of Energy. A final map and report on north and central Cascades gravity will be forthcoming by June 1, 1982. The 1980 budget for gravity investigations is the same as for 1979 (\$30,000).

#### Contracted Geophysical Advice

From time to time it has been necessary for members of the Washington State geothermal assessment team to review proposals or oversee projects involving geophysics. We have little or no difficulty in gauging the overall application of geophysical techniques to geothermal exploration, but because we have no geophysicist on our staff, it is difficult for us to judge the detailed merits of geophysical proposals or choose the best approach to be used for a given geophysical method and a given field area. Assistance is currently available from University of Utah Research Institute and local university personnel. However, we would like to have funds identified which could be used to pay, at minimum, the expenses of university personnel or the fee of a consulting firm for short-term assistance on geophysical questions. The \$5,000 identified in the 1980 budget is not currently earmarked for any specific individual group, or project.

Geochemistry—Thermal and mineral springs will continue to be sampled and analyzed during the 1980 field season. The emphasis will be on those springs occurring in the southeast Cascades and along the Columbia and Wind Rivers. The known springs include Klickitat Soda Springs, Klickitat Mineral Springs, Blockhouse Mineral Springs, McCormick Meadow Soda Springs, Soda Springs Creek Soda Springs, Fish Hatchery Warm Springs, Simco Warm and Soda Springs, Ahtanum Warm and Soda Springs in the southeast Cascades, and Rock Creek Hot Springs, St. Martins Hot Springs, Bass Lake Hot Spring, Shiperds Hot Springs, Little Wind River Thermal Seeps, Government Mineral Springs, and Little Soda Springs along the Columbia and Wind Rivers. In addition, a few springs in the central Cascades (including Money Creek Soda Springs, Skykomish Creek Soda Springs, Scenic - Madison Hot Springs, Goldmeyer Hot Springs, Mt. Hyak Warm Springs, Bumping River Soda Springs, Indian Soda Springs, Flaming Geyser Soda Springs and Black Diamond Mineral Springs) and others in the southwest Cascades (including Green River Warm Soda Springs, Vance Mineral Springs, and Packwood Hot Springs) will be examined. The number of water samples these and related springs represent will <sup>m</sup>most likely number in the hundreds.

If the opportunity lends itself, a few warm water wells in eastern Washington will be analyzed. This would be approached as a pilot study designed to identify and characterize anomalies within the Columbia Basin.

In all cases, analyses carried out in the field will include conductivity, pH,  $\text{Cl}^-$ ,  $\text{F}^-$ ,  $\text{SO}_4^{--}$ , Alk, and  $\text{SiO}_2$ . The primary tools for checking waters within areas of thermal and mineral springs will be conductivity, chloride, and fluoride. Those waters which prove to be anomalous will be analyzed in the laboratory for Na, K, Ca, Mg,  $\text{SiO}_2$ , Li, B, Fe, Hg, As,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{F}^-$ , and  $\text{I}^-$ .

With the acquisition of a field-portable mercury spectrophotometer with gold foil collector (included in the 1980 budget request under Capital Equipment), the D division will start the initial phases of a soil mercury survey. The first year will involve the collection of baseline data throughout the Cascades, including samples from around the thermal and mineral springs visited during the field season. This will lead to detailed site-specific studies of geothermal anomalies in the following years.

Soil mercury surveys have proven useful, convenient, and economical as a geothermal exploration tool. The merits are well documented by Matlick and Buseck, 1978 (Geothermal Energy Magazine v. 6, no. 9), Capuano and Bamford 1978 (U.U.R.I., ESL-13), and Klusman and Landress, 1978 (Journal of Geochemistry Exploration v. 9, no. 1).

Geochemical information accumulated during 1980 will be presented in the year-end report to the Department of Energy, published as a Division <sup>of</sup> Geology and Earth Resources Open-File Report, and will be made available to GEOTHERM. The data will be used to update the State Geothermal Resources Map and will lead to a final state-wide report to be completed in 1982 or 1983 and published by the D division as a bulletin.

Fault - Lineament Map--During 1980 we propose to construct a well-documented lineament map of a portion of the south Cascades and southwest Columbia Basin. Study area boundaries have not yet been established. The study will proceed as follows: 1.) compile a fault map using all available geologic maps, 2.) construct a detailed lineament map using ERTS and SLAR imagery, aerial photographs, and published lineament maps, 3.) compare the two maps and identify those lineaments whose existence is confirmed by geologic mapping, 4.) field check as many of the remaining lineaments as possible and identify those lineaments whose existence is confirmed, 5.) identify those lineaments whose

existence is suggested by other means, principally geophysics, 6.) identify those lineaments that are not attributable to the underlying geologic structure (roads, power lines, etc.), and 7.) draw a final lineament map showing the lineaments identified as belonging in one of the above categories plus, of course, those that cannot be documented. The overall objective will be to determine if individual structures or structural patterns can be related to known geothermal manifestations (thermal and mineral springs, volcanoes and young lava fields). We envision that the radon emanometer will be useful in proving the existence of faults that cannot be documented from outcrops or nearby geology.

One additional investigator (Glenda McLucas) has been added to the Washington geothermal resource assessment program team within the last month to assist with data compilation for the Washington public geothermal resources map. We propose that this investigator will be given responsibility for the lineament map project.

#### TRAVEL

The \$8,000 proposed travel budget will be used as follows: \$5,000 for in-state travel, mostly to support the geochemical and fault-lineament mapping projects; \$3,000 for out-of-state travel to resource assessment team meetings, USDOE offices in Idaho Falls, and one major technical meeting, such as the Geothermal Resources Council annual meeting for each of the Washington team members.

#### CAPITAL EQUIPMENT

Downhole temperature measuring equipment	\$4,000
Radon emanometer	4,000
Mercury detector	4,000

Most of the capital equipment needs of the geochemical water analysis lab have been fulfilled by purchases accrued during the first year of the project,

1979. The only additional equipment which would prove useful to the lab is a carbon rod furnace to supplement the atomic absorption spectrophotometer. Because there is no immediate need for this instrument, its purchase has been postponed until 1981.

The work proposed for 1980 will require the purchase of three pieces of field equipment, each costing about \$4,000.

As part of the temperature-gradient and heat-flow project, a set of downhole temperature-measuring gear will be purchased. The equipment will be used for measurement of gradients in heat-flow holes drilled by DGER, as well as measurement of gradients in existing wells. The Gisco-Keck temperature measurement gear purchased during 1979 has been disappointing because 1.) the cable reel has no slip rings (the cable must be unreeled on the ground before lowering it in the drill hole), 2.) the cable is too bulky and heavy and the reel design is not such as to allow the cable to be reeled up out of the hole directly onto the reel (it must be pulled up hand over hand and coiled on the ground), and 3.) the digital display reads only to 0.1° C of F, so we are not able to estimate low gradients with the precision we would like. If we cannot obtain a set of temperature gear that meets our requirements we will not purchase an additional set at all. We will instead rely on Dr. D. D. Blackwell to loan us the required gear.

A Radon emanometer will be purchased for field checking structures defined through the lineament and fault mapping portion of the assessment effort. It will also be used by the geochemist to survey areas around some of the thermal and mineral springs to be investigated.

The mercury detector will be a field portable Hg-spectrophotometer with gold foil collector for the detection of trace amounts of mercury in soils, air, and water. It's primary use will be soil surveying around thermal features by the geochemist.

## OPERATING EXPENSES

To keep the water analysis lab operating, support must continue for goods and services such as replacement of expended equipment, gas cylinder service, and deionized water cylinder exchange. The most significant lab costs will include the purchase of 6 additional single and multi-element hollow cathode tubes for the atomic absorption spectrophotometer, at a cost of \$200 to \$250 <sup>each</sup> ~~each~~. Lab operating expenses are estimated at \$3,000.

As part of the fault and lineament mapping, air photos and satellite imagery (SLAR, ERTS, etc.) will need to be purchased. The exact costs are undeterminable at this time but are estimated at about \$2,000.

## DELIVERABLES

1. Quarterly progress and fiscal reports to DOE.
2. Year end report to DOE.

Report will include a summary of all activities involving geothermal assessment, with individual reports on thermal spring surveys with analytical chemistry, the fault and lineament mapping project, temperature gradient measurements, heat-flow studies (including finalized data from 1979 work), progress report on Columbia Basin geohydrology project from Washington State University and progress report on site specific geological investigations from the University of Washington.

3. The above information will be available to the public through the Division as open-file reports.

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4. New information will be used to update the state geothermal resource maps (as prepared by NOAA).
5. Well and spring information will be passed on to the U. S. Geological Survey's GEOTHERM file.

PROPOSED BUDGET: USDOE WASHINGTON STATE GEOTHERMAL RESOURCE ASSESSMENT PROGRAM

CALENDAR YEAR 1980

Heat Flow Drilling:		
8-500 ft. holes @ \$12,000 each		\$ 96,000
Drilling Supervision:		
52 days @ \$200/day + \$1300 living expense		
+ \$500 mileage		12,200
Temperature Gradient Scrounging:		
130 days @ \$100/day + \$3,250 living expenses		
+ \$2,210 mileage		
Thesis Support:		
a) Mt. Baker or Mt. Adams geology,		
U. of W., under Dr. J. Vance		15,000
b) Columbia Basin geothermal resource		
assessment using water-well gradient		
data, WSU, under Dr. J. Crosby		15,000
Central & North Cascades Regional Gravity:		
Z.F. Danes and Al Eggers, U.P.S.		30,000
Contracted Geophysical Advice <u>Salaries</u>		5,000
Salaries:		
Korosec - 4/1/-6/30/80 @ 1914/mo.		
10/1-12/31/80 @ 2029/mo.		
(1/1-3/31/80 under old contract,		
and 7/1-9/30/80 State supported)		11,829
McLucas - 4/1-9/30/80 @ 1822/mo.		
10/1-12/31/80 @ 1931/mo.		
(1/1-3/31/80 under old contract)		16,725
Benefits:		
19.5% of salaries		
Korosec, 19.5% of \$11,829		2,307
McLucas, 19.5% of \$16,725		3,262
Travel:		8,000
Capital Equipment:		
a) Downhold temperature gear		4,000
b) Radon emanometer		4,000
c) Mercury detector		4,000
Lab Operating Expenses, Lineament Mapping Imagery:		<u>5,000</u>
	SUBTOTAL	\$250,783
	Overhead (17.85% on noncapital items)	<u>42,623</u>
	TOTAL	<u>\$293,406</u>