Carl Ruscetta

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

MEMORANDUM

May 19, 1981

TO: State Coupled Program Core Group

FROM: Duncan Foley D.F./by CR

SUBJECT: Washington Resource Assessment Team program review, 14 May, 1981, Idaho Falls, Idaho

Attendees: J. Eric Schuster, State of Washington Department of Natural Resources (WDNR); M.A. Widmayer, Mike Tucker, DOE/ID; Carl Ruscetta, Duncan Foley, ESLD/UURI

General and Business

1. The Washington team has requested and been granted a no cost time extension until the end of July to finish this year's work.
2. Departure of one employee means that a Geologist II position is open to work on the program.
3. The geochemistry lab is back on line after a move last year. So far, about 15 samples have been processed under the current contract.
4. Washington has supplied ESLD with required write-up and bibliography after the Glenwood Springs meeting.
5. Copies of the first year's final report are being made up now.
6. WDNR apparently will get a $140,000 appropriation to continue geothermal resource assessment activities beyond federal funding.

Technical

Two main discussions took place: the first on progress under the present contract, and the second on plans for next year.

On present tasks:

1. Drilling - Eight sites have been selected for thermal gradient holes, and bids have been received from drillers. Two holes will be at the Wind River area (including one near the USFS Nursery), three holes will continue the White Pass traverse of the Cascades, one will be located North of Mt. Rainier (in conjunction with Denison Mines), and one each on the Snoqualamie and Stevens Pass roads. Washington has requested bids for the services of a drilling consultant. The Environmental Assessment has been delivered to DOE, and processing for drilling permits is well along.

2. Thermal Gradients - Thermal gradients for 800-900 wells in the Yakima Valley, Columbia Basing and Southern Cascades areas have been investigated. The highest temperatures generally found in the Yakima-Columbia area are 40°C, typically from depths less than 2000 feet. The Washington team doesn't feel that there are any local sources of heat, but rather that regional phenomena are responsible for the heat concentrations. Dave Blackwell has not yet finished his analysis of the data from the last year.

3. Geologic mapping - Two projects from U. Washington and Portland State are moving along. K-Ar dating by U of Utah for this program has been only partially successful, due to young age and contamination of some samples. These two mapping projects will be integrated by WDNR staff, and the results included in this year's final report.

4. Gravity - The program is continuing, with about 2600 stations collected so far, and reduction by the USGS is well along. An open-file progress report will be available by the end of the month.

5. Geochemistry - This program was strongly impacted by Mount St. Helens' work, which took an estimated 40% of Mike Korosec's time (see the attached newspaper article). Only 15 samples have been run so far, but more will be finished before the end of the contract. The lab analyses check well with the USGS lab, but the cross analyses have not been re-run since the lab was moved. Mercury surveys are presently being designed; none have been run.

6. Lineaments - The map of the southern Cascades should be available soon.

7. User map (with NOAA) - WDNR is in the process of reviewing comments made by ESL, DOE, and Dave Blackwell, and will communicate with NOAA soon. They will be adding squibs to further explain the outlines of the gray areas. It may be appropriate to develop a new color for the unique data set of mineral springs.

On the proposal:

Overall, DOE requested a more specific set of deliverables with each task. Integration of all data collected so far, and interpretation of all the results of the program through the upcoming year should be provided in a comprehensive final report. It was felt by DOE and ESLD personnel that completion of packages in present areas of study should be emphasized, rather than starting new areas. This conforms with final year approaches in other states.

1. Geochemistry - The proposed mercury work needs to be clarified, so no confusion remains over which surveys are being done by which year's funding. The geochemistry of springs studies will continue, hopefully at a much accelerated pace.

2. Gravity - The program will be finished this year. It was originally proposed as a three year program, and this will be the third year.

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4. Wind River - The area proposed for mapping includes only one of the four known thermal springs in the area, and does not include the areas with highest user interest. If the mapping can not be redirected to include the thermally favorable areas, these monies will be directed toward some other task.

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Action Items

1. WDNR will have a revised proposal to DOE by the end of the month. They would like comments from DOE on possible directions for using the monies originally slated for tasks 4 and 5 above.

2. ESL will get from WDNR all the publications they have done so far, and will receive new materials as they are prepared.

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5. DOE will send WDNR a copy of Dave Blackwell's proposal.

Reality's Relative When Atop Dome of Lava

By Kathy McCarthy
Associated Press Writer

MOUNT ST. HELENS' CRATER RAMP, Wash. — Guided by a random wind gust, warm white breath from fumeroles on Mount St. Helens' north ramp suddenly shifts direction, hiding a nearby geologist in an outdoor steam bath.

Reality is relative here on the threshold of the giant amphitheater blown out of the volcano's summit on May 18, 1980.

Warm May Sun

High in a piercing blue sky, a warm May sun shines on the mountain's snow-covered slopes as it did the day almost 1,300 feet of the mountain exploded.

But when steam from the giant lava dome on the crater floor rises above the 8,400-foot crater rim, fashioning itself into thunderhead shapes, the cloud can block the sun in an instant, leaving the northern slope of the mountain in chill high Cascades shadow.

The ragtag bands of fumeroles, or steam vents, scattered on the ramp floor grumble constantly with a sound like river rapids, their steam occasionally obscuring the whole crater like a fog machine on a 1930s Hollywood set.

More ominous than the shifting steam is the intermittent, artillery-like crack-crack-crack of rockfalls avalanching down the crater's 2,000-foot western wall.

Respect for Volcano

The mile-and-a-quarter by two-and-a-quarter-mile amphitheater, and neighboring acreage offer a wealth of scientific riches, which scientists greet with enthusiasm tempered with respect for the volcano's power.

The lava dome, formed from successive "dome-building eruptions" which squeezed fresh lava up through the crater floor, now stands 375 feet high, ranges 1,200 feet east to west, and extends almost a half-mile north to south, the U.S. Geological Survey says.

Helicopters flying past the dome to pick up USGS scientists on the crater floor look like toys.

The dome's eastern flank steams innocuously on this day, but a cottage-sized chunk that has dropped off the dome to nestle at its base gives an idea of its power.

"A pocket eruption from the dome is truly the major danger in the crater now," says Mike Korosec, a state Department of Natural Resources geologist gathering mineral samples from the relative safety of the ramp.

Admit Only Scientists

The Forest Service has said only USGS scientists will be permitted to land in the crater itself.

"In a pocket eruption, rocks would fly out of the dome — rocks of all sizes — and a great ball of steam and ash would rise from the pocket," he said.

Rockfalls can be avoided and seismic warning signals are giving scientists better clues to both explosive and non-explosive eruptions, he says, but a pocket eruption can come without warning.

Josh Logan knows. Another state geologist studying pyroclastic flows — superheated gases and debris — in the upper reaches of the North Toutle River valley, Logan was in the crater during one recent pocket eruption.

"The dome just sort of lobbed out several large

See Page A-7, Column 1

Reality's Relative When Atop Dome of Lava

Continued From Page A-5

chunks of rock," he says. "There was a popping sound and a lot of dust."

Logan, 100 yards from the dome then, says he's hazy on other details. "I was running in the opposite direction."

Gathers Data

Armed with a temperature probe and plastic specimen tubes, Korosec busily chops, scoops and measures as he gathers data for his history of sublimates — mineral deposits — occurring around fumerole vents.

He thinks the steam of "rootless" fumeroles on the north ramp is caused by groundwater contacting hot material — such as hot deposits created by earlier eruptions — and flashing to steam, sometimes cracking rocks in its haste to escape.

As Korosec widens the throat of one fumerole with his pick, the little vent spits back loose volcanic ash like a disturbed ocean clam.

Temperatures of these ramp field fumeroles range from 86 to 94.7 degrees Celsius — near boiling at this 6,000-foot elevation, Korosec says. But that's nothing.

The USGS has recorded temperatures as high as 890 degrees Celsius — more than 1,600 degrees Fahrenheit — three feet beneath the ground near the dome.

Cracks Clearly Visible

Extremely hot steam vents from the dome and from radial cracks in the crater floor — cracks clearly visible from a helicopter as spidery lines extending from the dome to the back crater wall.

The temperatures and gas analyses seem to indicate those fumeroles are fueled by the direct degassing of magma, or the molten material within the volcano, Korosec says.

If he finds that mineral and element deposits differ from the high-temperature to the low-temperature fumeroles, the knowledge could provide a tool for studying ancient fumeroles and a key for geothermal exploration, Korosec says.

"Most Cascade volcanos have fumeroles, and it's likely they change prior to eruptions, so differences here also could help predict future eruptions," he said.

Salt Lake Tribune
17 May '81

CAR 67997

1. Please Review
2. Should be typed
3. Prior to mailing, add xerox of newspaper article
4. To core group (including Tucker!)

Tnx

DF

Pls type and return to Carl for review. CR

MEMORANDUM

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RE: Washington Resource Assessment Team program review, [illegible]

Idaho Falls, ID

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Duncan Foley
UURI

Proposed Washington State
Geothermal Resource Assessment Program
for
August 1, 1981, to July 31, 1982

by
Washington State Department of
Natural Resources,
Division of Geology and Earth Resources,
Olympia, WA 98504

April 24, 1981
Revised June 20, 1981

A proposed modification of U.S. Department
of Energy Contract No. DE-AC07-79ET27014

to

U.S. Department of Energy
Division of Geothermal Energy
Idaho Falls, Idaho

More on deliverables - esp Task 1 (Mike)
not just - as appropriate

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SUMMARY

Work proposed herein runs from August 1, 1981 to July 31, 1982, with a total U.S. Department of Energy cost of $203,636 and a State of Washington contribution of $13,000.

Management of this work will be carried out by Washington Division of Geology and Earth Resources personnel including one assistant state geologist, two geologists, and one secretary. The geologists will also pursue technical objectives. Several subcontracts are proposed as follows:

1. Southern Methodist University; Dr. David D. Blackwell, principal investigator; temperature gradient - heat flow subcontract; $93,746. This subcontract will allow for collection of new subsurface temperature data in the Columbia Basin of southeastern Washington, processing of these data and existing data, and presentation of the results in a series of maps and tables with explanatory text. This work will be funded directly by USDOE, Idaho Falls, under a separate proposal, so further detail and budget are omitted from this proposal.

2. Danes Research Associates; Dr. Z. F. Danes, principal investigator; Cascade Range-regional gravity subcontract; $25,700. The objective is to complete the Cascade Range regional gravity map with an average gravity station density of one station per five square miles. This is the third year of a three year program.

3. Washington State University; Professor James Crosby, principal investigator; John Biggane, investigator; Yakima Area Geothermal Investigations; $11,481. The objective is to collect both new and existing data on subsurface temperatures, hydrology, and geology of the Yakima area, and interpret these data sets to form a practical and technical guide to geothermal exploration and development. This is the second year of a two year program.

4. Portland State University; Dulcy A. Berri, principal investigator; Wind River Geology; ca. $20,000. The objective is to map the geology of the middle and lower portions of the Wind River Valley, a tributary of the Columbia River in southern Washington, and interpret the geologic environment responsible for the occurrence of several hot springs in the area. Resulting maps and report are to directly benefit potential geothermal energy users in the area. This project will require about 11 months.

5. Geohydrologist; investigator(s) to be selected; Low Temperature Geothermal Resources of the Moses Lake-Ritzville-Connell Area, Columbia Basin, Washington; ca. $30,000. The objective is to interpret approximately 150 suites of well logs to obtain information on the temperature, depth, size, quality, and production potential of low temperature geothermal aquifers. Duration of about one year.

In addition, the geothermal staff of the Division of Geology and Earth Resources proposes to pursue sampling and analysis of thermal springs, "closeout" collection, organization, and dissemination of several statewide geothermal-related geologic, geochemical, and geophysical data sets. Costs are as follows: Division of Geology and Earth Resources, $88,884; administrative overhead, $27,571 (charged at the rate of 15.66 percent of total costs).

Justification

During the past year and one-half a considerable amount of data has been accumulated regarding the occurrence of geothermal energy in the State of Washington. These data have been gathered from many sources, including our own in-house investigations, and they were compiled, in part, for the purpose of generating a "public" geothermal resources map for publication by the National Oceanic and Atmospheric Administration (NOAA). Types of data gathered include down-hole temperature data, geothermal lease applications in the Cascade Range (gathered by Washington State Energy Office), thermal and mineral spring data, gravity data, geologic data, distribution of young volcanic rocks, heat-flow data, faults and lineaments, seismic data, and aeromagnetic data. Although most of these data sets are still preliminary and incomplete, we have found that they, taken together, greatly expand our understanding of geothermal energy in this state.

Because the USDOE - sponsored resource assessment program is apparently in its final year, we propose to spend as much time as possible assembling, augmenting, and interpreting the above data sets and preparing them for rapid and convenient use by public and private geothermal investigators, explorationists, and developers.

Plan and Schedule

Work toward the objectives listed below will continue throughout the contract period, with preparation of data for distribution and/or open filing at intervals.

The objectives for the three geothermal employees of the Division of Geology and Earth Resources are as follows:

Geologist III:

A. Spring sampling

1. Sample and analyze additional known thermal springs.
2. Search for rumored thermal springs.
3. Monitor springs in the Mount St. Helens area.
4. Interpret and report on geology, geochemistry, and recommendations for further work and/or development of the springs.

B. Obtain and report on soil mercury determinations near selected thermal springs and near Mount St. Helens.

C. Assist with subcontract administration and directing the activities of the geothermal staff.

Geologist II:

A. Augment, interpret, and prepare for distribution data sets pertinent to assessment and exploration for geothermal energy in Washington. These data sets may include some or all of the following: geology, gravity, faults and lineaments, rock and water geochemistry, temperature gradients and heat flow, geothermal leasing, seismicity, and aeromagnetics. Assist in preparation of a state "scientific" geothermal map(s) if one is to be published by NOAA, transmit appropriate data to GEOTHERM, and prepare material for public dissemination.

B. Assist with field monitoring of subcontracts.

C. Temperature-gradient logging, mercury field measurements, assisting Geologist III in field, and other duties as required.

Clerk Typist II:

A. Assist geologists with the assembly, cataloging, and preparation for publication or other dissemination of geothermal data and reports.

B. Assist with correspondence and contract-related accounting and reporting.

Products

Year end report detailing all findings during the contract period; open-file and/or published reports as appropriate; and material for a state "scientific" geothermal resource map if one is to be published by NOAA.

Budget

Salaries: 8/1/81 to 7/31/82

Geologist III; @ $2029/mo.	$24,348	
Geologist II; @ $1839/mo.	$22,068	
Clerk-Typist II; @ $834/mo.	$10,008	
		$56,424
Benefits: 20 percent of salaries		$11,285

Travel:			
Per Diem: 125 days @ $35/day	$ 4,375		
Mileage: 8,000 mi. @ .20/mi.	$ 1,600		
Air Travel: to USDOE project mtgs.	$ 1,200		
		$ 7,175	
Equipment, Supplies, and Services:			
Laboratory supplies	$ 4,000		
Reproduction and publication	$10,000		
		$14,000	
Overhead:			
15.66 percent on Division of Geology and Earth Resources activities and subcontracts administered by DGER		$27,920	
		TOTAL	$116,804.00

TEMPERATURE GRADIENT - HEAT FLOW SUBCONTRACT

Temperature gradient and heat flow work, largely in the Columbia Basin, will be undertaken by Dr. D.D. Blackwell and his students and employees. Although this work is an indispensable part of the Washington State geothermal assessment program for 1981-82, it is being funded directly by the U.S. Department of Energy, Division of Geothermal Energy, and it will not be discussed further in this proposal.

Justification

Regional gravity surveying under subcontract has been underway in the Cascade Range since 1979. The project has been headed by Dr. Z.F. Danes, University of Puget Sound, Tacoma, Washington. The study area is shown on Figure 1. Work to date has been concentrated in the southern and central Cascades and in the area around Mount Baker in the northern Cascades.

Status of gravity mapping is shown on Figure 1. Previous data and newly measured stations bring the total for the study area (about 14,070 square miles) to some 2620 gravity stations, or an average distribution of one station per 5.4 square miles. The distribution is not even throughout the Cascade Range, however; in the part of the study area south of $47^{0}30'$ the station density is one per 3.8 square miles, with much heavier concentrations at Camas, North Bonneville, and Mount St. Helens. North of $47^{0}30'$ the station density is only one per 15.1 square miles.

Almost all of the gravity data gathered so far, including pre-existing data, has been reduced by the U.S. Geological Survey in Denver, through the use of their computer facilities. It is expected that preliminary gravity maps at a scale of 1:250,000 will be placed on open file by the Division of Geology and Earth Resources by May 31, 1981. These maps will be improved and updated, especially in the northern Cascades, following the 1981 field season. At the conclusion of the three-year gravity program we expect to publish a 1:250,000 scale gravity map of the bulk of the study area.

The UPS gravity work has already greatly expanded available coverage for the central and southern Cascades. By the end of the third year regional coverage will be available for most of the study area in sufficient detail to allow geothermal explorationists to integrate the gravity data into the evaluation of Cascade Range geothermal target areas, thus allowing for structural interpretations and tests of geothermal hypotheses not possible previously.

Figure 1. — Washington Cascades Gravity Survey as of March 1981

123° 122° 121°

Plan and Schedule

Sufficient funds are available from the existing USDOE - State of Washington contract to support the gravity subcontract until July 31, 1981. Work under the subcontract resulting from this proposal will begin on August 1, 1981, and continue to May 31, 1982.

The objectives are as follows:

1. Obtain regional gravity coverage (one station per five square miles) in the area west of Glacier Peak in the White Chuck Mtn., Pugh Mtn., Bedal, Sloan Peak, Prairie Mtn., and Huckleberry Mtn. 7½' quadrangles where known elevations and road access permit. Gravity in this area will help to provide a "tie" between Mount Baker and Glacier Peak and provide the first significant data in an area where geothermal lease applications have been made by private industry.
2. Obtain regional gravity coverage for the approximately 10 by 8 mile area centered on Mount Baker, to the extent that access, known elevations, and ordinary prudence will allow.
3. Collect and incorporate all pre-existing gravity data available for the part of the study area north of $47^{\circ}30'$.
4. Obtain regional gravity coverage for the area southeast of Mount Rainier in the northern part of the Hamilton Buttes 7½' quadrangle, southeastern part of the Packwood 15' quadrangle, White Pass 15' quadrangle, Rimrock Lake 7½' quadrangle, and Tieton Basin 7½' quadrangle to the extent that known elevations and road access will allow. This work will provide better gravity data for an area of considerable Quaternary volcanic activity.
5. Obtain regional gravity coverage for the western ½ of the Golden Lakes 7½' quadrangle, western ½ of the Mount Wow 7½' quadrangle, and eastern ½ of the Kapowsin 15' quadrangle, all located to the west of Mount Rainier. Coverage here should be to the extent practical with regard to road access, known

elevations, and landowner's permission. The transition between Puget Lowland type temperature gradients and Cascade type gradients is suspected to pass through this area, and gravity data may help to determine whether or not the transition in gradients is accompanied or caused by a transition in subsurface lithology and/or structure.

6. Obtain regional gravity coverage for the southeastern portion of the Wind River 15' quadrangle. Work here should largely complete regional coverage for two adjacent areas of potential geothermal significance, Wind River and Indian Heaven.

7. Remeasure gravity at a sufficient number of stations in the Mount St. Helens area to determine whether the 1980-81 eruptions and/or resulting geographic changes have caused significant changes in gravity. If so produce a map at 1:62,500 scale which details the changes. New stations should be established to add detail to gravity anomalies which were previously defined by only one or two stations.

   This objective must be considered tentative. Several factors must be favorable in order to carry out the work including:

   A) Mount St. Helens must be in a "quiet" state,
   B) Permits to work in the area must be obtainable,
   C) Access to previously occupied gravity stations must be possible, and
   D) The stations to be re-occupied must be recoverable with a reasonable assurance that their elevations have not changed significantly.

8. Obtain better-than-regional gravity coverage in the area of objective number 3 (Mount Baker). This objective is also tentative because of access problems and lack of known elevations.

Every effort should be made during the course of gravity surveying to insure that elevation errors are held to less than $\pm$ 10 feet (that reported gravity values are accurate to within about $\pm$ 0.6 milligals).

Objectives 1-6 should be completed in the order listed. The contractor is expected, within limitations imposed by lack of known elevations, road access, or landowner's permission, to allocate the time and finances available under this subcontract in such a way that good progress can be made toward completing each of objectives 1-6.

Objectives 7 and 8 are to be started only after objectives 1-6 have been completed to the extent that they can be completed without resorting to extensive backpacking or use of trail bikes for access to unroaded areas.

Note that these objectives specifically exclude gathering new gravity data in the northeastern part of the study area (in the area north of $47^{\circ}30'$ and east of $121^{\circ}15'$ as well as north of $48^{\circ}22.5'$ and east of $121^{\circ}37.5'$) because access to these areas is very difficult, the areas are of less geothermal importance (Glacier Peak is part of the excluded area, but it is a wilderness area and cannot be developed), and gravity data simply cannot be gathered there in an effective manner in the time and with the resources remaining. However, if all eight of the objectives listed above can be completed, any excess time and funds may be used by the contractor for gathering additional gravity data in these areas.

Products

Products to be delivered by May 31, 1982, are:

1) A complete Bouguer gravity anomaly map for the study area at a scale of 1:250,000. This map shall show locations of gravity stations and the contoured gravity values. It will include complete legend and explanation.

2) A text which describes the methods used to carry out the gravity survey, methods by which existing data have been incorporated, and major conclusions regarding geologic structure and geothermal resource potential in the study area.

3) A tabular listing of gravity stations showing station number, location, "raw" and reduced gravity values.

Budget

Salaries			
Principal Investigator:			
1.75 mo. @ $2000/mo.		$ 3,500	
Field Assistants:			
2 @ 7 mo. each, $5/hr., 170 hr./mo.		$11,900	
Key Punch Operator:			
2 wk. at 40 hr./week and $5/hr.		$ 400	
			$15,800
Travel			
Vehicle mileage and maintenance		$ 4,300	
Per Diem: 200 days @ $20/day		$ 4,000	
			$ 8,300
Other			
Office and Lab. supplies		$ 500	
Reproduction		$ 500	
Gravity meter calibration and repair		$ 600	
			$ 1,600
	TOTAL		$25,700

SUBCONTRACT FOR GEOTHERMAL INVESTIGATIONS IN THE YAKIMA AREA

Justification

This work has been underway since August 1, 1980. The investigation is being carried out by John Biggane of the Washington State University Department of Civil and Environmental Engineering, Geological Engineering Section, under the direction of Professor James W. Crosby. The initial subcontract (under USDOE contract DE-AC07-79ET27014, Modification No. A003) runs until May 31, 1981.

The objectives of the current subcontract are:

1. To measure temperature gradients in existing wells in the Yakima County region, and in cooperation with Dr. D.D. Blackwell, determine heat flow in as many wells as possible.
2. To delineate areas that possess a potential for geothermal development (define areas where warm and/or hot water and/or sources of heat exist in the subsurface).
3. To relate occurrences or potential occurrences of geothermal energy to the geology and hydrology of the study area.
5. To submit a report detailing work activities, pertinent data, and information relevant to the above objectives. This report shall contain appropriate geologic, temperature-gradient, heat-flow, and hydrologic maps and/or cross sections.

The initial study area was all of Yakima County — an area of 5,059 square miles. As the work progressed, the study area was to be reduced to the areas with the greatest potential for the occurrence of geothermal resources. The initial budget totalled $15,000.

The report from the initial subcontract will include the following:

I. Geologic Data and Stratigraphic Interpretations

   A. A review of the pertinent geological literature

      1. the occurrence and description of the geologic units.

      2. the previous geophysical surveys and their interpretations.

   B. Stratigraphic interpretations obtained from the WSU geophysical well logs.

      1. the correlation of geologic units, primarily along the trends of the irrigated valleys.

      2. the relationships that exist between the stratigraphy and ground water hydrology and temperature.

II. Geothermal Information

   A. Compilation of the available temperature-depth data.

      1. well locations, gradients, chemical data, pumping test temperatures, aquifer transmissivity and storage coefficient.

      2. a review of the previous geothermal research for Yakima County and the Columbia Plateau.

   B. Spatial distribution of the geothermal gradients

      1. the variation in the gradients as predicted by the bottom hole temperature regression analysis.

      2. a comparison of the methods available for the interpretation of water well geothermal gradients.

III. Assessment of the Geothermal Resources of the Yakima Area

   A. The areal relationship between aquifer temperatures and aquifer depths.

This report will go a long way toward integrating many sources of data that bear on the development and use of low temperature geothermal resources in the Yakima County area. Continuation of this subcontract from June 1, 1981 through January 31, 1982 will allow for the development of firmer and more detailed interpretations regarding the resources and their potential uses, and it will allow the time necessary to produce a final report suitable for journal publication.

Objectives

June 1, 1981 - January 31, 1982 — This subcontracted task will conclude on January 31, 1982 and will complete the following objectives:

I. To refine the preliminary conclusions of the study by:

   A. Additional stratigraphic correlation through the use of geophysical and driller's logs.

   B. Additional stratigraphic interpretation by means of structural contour maps and fence diagrams.

   C. The investigation in greater detail of the spatial relationship that exists between the aquifer depth and its temperature and stratigraphy.

II. Delineating regions according to their geothermal potential.

Schedule

Investigations will be continued between June 1, 1981 and January 31, 1982.

Products

A report detailing work activities, including all pertinent data and information relevant to the above objectives, shall be due on January 31, 1982. This report shall also incorporate the findings from the August 1, 1980 to May 31, 1981 contract period. The report shall contain appropriate geologic, temperature-gradient, heat-flow, and hydrologic maps and/or cross-sections. The report shall be delivered in a format suitable for publication, and it shall be subject to review by the Division of Geology and Earth Resources prior to final acceptance.

Budget

Salaries:			
Research Assistant (8/1/81-1/31/81)			
0.5 FTE	$ 3,890		
Secretarial	583		
		$ 4,473	
Benefits:			
8 percent of Research Asst. salary	$ 311		
23 percent of secretarial salary	134		
		$ 445	
Goods and Services		$ 1,875	
Travel		$ 1,125	
Overhead: 45% of total modified direct costs		$ 3,563	
		TOTAL	$11,481

Justification

The middle to lower reaches of the Wind River, a tributary of the Columbia River located in the southern Cascades of Washington, constitute one of the most promising areas in the state for development of low temperature geothermal resources. The area is overlain by young volcanic rocks; major thermal and mineral springs occur within and near the area; the course of the Wind River is apparently controlled by a fault which is on strike with a recently recognized seismic zone that passes through Mount St. Helens; and there are at least two potential users of low temperature geothermal resources in the Valley, a large U.S. Forest Service nursery and the schools of the town of Carson. These potential users have expressed interest in developing geothermal resources, and they are being assisted by the Division of Geology and Earth Resources, the Washington State Energy Office, and the Oregon Institute of Technology.

The area proposed for study extends through an approximately three by ten mile area along the middle and lower parts of the Wind River. It includes St. Martins (Carson) Hot Springs and Shiperd's Hot Springs in the lower part of the valley, near the Columbia River. The Wind River Valley is filled with Quaternary lava flows which originated just north of the study area (Trout Creek Hill and other volcanoes), and the river waters have constructed a steep-walled gorge which cuts through the valley-filling flows and into underlying Tertiary intrusive, volcanic, and volcaniclastic rocks. The hot springs occur within this incised gorge. There are no identified aquifers in the Tertiary rocks. The hot springs are believed to be controlled by fracture- and fault-related permeability.

The geology of the area has been mapped on a regional reconnaissance by several geologists, but no significant mapping at a scale of 1:24,000 has been done. No geologic mapping at any scale has been done with the objectives of structural interpretation and explanation of the existence of the hot springs and assessment of the geothermal development potential in the valley.

Objectives

1. Map the incised valley of the Wind River from its mouth to the vicinity of Bunker Hill - Warren Gap at a scale of 1:24,000. The Tertiary rocks cropping out in the bottom of the gorge are to be characterized lithologically (mapped as lithologic units). Particular attention is to be given to the mapping of fault and fracture systems and alteration zones. A careful search will be made for new (undiscovered) thermal or mineral springs.

   The upper walls of the gorge consist of Quaternary valley-filling lava flows and associated sediments (?). These units are to be examined for possible thermal aquifers, for any structures that may cut or deform them, and for their influence on the hydrologic pattern of the area.

2. Map the valley sides above the level of the valley-filling flows. Here outcrops are expected to be less numerous than within the gorge, and mapping will necessarily be less detailed. This portion of the mapping will still emphasize collection of structural data as well as lithologic characterization of geologic units.

Shouldn't dominate only in Wind R. area (Carson St. Martins)

3. Assist Division of Geology and Earth Resources staff in the collection of soil samples for mercury analysis as needed, and assist with the interpretation of these data.

4. Perform reconnaissance geologic mapping in the lower Little Wind River area and at any other location in the study area where cross faults or fractures might occur that would be expected to influence the hydrology of the area and, in turn, the existence and nature of thermal waters.

UURI (?)

5. The geologic mapping may be supported by commercially available geochemical analyses of rocks, as appropriate, and by water analyses through the facilities of the Division of Geology and Earth Resources. Two temperature gradient-heat flow holes will be drilled in the Wind River Valley this summer. Results will be available to aid in the geologic interpretation.

The overall objective of these studies will be to identify the geologic environment responsible for the existence of hot springs in the Wind River Valley, to determine if that environment exists anywhere else in the area (find geothermal targets), and to report these findings in a manner that will constructively influence the exploration and development of low temperature geothermal resources in the Wind River Valley.

Personnel and Schedule

Current plans call for the geologic work to be executed by a well-qualified graduate student under the guidance of Dr. Paul Hammond, Portland State University, and the geothermal staff of the Division of Geology and Earth Resources. The graduate student may be assisted by other graduate- or undergraduate-level personnel as appropriate. We have discussed this project with seven students from Portland State University and Oregon State University, and in our opinion Ms. Dulcy A. Berri (resume and other information attached) is the best qualified candidate to perform this work.

Field work will probably require about three person-months beginning in August, 1981. Data reduction, analytical work, and report writing will be done in the fall and winter, with geologic maps, cross sections, and interpretive text prepared for delivery by sometime in the spring of 1982.

Budget

Since the details of this subcontract are still being developed, no budget can be presented at this time. A budget will be prepared for USDOE consideration as soon as possible. We anticipate a total subcontract cost of approximately $20,000.

Dulcy A. Berri
5180 NW Neakahnie, No. 28
Portland, Oregon 97229
Phone: Home (503) 645-0543
Message (503) 229-3022

Date of birth: September 14, 1955

Education:

1973-74	Iowa State University Ames, Iowa Botany
1976-79	University of Oregon Eugene, Oregon B.S. in geology, June, 1979
1978	Miami University Oxford, Ohio Summer field methods course in vicinity of the Wind River Range, Wyoming
1979-present	Portland State University Portland, Oregon M.S. in geology, June, 1981

Master's Thesis: involving Glass Buttes, a silicic dome and vent complex in central Oregon composed of layered rhyolite, andesite and basalt flows, ash-flow tuffs, vitrophyre and obsidian flows. Hydrothermally altered zones show extensive silicification of ash-flow tuffs, resulting in masses of cinnabar-bearing opalite; other mineralization includes finely disseminated pyrite with minor pyrrhotite. Broad zones of possible argillic alteration extend frommineralized veins into country rock. Alteration control is structural; cinnabar-rich fluids may have circulated through primarily north-south and east-west trending fractures associated with the regional fault system. A blanketing opalite mass may have further restricted fluids. Research included field mapping, petrography, atomic absorption and neutron activation analyses and X-ray diffraction studies.

Coursework in geology:

Field Geophysics: field use of gravimeter, magnetometer, seismic refraction and resistivity instruments to determine subsurface geology in Coast Range basalts of Oregon.

Exploration Geochemistry: designed geochemical survey of a possible porphyry copper deposit in SW Washington; conducted soil survey, reconnaissance geologic mapping, atomic absorption analyses and interpretation in final report.

Volcanic Stratigraphy: classified stratigraphic units, eruptive mechanisms, deposition; field study of volcanic sediments in central Oregon.

Advanced Metamorphic Petrology: study of thermodynamics of metamorphic reactions, constructing petrogenetic grids, mineral parageneses, metamorphosed siliceous limestones, pelites, iron formations and exhalites.

Advanced Igneous Petrology: comprehensive study of the genesis of ophiolite, basalt, andesite and silicic plutonism in different tectonic settings; geochemical interpretation.

Geologic Interpretation: topographic map and air photo analysis, construction of planimetric map from air photos.

Also: Economic Geology, Structural Geology, Geophysics, Geochemistry, Igneous, Metamorphic and Sedimentary Petrography and Petrology (3 terms), Paleontology, Tectonics and Sedimentation, Geomorphology, Introductory Computer Programming.

<u>Organizations:</u> Northwest Mining Association
Geothermal Resources Council
Geological Society of America, Cordilleran Section

<u>Work Experience:</u> Retail and office work, details provided upon request.

<u>References:</u>

Dr. Michael L. Cummings
Department of Earth Sciences
Portland State University
P.O. Box 751
Portland, Oregon 97207
(503) 229-3022

Dr. Robert O. Van Atta
Department of Earth Sciences
Portland State University
P.O. Box 751
Portland, Oregon 97207
(503) 229-3022

Mr. Larry Wilkinson
Foundation Sciences, Inc.
1630 SW Morrison Street
Portland, Oregon 97205
(503) 224-4435

Mr. Eric Schuster, Assistant Manager
Division of Geology and Earth Resources
Department of Natural Resources
Olympia, Washington 98504

June 16, 1981

Dear Mr. Schuster:

It was a pleasure meeting you and Mike Korosec in Portland last Friday. Thank you again for your time spent discussing the Wind River project.

As I expressed to you at the time, I'm very excited about becoming involved in the Wind River study. I see it as a very challenging and rewarding opportunity, as well as a chance to further geothermal exploration in the Northwest. By August I will have completed my thesis work, which involved a structural study similar to that required at Wind River, and so I'll have a good idea of necessary field and office time, techniques, and materials, as well as have developed interpretive ability.

I'm interested in the position of Principal Investigator. I feel I could organize the work required within available time and funds, and also coordinate the work of assistants. Due to the many qualified persons interested in this project, I can understand your needing time to select personnel. I am, however, holding off a less rewarding offer in light of possibly becoming involved in the Wind River study, so I would very much appreciate notice of your decision when it is made.

Sincerely,

Dulcy Berri

Dulcy Berri

Earth Sciences Department
Portland State University
P. O. Box 751
Portland, Oregon 97207

LOW TEMPERATURE GEOTHERMAL RESOURCES
OF THE MOSES LAKE-RITZVILLE-CONNELL AREA

Justification

The Moses Lake-Ritzville-Connell area is a triangular area located near the center of the Columbia Basin in southeastern Washington. It is one of several areas in southeastern Washington where many temperature records from water wells show that low temperature geothermal resource potential exists within 2,000-3,000 feet of the surface or less.

The Moses Lake-Ritzville-Connell area is intensively cultivated and presents considerable opportunity for the rise of geothermal energy as a source of space heat as well as process heat for agriculture-related industries. Although other areas in or near the Columbia Basin, such as the Walla Walla and Ellensburg areas, may present opportunities for the rise of low temperature geothermal resources which are as good or nearly as good as the Moses Lake-Ritzville-Connell area, the latter area is the one for which the best subsurface data exist. These data consist of suites of continuous geophysical logs, including temperature logs, for about 150 wells. The logs have been obtained by personnel of the Washington State University Geological Engineering Section over the past several years.

Objectives

We propose to employ the services of a geohydrological consultant, or a graduate student and/or staff hydrologist of the Washington State University Geological Engineering Section to study, interpret, and report findings regarding the occurrence of low temperature geothermal energy in the Moses Lake-Ritzville-Connell area. The proposed study would be very similar to the one presently being done in the Yakima Valley area by John Biggane (see earlier section of this proposal).

The objective will be to interpret the geologic and hydrologic literature and the suites of well logs for the following:

1. Stratigraphic correlation
2. Structural interpretation
3. Identification of thermal aquifers and their characteristics, such as
   a. transmissivity
   b. storage coefficient
   c. temperature
   d. depth
   e. water quality
   f. source of heat
4. Temperature gradients and heat flow (if practical)
5. Identification and characterization of the geographic areas with the best potential for low temperature geothermal resource development.

The resulting report will be designed to be of direct use to potential geothermal developers and users, while at the same time incorporating all of the scientific data and interpretations that would be of use to other highly trained investigators.

Because this study will have to be completed in slightly less than one year, it will not be possible to incorporate much, if any, field investigation. The personnel who will perform the work have yet to be identified. This matter and the details of the investigation will be under discussion with Professor James Crosby, and other possible subcontractors, with the aim of drafting a more detailed joint proposal for USDOE consideration as soon as possible.

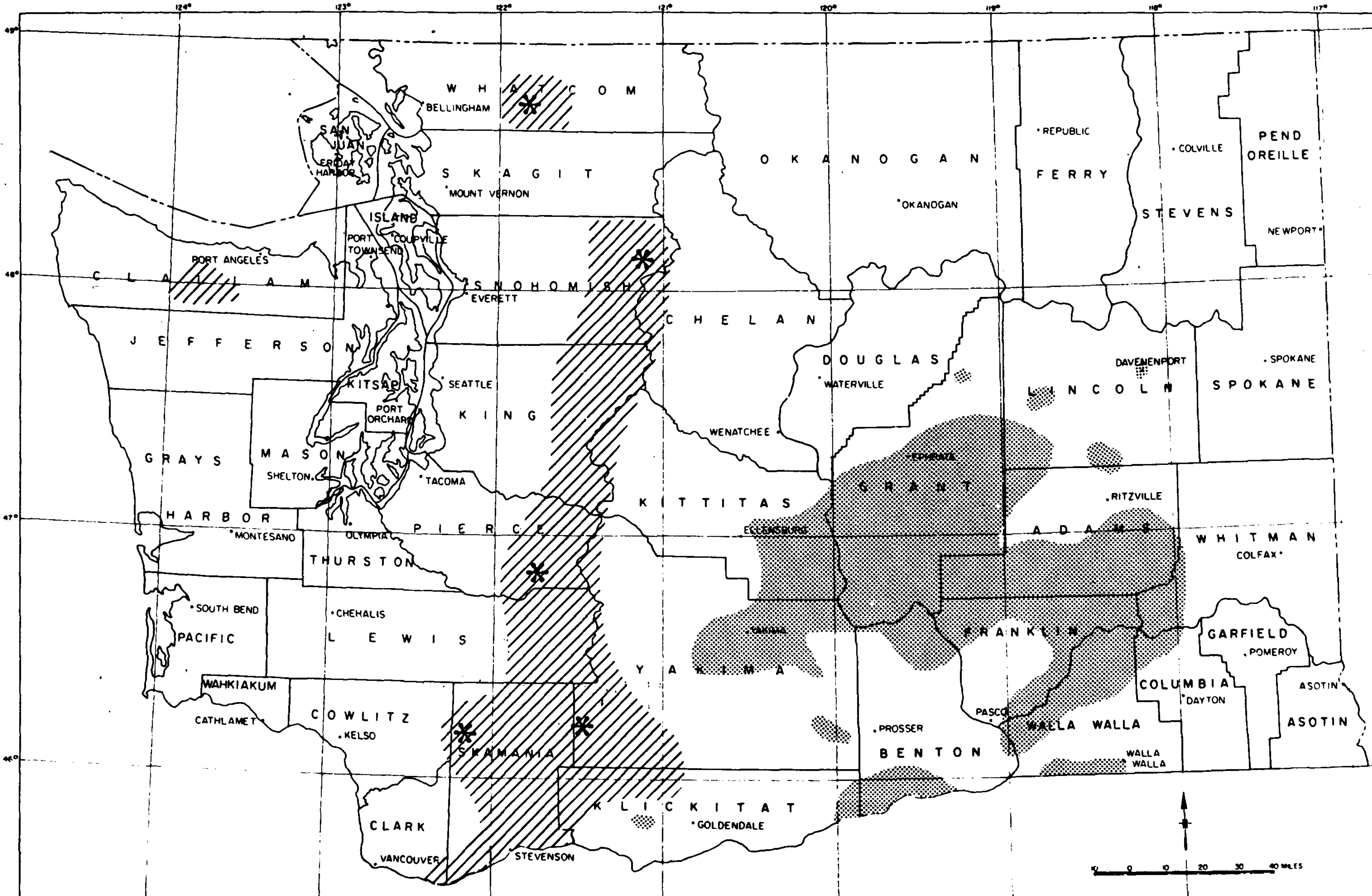
Budget

The budget for this subcontract has yet to be formulated, but we anticipate that the work can be done for $30,000 or less.

STATUS OF GEOTHERMAL ASSESSMENT IN WASHINGTON

The Washington State Geothermal Resource Assessment team has been operating under U.S. Department of Energy sponsorship for nearly three years. In that time considerable progress has been made toward identifying and understanding the state's geothermal resources. This progress is summarized in the following figures and table. Figures 2 and 4 and Table 1 were compiled jointly by the Washington State Resource Assessment and Commercialization Teams (Washington State Division of Geology and Earth Resources and Washington State Energy Office, respectively), while Figure 3, Geothermal Leases in Washington, was prepared entirely by the Commercialization Team.

Figure 2. — **POTENTIAL GEOTHERMAL RESOURCE AREAS IN WASHINGTON**

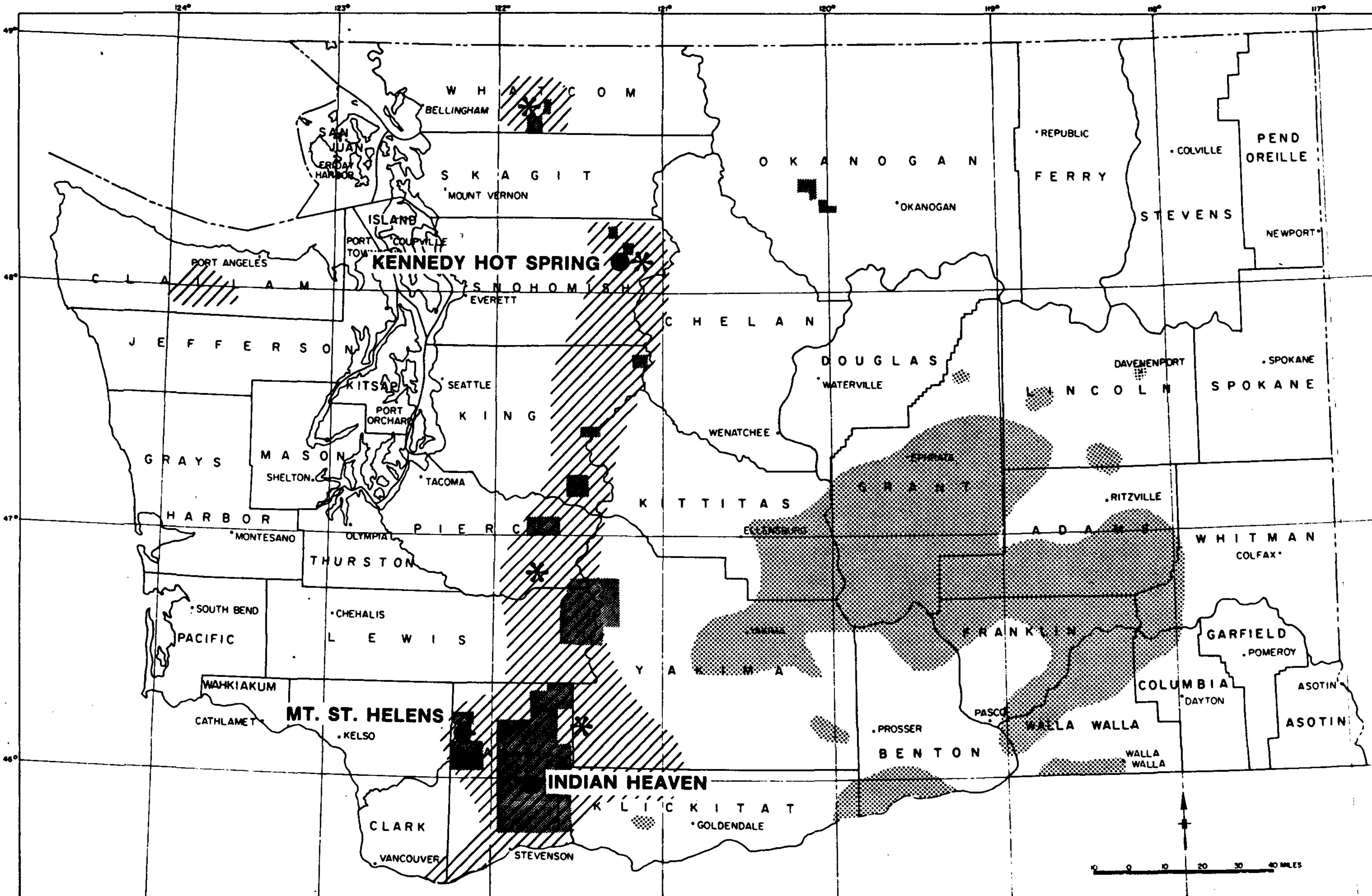


Areas depict regions where several wells have calculated temperature gradients higher than 45° C/km, although there are also colder wells within these areas. Low-to moderate-temperature resources may underlie large portions of these regions. Further exploration is needed to delineate the resource.

Areas with high potential for low-to high-temperature geothermal resources. Typical temperature gradients are in the range of 45° to 55° C/km. Favorable indicators are young igneous rocks, hot springs, or fumaroles.

* **VOLCANOES**

Figure 3. — **GEOTHERMAL LEASES IN WASHINGTON**



LANDS WITH GEOTHERMAL LEASE APPLICATIONS

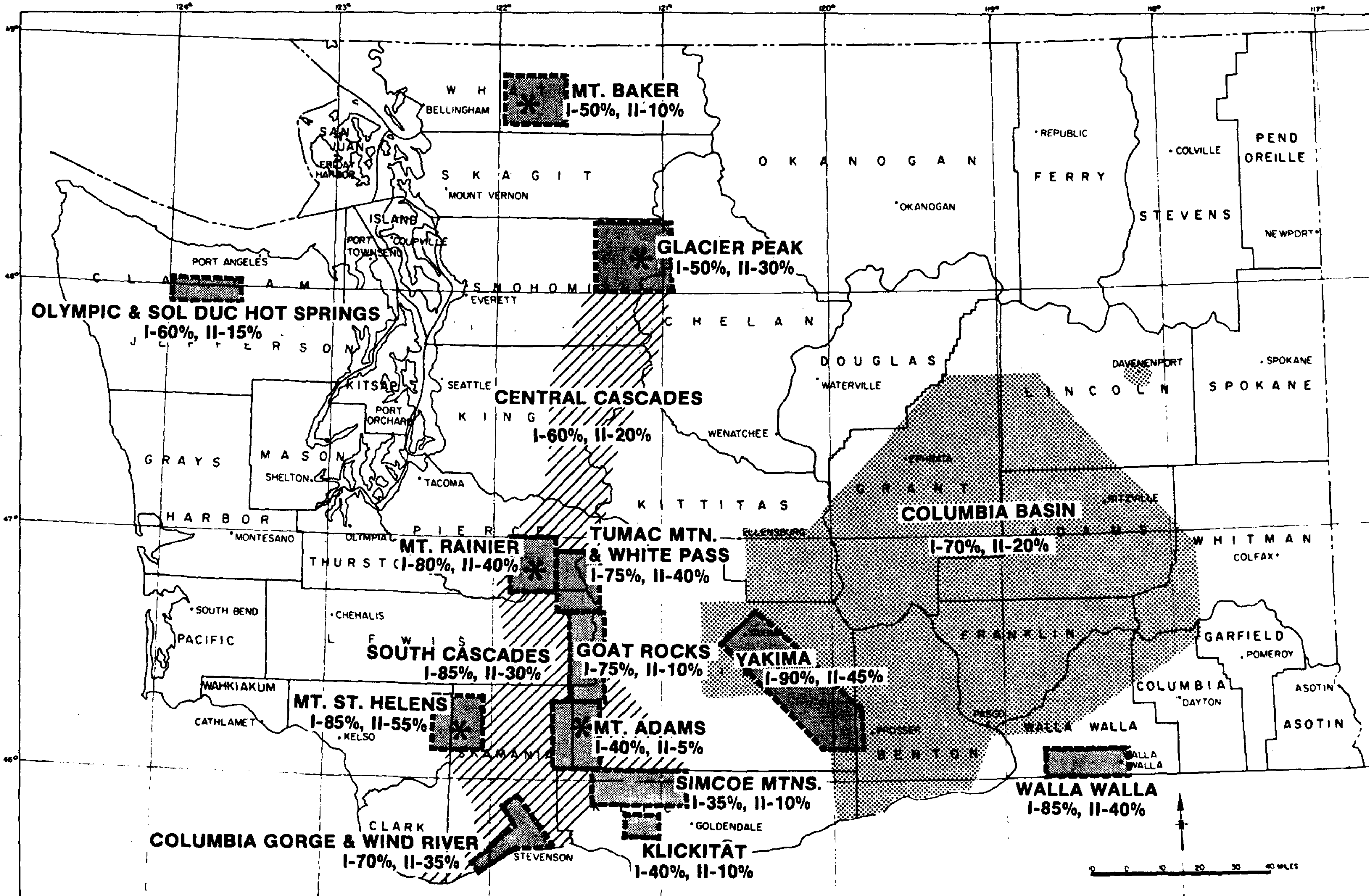
Areas depict regions where several wells have calculated temperature gradients higher than 45° C/km, although there are also colder wells within these areas.

● KNOWN GEOTHERMAL RESOURCE AREAS

✻ VOLCANOES

Areas with high potential for low-to high-temperature geothermal resources indicated by high-gradients, young igneous rocks, hot springs, or fumaroles.

Figure 4. — **WASHINGTON GEOTHERMAL RESOURCE ASSESSMENT MAP**



I, II, III, IV — EXPLORATION PHASES
% — PERCENT COMPLETE

AREAS OF ASSESSMENT ACTIVITY
✱ VOLCANOES

Table 1. — Status of Geothermal Energy Assessment in Washington, March 1981.

Status of Geothermal Energy Assessment in Washington, 3/81 NA = Not Applicable Numbers represent percent of work completed	PHASE I Regional Reconnaissance	Literature search	Temperature gradient measurement in existing wells - wide spacing	Spring & well sampling of ground water - wide spacing	Broad reconnaissance geologic mapping, 1:100,000 scale or smaller.	Regional geophysical studies - wide spacing. Includes gravity, seismic, and aeromagnetic surveys	Regional heat flow	PHASE II Initial direct exploration of identified resource	Temperature gradient measurement in all available wells	Spring and well sampling of water in all available wells and springs	Detailed geologic mapping. 1:62,500 scale or larger	Shallow drilling of 500' temperature gradient wells to define heat flow anomalies	Detailed geophysical exploration close spacing. Includes gravity, seismic, and aeromagnetic surveys	Qualitative and quantitative hydrologic analysis	PHASE III Direct exploration of thermal anomalies	Intermediate depth drilling of 2000' wells to define thermal anomalies	Geophysical exploration	Quantitative hydrologic modeling of the geothermal system	Phase IV Direct testing of geothermal resource at depth	Deep drilling of 3000' to 6000' wells to test geothermal aquifers	Reservoir testing engineering evaluation including pump testing	Quantitative reservoir estimation
Olympic & Sol Duc Hot Springs	60	100	NA	100	100	0	0	15	NA	75	0	0	0	0	0	0	0	0	0	0	0	0
Glacier Peak	50	80	NA	60	100	10	0	30	NA	60	100	0	0	0	0	0	0	0	0	0	0	0
Mt. Baker	50	80	NA	60	60	40	0	10	NA	40	20	0	0	0	0	0	0	0	0	0	0	0
Central Cascades	60	50	NA	80	100	40	20	20	NA	60	40	0	0	0	0	0	0	0	0	0	0	0
South Cascades	85	100	NA	100	100	80	40	30	NA	80	40	20	5	0	0	0	0	0	0	0	0	0
Columbia Gorge Wind River	70	100	60	60	100	65	30	35	40	60	60	20	40	0	0	0	0	0	0	0	0	0
Goat Rocks	75	80	NA	0	60	50	0	10	NA	0	20	0	20	0	0	0	0	0	0	0	0	0
Klickitat	40	60	30	20	100	20	0	10	40	20	0	0	0	0	0	0	0	0	0	0	0	0
Mt. Adams	40	60	NA	0	80	60	0	5	NA	0	20	0	0	0	0	0	0	0	0	0	0	0
Mt. Rainier	80	100	NA	100	100	60	40	40	NA	80	100	20	0	0	0	0	0	0	0	0	0	0
Mt. St. Helens	85	100	NA	100	100	90	40	55	NA	100	100	30	40	10?	0	0	0	0	0	0	0	0
Simcoe Mtns.	35	60	NA	0	100	20	0	10	NA	0	60	0	0	0	0	0	0	0	0	0	0	0
Tumac Mtn. White Pass	75	100	NA	100	100	50	20	40	NA	80	100	20	0	0	0	0	0	0	0	0	0	0
Columbia Basin	70	80	60	100	100	50	40	20	20	20	60	0	20?	15?	0	0	0	0	0	0	0	0
Walla Walla	85	80	100	100	100	90	50	40	60	60	80	0	20?	10?	0	0	0	0	0	0	0	0
Yakima	90	100	100	100	100	90	50	45	75	60	100	0	20?	20?	0	0	0	0	0	0	0	0

OVERALL PROPOSED BUDGET

Subcontracts:	
Cascade Range regional gravity by Danes Research Assoc.	$ 25,700
Geothermal investigations in the Yakima area by Washington State University	11,481
Wind River geologic investigations	20,000
Geothermal investigations in the Moses Lake-Ritzville-Connell area by Washington State University	30,000
Division of Geology and Earth Resources:	
Salaries, benefits, travel, equipment, supplies, and services	88,884
Overhead - 15.66 percent on Division of Geology and Earth Resources administered activities	27,571
USDOE CONTRIBUTION	$203,636
STATE OF WASHINGTON CONTRIBUTION	13,000
TOTAL	$216,636

WASHINGTON

Department of Geological Sciences
Institute for the Study of Earth and Man
Southern Methodist University
Dallas, Texas 75275

April 28, 1981

CONTINUATION PROPOSAL

Heat Flow and Geothermal Evaluation

of Oregon and Washington

Submitted to

Ms. Maggie Widmayer
U.S. Department of Energy
550 Second Avenue
Idaho Falls, Idaho 83401

Period of Grant: June 1, 1981 through May 31, 1982

Amount Requested: $163,653

David D. Blackwell
Principal Investigator
S.S. #449-62-6377
Tel. (214) 692-2745

Michael J. Holdaway
Chairman, Dept. of Geol. Sci.
S.S. #471-38-2275
Tel. (214) 692-2270

Truman F. Cook
Director, Office of Research Administration
S.S. #456-12-6041
Tel. (214) 692-2030

SMU Proposal Number 11101

HEAT FLOW AND GEOTHERMAL EVALUATION OF OREGON AND WASHINGTON

ABSTRACT

This proposal is for the third year of a program of cooperative heat flow studies and geothermal evaluation of Oregon and Washington. Personnel of the Geothermal Laboratory at SMU, as outlined in the accompanying budget, will perform field and laboratory tasks dealing with geothermal measurements and evaluation in cooperation with the low-temperature assessment studies of the Oregon Department of Geology and Mineral Industries and the Washington Department of Natural Resources, Division of Geology. The specific SMU tasks include the following.

Based on extensive geothermal experience in the Pacific Northwest, consultation on the nature of the field program of the two states and interpretation of final results will be a major task. In addition, three people will be supplied and supervised for field operations in the state of Washington during the summer of 1981. One person will operate a motorized logging system and the other two will operate hand-powered equipment (9 man-months total). Most of the field program in Oregon will be carried out by personnel of the Department of Geology and Mineral Industries. Approximately 1 1/2 man-months of SMU effort will be involved in the field aspects of the Oregon program.

Five sets of portable temperature logging equipment for support of the field temperature-gradient heat-flow study aspects of the state programs will be supplied and maintained by SMU. Two motorized logging systems, one capable of measuring temperatures to 110°C at 1050 m and the other capable

of measuring temperatures to 150°C at 3000 m will also be supplied and maintained. Gamma-ray, SP, and resistivity logs will be recorded in wells for which such information would be useful in interpretation or evaluation. Thermal conductivity measurements will be made on cuttings and core samples collected from the wells in which temperature logs have been made and from surrounding outcrops, etc. The samples will be collected by SMU, WDNR and DOGAMI personnel. The thermal conductivity apparatus is operated and maintained by SMU. As needed, heat production studies involving measurement of the uranium, thorium and potassium content of rocks will be carried out on samples collected by field personnel. This equipment is maintained and operated by SMU. The results of current and past temperature-depth logging, geothermal gradient calculations, etc., will be maintained on computerized data files at SMU. Computer-processed temperature-depth data in the form of listings and plots will be supplied, based on data collected by the field parties, for inclusion in open-file reports following completion of the field season. Summary reports and maps will be supplied using the data base available. Included will be tabulated lists of all geothermal data in each state; maps at a scale of 1:1,000,000 detailing heat flow measurements in the states of Oregon and Washington, with accompanying reports; and a contour map of temperatures and/or depth of certain temperatures in the Columbia Basin. Reports on local geothermal systems and detailed studies will be prepared at the request of the states, on a manpower-available basis.

INTRODUCTION

During the past two years there has been a continued program of investigation of low-temperature geothermal resources in the Pacific Northwest, sponsored by DOE and carried out by state organizations. One of the major techniques used in this resource evaluation-investigation program is the collection of geothermal gradient-heat flow data. The object of work during this contract period is to provide a third year of logistical, technical, analytical and report preparation support relating to geothermal gradient-heat flow data for the low-temperature geothermal programs in the states of Oregon and Washington. During the period of this contract (June 1, 1981 through May 31, 1982), the work effort in Oregon and Washington will be focused on specific areas and problems of completion of the statewide studies. The overall objective of the project will be to bring to completion several parts of the study which have been in progress for some time.

PROPOSED WORK

Oregon

The program of the Oregon Department of Geology and Mineral Industries (DOE contract) for the 1981-82 season includes a minimum amount of drilling, an extensive collection of free hole (scrounge) data, and consolidation and interpretation of existing information. Services to be provided by SMU include supply and maintenance of two sets of portable temperature logging gear. In addition, the state owns a third set, so that the three field parties will be active during the summer collecting drill hole data. A truck with a motorized winch capable of measuring temperatures to a depth of 3000 m and a truck capable of measuring temperatures to 1000 m as well as gamma-ray, SP and resistivity logs in wells, will be supplied and maintained for joint use by the states of Oregon and Washington. Each truck will be available approximately 50% of the time in each state during the field season. Personnel from the state of Oregon will collect the field data, which will be sent to SMU to be collated and combined with an extensive computer file of existing data from the state of Oregon (the file already totals over 500 holes). With the several parties in the field it is estimated that between 100 and 200 new holes will be logged during the 1981 field season.

Copies of computer-processed temperature-depth information and plots for each hole will be submitted to the state of Oregon for open-file in the fall of 1981, for ready access by the geothermal community. Thermal conductivity measurements will be made on samples collected by the field parties in order to calculate heat flow values for holes, where possible, and to obtain better information on thermal properties of geothermal areas. Radioactivity measurement on well and surface samples, as well as terrain corrections, will be made as needed.

Reports will be prepared and personnel from the geothermal laboratory will consult with personnel from the state of Oregon in the interpretation and reporting of the geothermal results. Special areas of study are listed in the DOGAMI contract. Specific publications to be submitted by May 31, 1982, include: a report of geothermal gradient data, geothermal gradient and heat flow summary for special papers on high-priority resource areas;

a geothermal gradient and heat flow summary for a special paper summarizing the geothermal resource potential of all of the study areas; and a new edition of the statewide 1:1,000,000 heat flow map.

Washington

Under contract to DOE, the Washington Department of Natural Resources (WDNR) plans to drill approximately 10 holes specifically for geothermal graident-heat flow determinations in the southeastern Washington Cascade Range. SMU will log temperatures, gamma-ray, SP and resistivity in these holes as they are drilled. In addition, SMU will supply 9 man-months of field effort in support of the state of Washington program; 6 man-months of field effort will be involved with geothermal gradient scrounge studies, and 3 man-months will be involved in operating one of the mobilized logging systems. Two sets of portable temperature-depth equipment will be supplied for the field studies. The areas to be emphasized are the eastern border of the Cascade Range, the Columbia Plateau, and the boundary between the Columbia Plateau and Okanogan Highlands. These areas afford a combination of population centers and geothermal potential such that they are the areas most likely to be utilized for low-temperature geothermal applications in the state of Washington. In the field effort, approximately 100 to 150 holes will be logged, in addition to the holes which are to be drilled. All of the off-campus budget is devoted to the field effort in the state of Washington, with the exception of one budget month of the principal investigator's time and 1/2 month of the research associate's time.

Upon return to Dallas, the temperature-depth data will be computer processed and returned to the state for open-file in the early fall, as is the case in Oregon. Products to be delivered by May 31, 1982, include the following:

1. Depth-to-isotherm maps
   a) sketch map of entire state at 1:2,000,000
   b) Columbia Basin at 1:500,000
   c) more detailed maps in anomalous areas, such as Moses Lake, Walla Walla, or Yakima, at scales of 1:250,000 or 1:100,000 as data quantity and quality permit.

   [NOTE: These maps might be formulated as depth-to-isotherm maps (probably depth to 20°C and/or 30°C) and/or temperature-at-fixed-depth maps (such as temperature at a depth of 1 km).]

2. Mean surface temperature maps for the areas listed under 1a, 1b and 1c, where data quantity and quality permit.

3. Heat flow and gradient maps for the entire state at 1:1,000,000.

4. Tabulated and graphical temperature-depth data for all wells in the state from which these data are available.

5. Tabulated gradients, thermal conductivities and heat flow (corrected and uncorrected) for all wells in the state from which these data are available.

6. An explanatory and interpretative text.

BUDGET NOTES

The on-campus budget breakdown is 50-50 between the states of Oregon and Washington, so the supplies, publication, computer and on-campus travel line-items, as well as the on-campus direct costs, are evenly divided. The maintenance and repair of the field equipment (truck and portable logging gear) will occupy approximately 50% of a technician's time for 12 months (25% for the state of Oregon and 25% for the state of Washington). The laboratory aspects relating to the state of Oregon studies will occupy approximately 45% of the time of the research associate and 15% of the time of the principal investigator; 50% of the time of the laboratory assistants, 30% of the secretary's time for report preparation, and approximately $200 of undergraduate assistants' time. The technician will spend 10% of time on maintenance of the laboratory equipment. Similar on-campus effort will be directed to the state of Washington program.

Half-time for the two logging trucks will be spent in the state of Washington to obtain information in deeper holes; also, resistivity, SP and gamma-ray information on selected holes of special interest.

All of the off-campus budget is devoted to the field effort of the state of Washington with the exception of one month of the principal investigator's time and 1/2 month of the research associate's time. The breakdown of the budget items devoted to support of the Oregon program comes to a total of $70,000; that devoted to support of the Washington program comes to a total of $93,653. The field aspect represents the only difference in the level of budgeted effort between the states of Oregon and Washington.

OFF CAMPUS BUDGET

Salaries	TOTAL	DOE	SMU
Principal Investigator, David Blackwell			
100% of 2 months @ $4,666/month	9,332	9,332	
Research Associate, John Steele			
100% of 3 months @ $1946/month	5,838	5,838	
Field Assistants			
100% of 6 months @ $1000/month	6,000	6,000	
TOTAL SALARIES	21,170	21,170	
Employee Benefits			
Blackwell @ 13% of salary	1,214	1,214	
Research Associate @ 15.1%	882	882	
Field Assistants @ .8% of salary	48	48	
TOTAL BENEFITS	2,144	2,144	
Supplies	2,000	2,000	
Travel			
11 man-months @ $35/day	11,550	11,550	
60,000 miles @ 22.5¢/mile	13,500	13,500	
TOTAL DIRECT COSTS	50,364	50,364	
INDIRECT COSTS -23.4% of MTDC	11,786	11,786	
TOTAL OFF CAMPUS PROJECT COSTS	62,150	62,150	

ON CAMPUS BUDGET

Salaries	TOTAL	DOE	SMU
Principal Investigator, David Blackwell			
30% of AY 1981/82 @ $44,520/AY	13,356	4,452	8,904
Research Associate, John Steele			
90% of 9 months @ $23,353/CY	15,764	15,764	
Technician			
70% of 12 months @ $1650/month	13,860	13,860	
Lab Assistant			
100% of 9 months @ $1000/month	9,000	9,000	
Secretary			
60% of 12 months @ $800/month	5,760	5,760	
Undergraduate Assistant			
400 hours @ $4/hour	1,600	1,600	
TOTAL SALARIES	59,340	50,436	8,904

	Total	DOE	SMU
Employee Benefits			
Blackwell @ 13%	1,736	578	1,158
Research Assoc & Technician @ 15.1%	4,474	4,474	
Secretary @ 9.2%	530	530	
Others @ .8%	84	84	
TOTAL BENEFITS	6,824	5,666	1,158
Supplies	2,000	2,000	
Publication	1,500	1,500	
Computer - 800 hours @ $12.50/hour	10,000	10,000	
Travel			
2 professional meetings @ $750/mtg	1,500	1,500	
2 contractor's meetings @ $700/mtg	1,400	1,400	
TOTAL DIRECT COSTS	82,564	72,502	10,062
INDIRECT COSTS -40% of MTDC	33,026	29,001	4,025
TOTAL ON CAMPUS PROJECT COSTS	/ 115,590	101,503	14,087

BUDGET SUMMARY

	Total	DOE	SMU
Salaries	80,510	71,606	8,904
Employee Benefits	8,968	7,810	1,158
Supplies	4,000	4,000	
Travel	27,950	27,950	
Computer	10,000	10,000	
Publication	1,500	1,500	
TOTAL DIRECT COSTS	132,928	122,866	10,062
INDIRECT COSTS	44,812	40,787	4,025
TOTAL PROJECT COSTS	177,355	163,653	14,087

File M.2.15

RECEIVED
JUN 16 1980
GEOTHERMAL ENERGY
BRANCH

June 13, 1980

State of Washington
Department of Natural Resources
Olympia, Washington 98504

ATTENTION: J. Eric Schuster

SUBJECT: MODIFICATION NO. A003 - CONTRACT NO. DE-AC07-79ET27014

Gentlemen:

Enclosed are four copies of the subject modification. If this modification is satisfactory to you, please have three copies signed by an authorized official and return them to this office for execution by DOE. The fourth copy is for your files pending receipt of one fully executed copy.

If you have any questions, please contact J. O. Lee of this office at telephone 208-526-1838.

Very truly yours,

/s/ H. B. Clark, for

J. P. Anderson, Chief
Contract Operations Branch
Contracts Management Division

4 Enclosures

bcc: M. A. Widmayer, w/encl.

COB MHanson 6/13/80	COB JOLee	COB JPAnderson

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. A003
2. EFFECTIVE DATE 7/1/80
3. REQUISITION/PURCHASE REQUEST NO. 07-80ET27014.504
4. PROJECT NO. (If applicable)

5. ISSUED BY CODE
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS CODE FACILITY CODE
(Street, city, county, state, and ZIP Code)
State of Washington
Department of Natural Resources
Olympia, Washington 98504
Attn: J. Eric Schuster

8.
☐ AMENDMENT OF SOLICITATION NO.
DATED (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5/8/79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

1. Article I, Scope of Work, of the "SCHEDULE" is revised to include the following tasks which shall be performed under this Modification No. A003 in continuation of the Washington State Coop Program:

Task 1. Heat Flow Drilling - Eight heat flow holes to a maximum depth of 500 feet will be drilled in the Southern Cascades: Two holes will be drilled east of Mt. Saint Helens, one hole will be drilled in the Cowlitz Valley in the Puget Lowland, one hole will be drilled near St. Martins Hot Springs, and one hole will be located in the North Bonneville area. The locations for the other three holes will be determined later. Changes in drilling location and/or number of holes must be approved by DOE prior to change. Drilling will be accomplished by a subcontract, which will have DOE approval prior to issuance by the State of Washington.

--continued

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY ____
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY ____
(Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)

16. DATE SIGNED

18. NAME OF CONTRACTING OFFICER (Type or print)
Nell W. Fraser, Director
Contracts Management Division

19. DATE SIGNED

☆U.S.GPO:1979-0-281-187/5001

Task 2. Temperature Measurements - Temperature measurements and thermal gradients will be obtained for all available existing wells in the Southeastern Cascades, Yakima Valley, and southwestern Columbia Basin. A preliminary map and interpretation of these data to include geo-hydrologic, and existing data on file with this program, will be produced.

Task 3. Geologic Mapping - Detailed geologic mapping, of lithology and structures, rock analysis, and age dating will be conducted on one of the strato-volcanoes (i.e., Mt. Adams or Mt. Baker). The study area to be studied will be approved by DOE prior to beginning work. Preliminary maps and interpretations of geothermal potential of the study area will be produced.

Task 4. Gravity Survey - A subcontract will be issued to perform gravity surveys (one station per five square miles density) in the central and Northern Cascades. Data reduction and preliminary interpretations will be produced. A gravity map of the Cascades of Washington will be prepared by 1982. This subcontract must be approved by DOE prior to issuance.

Task 5. Geophysical Interpretations - A task within this program is to assist in the evaluation of data as it relates to geothermal development in the State of Washington. It is understood that $5,000 will be available under this modification to purchase consultant time, as required, to aid in the interpretation of geothermal information associated with this program.

Task 6. Geochemistry - Water samples will be collected from thermal springs and wells along the Columbia and Wind Rivers, in the southeast Cascades, and in eastern Washington. Geochemical analyses will be performed on the samples as outlined in the participant's proposal, herein incorporated as part of this modification. Soil mercury and radon studies will be conducted in these areas to help delineate faults associated with geothermal fluids. Preliminary maps and results of these surveys will be presented in the yearend report.

Task 7. Fault - Lineament Map - Construct a well documented lineament map of south Cascades and southwest Columbia Basin areas. Field verification of lineaments and faults will be accomplished.

Task 8. USGS GEOTHERM file - All pertinent information on geothermal resources will be transmitted to the USGS GOETHERM File for encorporation.

Task 9. Reports - The Contractor shall furnish reports for work under this modification in accordance with attached DOE Form CF-537.

2. Article II - PERIOD OF PERFORMANCE of the "SCHEDULE" is revised to read as follows:

   The period of performance for work under this modification shall begin on July 1, 1980 and be completed on May 31, 1981. The period of performance may be extended for additional periods by written agreement of the parties.

3. Paragraphs (a), (c) and (d) of Article III - ESTIMATED COST AND COST SHARING of the "SCHEDULE" are revised to read as follows:

   (a) The total estimated cost of the work under this contract is increased from $309,878 to $616,962 for work under the original contract and this Modification No. A003. Of this estimated cost, the amount that DOE will fund is increased from $296,894 to $591,111 for work under this Modification No. A003.

   (c) The amount of costs that the Contractor shall fund out of its own resources is increased from $12,984 to $25,851 for work under the this Modification No. A003. In the event that the actual cost of the work under the original contract and this Modification No. A003 exceeds the amount of $616,962 it is understood and agreed that the Contractor shall be under no further obligation to thereafter share costs of contract performance hereunder, and in no event shall the Contractor be obligated to contribute an amount from its own resources in excess of $25,851 for work under the original contract and this Modification No. A003.

   (d) The total amount presently obligated under this contract is increased from $296,894 to $591,111. Of these funds $549,510 is available for operating expenses and $41,601 for the purchase of capitol equipment. Amounts obligated under the contract by both parties is summarized as follows:

	DOE Share	SOW Share
Original contract	$296,894	$12,984
Increase Mod A003	294,217	12,867
Totals	$591,111	$25,851

4. Paragraph (e) is added to Article IV - TECHNICAL DIRECTION AND SURVEILLANCE, of the "SCHEDULE" to read as follows:

   (e) The "Technical Manager" for DOE is as follows:

   M. A. Widmayer
   Resource Definition Branch
   USDOE - Idaho Operations Office
   550 Second Street
   Idaho Falls, ID 83401
   Telephone (208) 526-1466

The Principal Investigator for the Contractor under this contract is:

J. Eric Schuster
Assistant Manager
Division of Geology and Earth Resources
Department of Natural Resources
State of Washington
Olympia, WA 98504
Telephone (206) 754-1616

U. S. DEPARTMENT OF ENERGY

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-537
(1-78)

(See Instructions on Reverse)

FORM APPROVED
OMB NO. 38R-0190

1. IDENTIFICATION Geothermal Resource Assessment in Washington

2. OBLIGATION INSTRUMENT: Modification No. A003 to Contract No. DE-AC07-79ET27014

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. ☐ Management Plan		1. ☐ Notice of Energy RD&D Project (SSIE)	
2. ☐ Milestone Schedule & Status Report		2. ☒ Technical Progress Report	M
3. ☐ Cost Plan		3. ☒ Topical Report	Y
4. ☐ Manpower Plan		4. ☒ Final Technical Report	Y
5. ☒ Contract Management Summary Report	M	C. PMS/MINI-PMS	
6. ☒ Project Status Report	M	1. Cost Performance Report	
7. ☒ Cost Management Report	M	☐ Format 1 WBS	
8. ☐ Manpower Management Report		☐ Format 2 Functional	
9. ☐ Conference Record		☐ Format 3 Baseline	
10. ☐ Hot Line Report		☐ Format 5 Problem Analysis	
		2. ☐ Cost/Schedule Status Report	
		3. ☐ Management Control System Description	
		4. ☐ Summary System Description	
		5. ☐ WBS Dictionary	

FREQUENCY CODES:
A — As Required
C — Contract Change
F — Final (End of Contract)
M — Monthly
O — One Time (Soon After Contract Award)
Q — Quarterly
S — Semi-Annually
X — Mandatory for Delivery with Proposals/Bid
Y — Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

A.5., A.6., and A.7. - Copies are due within fifteen days after end of the calendar month.

B.2. - Copies are due within fifteen days after end of the calendar month.

B.3. - Submit 2 copies in draft forty-five days prior to completion of the yearly term. After DOE approval is received, submit copies as required on attached "Report Distribution List."

B.4. - Submit 2 copies in draft forty-five days prior to completion date of contract term. After DOE approval is received, submit eleven copies including one camera-ready copy.

5. ATTACHED HEREWITH:

☐ Report Distribution List
☐ WBS, Reporting Category

6. PREPARED BY (Signature and date)

7. REVIEWED BY (Signature and date) J. O'Kee 5-28-80

REPORTING REQUIREMENTS CHECKLIST

PURPOSE

A checklist to identify and communicate additional reporting requirements which are not otherwise set forth in the General Purpose clauses of DOE contracts and agreements. It will be included as part of the contract or agreement. This form will be completed for each proposed contract or agreement and can be modified as required in Special Instructions to adapt it to a specific situation.

INSTRUCTIONS

Item 1 — Enter the title as indicated in the Procurement Request, Interagency Agreement, or initiating memorandum.

Item 2 — Enter the identification number of the Procurement Request or Interagency Agreement, the date of the memorandum, and contract number after award.

Item 3 — Check spaces to indicate plans and reports required. For each reporting requirement checked, indicate frequency of delivery in column provided using one of the frequency codes shown.

3.A.1 *Management Plan* — The contractor's plan to manage the effort described in the statement of work or similar document. It will contain management methodologies, control systems, and procedures he will use. Includes milestones and other planning schedules, organizational identification and descriptions, and special and critical plans, such as test plans, plans for handling of Government owned property. Work breakdown structures, key personnel identification, and methods for monitoring progress toward objectives may be required.

3.A.2 *Milestone Schedule and Status Report* — The contractor's milestone schedule for all work breakdown structure items, line items, or deliverables specified in the contract. Updated periodically (usually monthly) with status, progress toward completion, and percent completion of each line item and of the total contract.

3.A.3 *Cost Plan* — A baseline plan for incurring costs on a contract or agreement to measure progress in terms of cost; update and forecast contract fund requirements; plan funding changes; and develop fund requirements and budget estimates.

3.A.4 *Manpower Plan* — A baseline plan to allocate manpower to each reporting category identified in the contract or agreement.

3.A.5 *Contract Management Summary Report* — A single-page graphic presentation of integrated cost, major milestones, and manpower for rapid visual analysis and trend forecasting.

3.A.6 *Project Status Report* — A periodic report to communicate to DOE management an assessment of contract status, to explain variances and problems, and to discuss any other areas of concern or achievements.

3.A.7 *Cost Management Report* — A periodic report of the status of costs compared to the Cost Plan. Data is used to: report actual and projected accrued costs; evaluate performance against plan; identify actual and potential problem areas; construct cost experience for projects and budgeting efforts; and, to verify the reasonableness of contractors' invoices.

3.A.8 *Manpower Management Report* — A periodic report of the status of actual and projected manpower expenditure against the Manpower Plan. Data is used to evaluate performance against plan; identify actual and potential problem areas; and to construct manpower experience for projections and planning efforts.

3.A.9 *Conference Record* — Documentation of the contractor's understanding of significant decisions, direction or redirection or required actions resulting from any meeting with DOE representatives.

3.A.10 *Hot Line Report* — A hardcopy report by the fastest means available, (TWX, etc) documenting critical problems, emergency situations, and important technical breakthroughs.

3.B.1 *Notice of Energy R&D Project* — A formatted, two-page report to provide information on unclassified DOE R&D projects for dissemination to the scientific, technical, and industrial communities and to the public. Also provides information to the Smithsonian Scientific Information Exchange.

3.B.2 *Technical Progress Report* — A formal, structured technical report, submitted periodically to communicate project results for dissemination to Government agencies, the scientific, technical and industrial communities and the public.

3.B.3 *Topical Report* — A special technical report prepared when a project has reached a point at which a major milestone or a significant phase has been completed, when unexpected results have been achieved, when it is logical to summarize results achieved, or when a new scientific or technological finding is deemed to warrant prompt publication.

3.B.4 *Final Technical Report* — Technical Progress Report reporting final results of DOE supported RD&D and scientific projects.

3.C *PMS/Mini-PMS*

1) *Cost Performance Report (PMS Application)*

Format 1 — Reports current period and cumulative budget, actual costs and earned value data by work breakdown structure elements. Identifies cost and schedule variances and provides contractor's estimate to complete comparisons to budgets.

Format 2 — Reports current period and cumulative budget, actual costs, and earned value data by contractor functional elements.

Format 3 — Provides periodic updating to the established performance measurement baseline. Incorporates authorized contract changes and internal re-planning into the performance measurement baseline.

Format 5 — Provides a narrative analysis of contract variances.

2) *Cost/Schedule Report (Mini-PMS Application)*— Periodic, usually monthly, report of cumulative budget, actual costs and earned value by summary work breakdown structure elements. Identifies cost and schedule variances and provides contractor's estimate to complete comparisons to budgets.

3) *System Description (PMS Application)* — Contractor's description of the management control system to be used in performing contract work. Must address all elements of the PMS criteria.

4) *Summary System Description (Mini-PMS Application)* — Contractor's summarized description of the management control system to be used in performing contract work.

5) *WBS Dictionary* — Lists and defines work breakdown structure. For more detailed instructions see PMS Manual.

Frequency Codes — Each code must have an identified time period (i.e., As Required — 5 days after event occurrence). These time periods are suggested in the solicitation and negotiated at contract award.

Item 4 — Identify any special reporting requirements not indicated in Item 3 and/or qualifiers to those selected. (Use additional sheets as necessary.)

Item 5 — Check appropriate blocks.

Report Distribution List — A comprehensive informative listing of reports by frequency of submission, addresses and number of copies for each addressee.

Reporting Categories (level of detail) — An identification by WBS level of task elements for which reporting will be required by DOE.

Item 6 — Signature of person or persons preparing the checklist and the date prepared. Preparation is by person or persons responsible for preparation of Procurement Request or Statement of Work.

Item 7 — Signature of the person reviewing the checklist and date reviewed.

U.S. GOVERNMENT PRINTING OFFICE : 1979-281-133 :

ID F-129 (Rev. 08-79)
Ref. DOE 13302
(use with DOE CR-537)

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

REPORT DISTRIBUTION LIST

Contract No.
DE-AC07-79ET27014

Modification No. A003

Addressees	Management Plan	Milestone Schedule & Status Report	Cost Plan	Manpower Plan	Contract Management Summary Report	Project Status Report	Cost Management Report	Manpower Management Report	Conference Report	Hot Line Report	Notice of Energy RD&D Project (SSIE)	Technical Progress Report	Topical Report	Final Technical Report	Cost Performance Report	Cost/Schedule Status Report	Management Control System Description	Summary System Description	WBS Dictionary
M. A. Widmayer, Program Manager Resource Definition Branch U.S.D.O.E. Idaho Operations Office 550 Second Street Idaho Falls, ID 83401					2	2						2	2	12					
Bob Gray U.S.D.O.E. Division of Geothermal Energy MS 3344 Federal Building 12th and Penn., N.W. Washington, D.C. 20461					2	2						2	2						
Duncan Foley UURI 420 Chipeta Way Suite 120 Salt Lake City, UT 84108					1	1						1	1						
E. G. Jones, Director Financial Management Division U.S.D.O.E. Idaho Operations Office 550 Second Street Idaho Falls, ID 83401							1												

Number of Report Copies

Special Instructions

UNIFORM DOE CONTRACTOR SCIENTIFIC, TECHNICAL AND ENGINEERING REPORT NUMBERING SYSTEM

Effective with the implementation of the Procurement/Contract numbering system as shown in the example below, the following guidelines are established for identifying scientific and technical reports (progress, interim, final topical, etc.) conference papers, proceedings, theses, and translations.

1. All DOE contractors now applying uniquely identifying codes and systems approved by TIC are to continue using such codes and systems.

2. DOE Field Office codes such as ALO, IDO, COO, HCP, NVO, ORO, RLO, SAN, and SRO; and program codes such as FE, DSE, etc., are no longer approved for use by contractors.

3. Contractors having no approved unique codes are to number information products as shown below. All contractors in this category should create unique report numbers by (a) identifying the report with a DOE code, (b) selecting the final seven characters from the applicable contract number (two alphabetic and five numerals), and (c) adding suffix numbers sequentially for each report generated under the contract. For new contracts, the sequential number should begin with 1. For existing contracts the established sequence should continue. Slash marks and hyphens should be applied as shown in the examples.

   Examples: Report numbers generated from contract number DE-AC03-79ET01834.M001:

   DOE/ET/01834-1; DOE/ET/01834-2; DOE/ET/01834-3; etc.

   Note: It is essential that both the final five-digit numeral and the two preceeding alphabetical characters be extracted from the contract number as shown. The modification number, if any, normally shown as M001, etc., following the basic five-digit number is NOT used in the report number.

4. Reports issued in more than one binding, or reissued as revisions or later editions, are to be identified by adding the following aditional suffixes to the basic number: Rev. - Revision; Vol. -Volume; Pt. - part; Add. - Addenda; Ed. - Edition, etc.

   Examples: DOE/ET-01834-1 Rev.
   DOE/ET/01834-1 Rev. 2

   DOE/ET-01834-1 Pt. 1
   DOE/ET/01834-1 Pt. 2

It is intended that report numbers be structured exactly as specified in the examples insofar as possible. If modification to this basic format is essential, it is to be approved through normal channels before being used.

File M.2.15

MAY 29 1980

RECEIVED

MAY 30 1980

GEOTHERMAL ENERGY BRANCH

State of Washington
Department of Natural Resources
Olympia, Washington 98504

ATTENTION: Eric Schuster

SUBJECT: MODIFICATIONS NOS. M002 AND A003 TO CONTRACT NO. DE-AC07-79ET27014

Gentlemen:

Enclosed are four copies of Modification No. M002 to the subject contract which extends the completion period from June 1, 1980, through June 30, 1980. This time extension allows enough time to execute Modification No. A003. If the modification is acceptable to you, please have three copies signed by an authorized official and return them to this office.

I am also enclosing a draft copy of Modification No. A003 with a performance period from July 1, 1980, through May 31, 1981. Please review the modification and let me know whether it is acceptable.

In addition to the above two requests, please fill out and return the attached "Certificate of Current Cost or Pricing Data" as soon as possible.

If you have questions, please contact J. O. Lee of my staff.

Very truly yours,

/s/ J.P. Anderson

J. P. Anderson
Contracting Officer
Chief, Contract Operations Branch
Contracts Management Division

Enclosures

bcc: M. A. Widmayer, w/o encl.

COB
JOLee:mh
5/29/80

COB
JPAnderson

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 1

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
M002			

5. ISSUED BY CODE
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

File M.2.15

7. CONTRACTOR CODE FACILITY CODE
NAME AND ADDRESS (Street, city, county, state, and ZIP code)

State of Washington
Department of Natural Resources
Olympia, Washington 98504

Attn: J. Eric Schuster

8.
☐ AMENDMENT OF SOLICITATION NO. ______
DATED ______ (See block 9)

☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5/8/79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ______
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The period of performance under Article II, Period of Performance, of the "SCHEDULE" is extended from June 1, 1980, to June 30, 1980.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT   14. ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

15. NAME OF CONTRACTOR/OFFEROR		17. UNITED STATES OF AMERICA	
(Signature of person authorized to sign)		BY J P Anderson (Signature of Contracting Officer)	
NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
Manager, Dept. of Natural Resources, Division of Geology	June 9, 1980	J. P. Anderson, Chief Contract Operations Branch	6/17/80

30-101

☆ U.S.GPO:1979-0-281-187/5001

M.2.15

Mr. [illegible]

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 1

1. AMENDMENT/MODIFICATION NO. M001
2. EFFECTIVE DATE
3. REQUISITION/PURCHASE REQUEST NO.
4. PROJECT NO. (If applicable)

5. ISSUED BY CODE
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

RECEIVED
NOV 19 1979
ENERGY & TECHNOLOGY DIVISION

7. CONTRACTOR NAME AND ADDRESS CODE FACILITY CODE
(Street, city, county, state, and ZIP Code)
State of Washington
Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington 98504
Attn: Eric Schuster

8.
☐ AMENDMENT OF SOLICITATION NO.
DATED (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5-8-79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS
☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:
(a) By signing and returning ___ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS
(a) ☐ This Change Order is issued pursuant to
The Changes set forth in block 12 are made to the above numbered contract/order.
(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.
(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

As requested in your letter dated October 23, 1979, the completion date of the subject contract, as set forth in Article II - Period of Performance, is hereby extended from October 31, 1979, through June 1, 1980.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY Paul E. Krauss
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY J. P. Anderson
(Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)
Paul E. Krauss
Deputy Supervisor, Governmental

16. DATE SIGNED 11-13-79

18. NAME OF CONTRACTING OFFICER (Type or print)
J. P. Anderson, Chief
Contract Administration Branch

19. DATE SIGNED 11/15/79

M.2.15

Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

RECEIVED
SEP 11 1979
ENERGY & TECHNOLOGY DIVISION

SEP 10 1979

State of Washington
Department of Natural Resources
Olympia, Washington 98504

Attention: J.Eric Schuster

Subject: CONTRACT NO. DE-AC07-79ET27014

Gentlemen:

You are authorized to make the budget changes that were proposed in your letter dated June 11, 1979 to L. L. Mink. It is understood that the changes will not increase the total cost of the contract.

As you are aware, the subject contract has now been transferred to Idaho Operations for administering. If you have any questions, please contact J. O. Lee of my staff at telephone 208-526-1838.

Very truly yours,

Original Signed by
J. P. Anderson

J. P. Anderson, Chief
Contract Administration Branch
Contracts Management Division

bcc: M. A. Widmayer

CAB
JOLee:ahb
9/10/79

CAB
JPAnderson

JUL 11 1979

GED
Molloy:cp
7/11/79
GED
Heenan
7/ /79

Kaye Smith, PRO, SAN

TRANSFER OF CONTRACT TO IDO

DGE/Brophy approved by phone 7/11/79 the transfer of State-coupled resource assessment contract DE-AC03-79ET27014 to IDO/Clay Nichols. This contract is with Washington State Department of Natural Resources, Division of Geology and Earth Resources; J. Eric Schuster Project Manager.

IDO/Roy Mink joined in a project review meeting last March and is acquainted with the technical aspects. Clay Nichols has agreed to accept this contract. WA/Schuster knows his contract will be transferred to IDO.

Please transfer the contract and files immediately.

Thomas F. Heenan
Director
Geothermal Energy Division

cc: Brophy, DGE
Nichols, IDO
Schuster, WA

GENERAL SERVICES ADMINISTRATION
FED PROC. REG. (41CFR) 1-16.101

AWARD/CONTRACT

File M.2 15

1. CONTRACT (Proc. Inst. Ident.) NO.
DE-AC03-79ET27014

2. EFFECTIVE DATE
[redacted]

3. REQUISITION/PURCHASE REQUEST/PROJECT NO.
03-79ET27014

4. CERTIFIED FOR NATIONAL DEFENSE UNDER BDSA REG. 2 AND/OR DMS REG. 1
RATING

5. ISSUED BY CODE

DEPARTMENT OF ENERGY
SAN FRANCISCO OPERATIONS OFFICE
1333 BROADWAY
OAKLAND, CA 94612

6. ADMINISTERED BY (If other than block 5) CODE ACN

EXECUTED COPY

7. DELIVERY
[X] FOB DESTINATION
[ ] OTHER (S below)

8. CONTRACTOR NAME AND ADDRESS CODE FACILITY CODE
(Street, city, county, State, and ZIP code)

Washington State
Department of Natural Resources
Olympia, WA 98504
ATTN: Eric Schuster

9. DISCOUNT FOR PROMPT PAYMENT

10. SUBMIT INVOICES (4 copies unless otherwise specified) TO ADDRESS SHOWN IN BLOCK 12

11. SHIP TO/MARK FOR CODE

12. PAYMENT WILL BE MADE BY CODE

FINANCE DIVISION
DOE/SAN
1333 BROADWAY
OAKLAND, CA 94612

13. THIS PROCUREMENT WAS [ ] ADVERTISED, [X] NEGOTIATED, PURSUANT TO: [ ] 10 U.S.C. 2304 (a)( ) [X] 41 U.S.C. 252 (c)(10)

14. ACCOUNTING AND APPROPRIATION DATA
B&R NO. AE-1001020 & 35-AE-10
ALLOTMENT NO. SF-90-91 and SF-91-40

15. ITEM NO.	16. SUPPLIES/SERVICES	17. QUANTITY	18. UNIT	19. UNIT PRICE	20. AMOUNT
	SEE ATTACHED SCHEDULE				
	DUNS Contractor Establishment No.: 079-248-936 Principal Place of Performance: Olympia, Washington	DOE Share -			$296,894
		Contractor Share -			$ 12,984
	THIS CONTRACT SUPERSEDES IN ITS ENTIRETY LETTER CONTRACT DE-AC03-79ET27014 DATED FEBRUARY 9, 1979				

21. TOTAL AMOUNT OF CONTRACT $ 309,878

CONTRACTING OFFICER WILL COMPLETE BLOCK 22 OR 26 AS APPLICABLE

22. [X] CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return 2 copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)

26. [ ] AWARD (Contractor is not required to sign this document.) Your offer on Solicitation Number ______ including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the items listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your offer, and (b) this award/contract. No further contractual document is necessary.

23. NAME OF CONTRACTOR DEPT. OF NATURAL RESOURCES

BY Paul E. Krauss
(Signature of person authorized to sign)

27. UNITED STATES OF AMERICA

BY Robert H. Ragan
(Signature of Contracting Officer)

24. NAME AND TITLE OF SIGNER (Type or print)
PAUL E. KRAUSS
DEPUTY SUPERVISOR

25. DATE SIGNED
APR. 23, 1979

28. NAME OF CONTRACTING OFFICER (Type or print)
Robert H. Ragan

29. DATE SIGNED
5/8/79

SCHEDULE

ARTICLE I SCOPE OF WORK

(a) The Contractor shall conduct a program titled, "Geothermal Assessment and Reservoir Definition in Washington," to accomplish the work set forth in:

Exhibit I - Statement of Work
Exhibit II - Reporting Requirements

Work completed, including the submittal of the reports required by Exhibit II in an acceptable manner, are used to measure progress under the contract and as a basis for the approval of payments. Failure to comply with the reporting requirements of Exhibit II may result in a delay in the payment of invoices until corrective action is taken.

(b) All work under this contract shall be performed under the general guidance and direction of the Technical Manager whose responsibilities are defined in ARTICLE IV. Such guidance and direction shall not, however, effect any change in the specification requirements or cost structure of this contract, increase its estimated cost, or extend the period of performance. Such changes shall be only by action of the Contracting Officer.

ARTICLE II PERIOD OF PERFORMANCE

The period of performance under this contract shall commence on November 1, 1978 and expire on October 31, 1979. The period of performance may be extended for additional periods by the written agreement of the parties.

ARTICLE III ESTIMATED COST AND COST SHARING

(a) The total estimated cost of the work under this contract is $309,878. Of this estimated cost, the Government will fund a maximum amount of $296,894.

(b) The Contractor and the Government have agreed to share the cost of all work performed in accordance with the provisions of this Contract in a ratio of 95.810 percent by the Government and 4.190 percent by the Contractor of all operating-funded costs determined to be allowable in accordance with the Clause of the General Provisions entitled "Allowable Cost and Payment." The Contractor will not share in the cost of the capital equipment. The Contractor shall be paid no fee for the work performed under this contract.

(c) The Contractor shall fund out of its own resources an estimated amount of $12,984 for its share of costs identified in paragraph (b) above. In the event that the actual cost of the work exceeds the amount of $309,878, it is agreed that the Contractor shall be under no further obligation to thereafter share costs of contract performance hereunder for its own account, and in no event shall Contractor be obligated to contribute an amount hereunder for its own account in excess of a total of $12,984.

(d) The total amount presently obligated by the Government under this contract is $296,894. Of these funds $248,235 are available for operating expenses and $48,659 for the purchase of capital equipment.

ARTICLE IV TECHNICAL DIRECTION AND SURVEILLANCE

(a) The work to be performed by the contractor under this contract is subject to the surveillance and written technical direction of a "Technical Manager" who shall be specifically appointed by the Contracting Officer in writing. Technical direction is defined as a directive to the contractor within the requirements of the Article hereof entitled "Scope of Work," which approves approaches, solutions, designs, or refinements; defines or otherwise completes the general description of work; and otherwise furnishes technical guidance to the contractor. The Technical Manager shall monitor the contractor's performance with respect to compliance with the requirements of the Scope of Work, schedule and cost. Technical direction includes the process of conducting inquiries or transmitting information or advice by the Technical Manager, regarding matters within the requirements of the Scope of Work. Technical direction and management surveillance shall not impose tasks or requirements upon the contractor additional to or different from the general tasks and requirements stated in the Article of this contract entitled "Scope of Work." The technical direction to be valid:

(1) Must be issued in writing consistent with the general scope of the work set forth in this contract;

(2) Shall not commit the Government to any adjustment of the estimated cost and fees or other contract provisions.

(b) In the event any Government technical direction is interpreted by the contractor to fall within the Clause of the General Provisions hereof, entitled "Changes" the contractor shall not implement such direction, but shall notify the Contracting Officer in writing of such interpretation within ten (10) days after the contractor's receipt of such direction. Such notice shall (i) include the reasons upon which the contractor bases its belief that the technical direction falls within the purview of the "Changes" clause; and (ii) include the contractor's best estimate as to revision in estimated cost, fee, performance time, delivery schedules and any other contractual provisions that would result from implementing the technical direction.

(1) If, after reviewing the information presented pursuant to paragraph (b) above, the Contracting Officer is of the opinion that such direction is within the purview of the "Changes" clause and he considers such change desirable, he will issue unilateral direction to proceed pursuant to the authority granted him under the clause. If he determines that such direction is technical direction authorized by this article, he will direct the contractor to proceed with the implementation of such technical direction.

(2) In the event the Contracting Officer determines that it is necessary to avoid a delay in performance of the contract he may, in writing, direct the contractor to proceed with the implementation of the technical direction pending receipt of the information to be submitted under paragraph (b) above. Should the Contracting Officer later determine that a direction under the "Changes" clause is appropriate, the written decision issued hereunder shall constitute the required direction.

(c) Failure of the Contractor and the Contracting Officer to agree on whether Government Direction is technical direction or a change within the purview of the "Changes" clause shall be a dispute concerning a question of fact within the meaning of the Clause of the General Provisions entitled "Disputes."

(d) The only persons authorized to give technical direction to the Contractor under this contract are the Contracting Officer and any "Technical Manager" who may be appointed by him as contemplated by paragraph (a) above. Any action taken by the Contractor in response to any direction given by any person other than the Contracting Officer or Technical Manager whom he may appoint shall be at the contractor's own risk.

ARTICLE V ORDER OF PRECEDENCE

In the event of inconsistency in this contract, the inconsistency shall be resolved by giving precedence in the following order: (A) Schedule, (B) Statement of Work, (C) General Provisions, (D) any other provisions of this contract, whether incorporated by reference or otherwise; and (E) the Contractor's technical proposal if incorporated in this contract by reference or otherwise.

ARTICLE VI GENERAL PROVISIONS

The Contractor shall comply with clauses which are set forth in General Provisions "DOE/SAN Cost-Type Contracts with Commercial Organizations dated March 1978" consisting of 45 pages which are a part of this contract. In accordance with the clause entitled "Subcontracts", any consent by the Contracting Officer to the placement of subcontracts shall not be construed to constitute approval of the subcontractor or any subcontract terms or conditions, determination of the allowability of any cost, revision of this contract or any of the respective obligations of the parties thereunder, or creation of any subcontractor privity of contract with the Government.

ARTICLE VII ALTERATIONS AND ADDITIONS

(a) Clause 2 "Limitation of Cost" is deleted in its entirety and the following new clause entitled, "Limitation of Cost (Cost-Sharing)" is added as follows:

"CLAUSE 2 LIMITATION OF COST (COST-SHARING)

(a) It is estimated that the cost of the Government for the performance of this contract will not exceed the estimated cost to the Government set forth in the Schedule, and the Contractor agrees to use his best efforts to perform the work specified in the Schedule and all obligations under this contract within such estimated cost to the Government plus the share of the cost of performance agreed to be borne by the Contractor, as set forth in the Schedule. If, at any time, the Contractor has reason to believe that the costs which he expects to be incurred in the performance of this contract in the next succeeding 60 days, when added to all costs previously incurred, will exceed 75 percent of the estimated total cost to the Government and to the

Contractor then set forth in the Schedule, or if, at any time, the Contractor has reason to believe that the total cost for the performance of the contract (exclusive of any fee) will be greater or substantially less than the then estimated total cost thereof, the Contractor shall notify the Contracting Officer in writing to that effect, giving his revised estimate of such total cost for the performance of this contract.

(b) Except as required by other provisions of this contract, specifically citing and stated to be an exception from this clause, the Government shall not be obligated to reimburse the Contractor for costs incurred in excess of the estimated cost to the Government set forth in the Schedule, and the Contractor shall not be obligated to continue performance under the contract (including actions under the Termination clause) or otherwise to incur costs in excess of the estimated total cost set forth in the Schedule, unless and until the Contracting Officer shall have notified the Contractor in writing that such estimated total cost has been increased and shall have specified in such notice a revised estimated total cost which shall thereupon constitute the estimated total cost of performance of this contract. The increase in such estimated total cost shall be allocated in accordance with the formula set forth in the Schedule governing such increases. No notice, communication, or representation in any other form or from any person other than the Contracting Officer shall affect the estimated cost to the Government of this contract. In the absence of the specified notice, the Government shall not be obligated to reimburse the Contractor for any costs in excess of the estimated cost to the Government set forth in the Schedule, whether those excess costs were incurred during the course of the contract or as a result of termination. When and to the extent that the estimated total cost set forth in the Schedule has been increased, any costs incurred by the Contractor in excess of the estimated total cost prior to such increase shall be allowable to the same extent and in the same percentage as if such costs had been incurred after the increase; unless the Contracting Officer issues a termination or other notice and directs that the increase is solely for the purpose of covering termination or other specified expenses.

(c) Change orders issued pursuant to the Changes clause of this Contract shall not be considered an authorization to the Contractor to exceed the estimated cost to the Government set forth in the Schedule in the absence of a statement in the change order, or other contract modification, increasing the estimated cost.

(d) In the event this contract is terminated or the estimated cost not increased, the Government and the Contractor shall negotiate an equitable distribution of all property produced or purchased under the contract based upon the share of costs incurred by each."

(b) Clause 3, "Allowable Cost, Fixed-Fee and Payment" is retitled "Allowable Cost and Payment" and the following changes thereto are made:

(1) Insert the following sentence in lieu of the second sentence of paragraph (c) of the clause:

"After payment of an amount equal to 80 percent of (the Government's share of) the total estimated cost of performance of this contract set forth in the Schedule, the Contracting Officer may withhold further payment on account of allowable cost until a reserve shall have been set aside in an amount which he considers necessary to protect the interests of the Government, but such reserve shall not exceed 5 percent of the Government's share of such total estimated cost or $50,000 whichever is less."

(2) In paragraph (e) delete the words "and any part of the fixed fee."

(3) In paragraph (a)(1)(i), delete Subpart 1-15.2 of the Federal Procurement Regulations (41 CFR 1-15.2), as supplemented or modified by DOEPR 9-15.2 (41 CFR 9-15.2), and replace with "Subpart 1-15.7 (41 CFR 1-15.7), as in effect on the date of this contract; and

(c) Clause 22, "Utilization of Labor Surplus Area Concerns" and Clause 49, "Labor Surplus Area Subcontracting Program" are deleted in their entirety and replaced with the following:

"CLAUSE 22 UTILIZATION OF LABOR SURPLUS AREA CONCERNS

(The following clause is applicable if this contract exceeds $10,000.)

(a) It is the policy of the Government to award contracts to labor surplus area concerns that agree to perform substantially in labor surplus areas, where this can be done consistent with the efficient performance of the contract and at prices no higher than are obtainable elsewhere. The Contractor agrees to use his best efforts to place his subcontracts in accordance with this policy.

(b) In complying with paragraph (a) of this clause and with paragraph (b) of the clause of this contract entitled "Utilization of Small Business Concerns," the Contractor in placing his subcontracts shall observe the following order of preference: (1) Small business concerns that are labor surplus area concerns, (2) other small business concerns, and (3) other labor surplus area concerns.

(c) (1) The term "labor surplus area" means a geographical area identified by the Department of Labor as an area of concentrated unemployment or underemployment or an area of labor surplus.

(2) The term "labor surplus area concern" means a concern that together with its first-tier subcontractors will perform substantially in labor surplus areas.

(3) The term "perform substantially in a labor surplus area" means that the costs incurred on account of manufacturing, production, or appropriate services in labor surplus areas exceed 50 percent of the contract price.

CLAUSE 49 LABOR SURPLUS AREA SUBCONTRACTING PROGRAM
(applicable if this contract exceeds $500,000)

(a) The Contractor agrees to establish and conduct a program which will encourage labor surplus area concerns to compete for subcontracts within their capabilities. In this connection, the Contractor shall --

(1) Designate a liaison officer who will (i) maintain liaison with duly authorized representatives of the Government on labor surplus area matters, (ii) supervise compliance with the Utilization of Concerns in Labor Surplus Areas clause, and (iii) administer the Contractor's "Labor Surplus Area Subcontracting Program";

(2) Provide adequate and timely consideration of the potentialities of labor surplus area concerns in all "make-or-buy" decisions;

(3) Assure that labor surplus area concerns will have an equitable opportunity to compete for subcontracts, particularly by arranging solicitations, time for the preparation of bids, quantities, specifications, and delivery schedules so as to facilitate the participation of labor surplus area concerns;

(4) Maintain records showing the procedures which have been adopted to comply with the policies set forth in this clause and report subcontract awards (see 41 CFR 1-16.804-5 regarding use of Optional Form 61). Records maintained pursuant to this clause will be kept available for review by the Government until the expiration of 1 year after the award of this contract, or for such longer period as may be required by any other clause of this contracts or by applicable law or regulations; and

(5) Include the Utilization of Labor Surplus Area Concerns clause in subcontracts which offer substantial labor surplus area subcontracting opportunities.

(b) (1) The term "labor surplus area" means a geographical area identified by the Department of Labor as an area of concentrated unemployment or underemployment or an area of labor surplus.

(2) The term "concern located in a labor surplus area" means a labor surplus area concern.

(3) The term "labor surplus area concern" means a concern that, together with its first-tier subcontractors, will perform substantially in labor surplus areas.

(4) The term "perform substantially in labor surplus areas" means that the costs incurred on account of manufacturing, production, or appropriate services in labor surplus areas exceed 50 percent of the contract price.

(c) The Contractor further agrees to insert, in any subcontract hereunder which may exceed $500,000 and which contains the Utilization of Labor Surplus Area Concerns clause, provisions which shall conform substantially to the language of this clause, including this paragraph (c), and to notify the Contracting Officer of the names of such subcontractors."

(d) Clause 46 "Cost Accounting Standards" and Clause 47 "Administration of Cost Accounting Standards" are deleted in their entirety.

(e) Paragraphs (g) and (h) of Clause 37, "Rights In Technical Data," are not applicable unless the Contractor is withholding proprietary data under paragraph (e) of that clause.

(f) Clause 55, "Date of Incurrence of Costs" is hereby added:

"CLAUSE 55 DATE OF INCURRENCE OF COSTS

The Contractor shall be entitled to reimbursement for costs incurred in an amount not to exceed $100,000 on or after November 1, 1978 which, if incurred after this contract had been entered into, would have been reimbursable under the provisions of this contract."

STATEMENT OF WORK

1. General Scope (Objective)

The State of Washington will investigate geothermal reservoirs in the State, as a continuation of the Washington State Coop Project. The objective of this investigation is to characterize the geothermal reservoirs in the State of Washington. This information is necessary to develop specific geothermal reservoirs for direct use of the heat energy.

The Washington Division of Geology and Earth Resources has been involved in the assessment of the state's geothermal resources since 1971 when the First Northwest Conference on Geothermal Power was held in Olympia. From the beginning the goal has been to assess the geothermal potential of the State of Washington. Progress toward achieving this goal has been made by engaging in projects that: 1) provide baseline geologic, geophysical, and geochemical data that can be utilized by industry to cut exploration lead time and speed its assessment of Washington's geothermal resources; and 2) assess the geothermal potential of specific geographic areas where the possible occurrence of geothermal energy is recognized but where industry either shows no strong interest or is prevented from conducting exploration by legal and institutional barriers. The geothermal resource assessment results of the contract will supply information to the U.S Geological Survey for its continuing national assessment. The reservoir definition results will provide the State and DOE planning groups with the resource information necessary for future geothermal development in Washington.

2. Specific Contractor Tasks

   A. Establish a Geothermal Data Bank.

      Acquire, evaluate, and compile all geologic, hydrologic, geophysical, and geochemical information that pertains to the assessment of Washington's geothermal resources. The resulting data bank will be maintained as part of the Division library and, as such, it will be available for reference by anyone interested in Washington's geothermal resources. Evaluate the applicability of existing data to geothermal resource assessment, and transmit these evaluations on to users in the form of annotated bibliographies. Incorporate data compilations whenever possible in order to avoid unnecessary duplication of effort.

   B. Provide Technical Advice to the State Interagency Geothermal Council.

      An Interagency Geothermal Council has been formed for the purposes of encouraging the timely assessment and development of Washington's geothermal resources. Provide technical assistance to the Council regarding the assessment of geothermal resources.

C. Conduct Geothermal Resource Assessment Projects.

Conduct and manage assessment-oriented field operations as soon as projects are selected and subcontracted. The selection of projects to be subcontracted will be done with the advice and cooperation of USGS, USDOE, and university personnel. Projects to be subcontracted will include heat flow, temperature gradient, and possibly magnetotelluric and telluric, resistivity, and gravity studies. When analytical facilities or outside geochemical analyses are available, begin a comprehensive thermal and mineral spring inventory, sampling, and source-temperature estimating project. It is estimated that 3 to 4 years will be required to complete the initial inventory, with results reported each year to provide information to users in a timely manner. Following the initial inventory, a follow-up project will involve resampling important springs at different times of the year in an effort to evaluate mixing effects of spring waters with near-surface and ground waters to try and determine if there is a significant "masking effect" caused by high precipitation.

D. Planning

The full assessment of Washington's geothermal resources will be a multi-year project involving federal, state, corporate, university, and probably local agencies. The Division of Geology and Earth Resources will develop plans that will draw together and wisely apply the talents of all individuals and agencies that are involved in geothermal resource assessment in Washington. These planning and assessment activities will be carried out in full cooperation with the USGS, USDOE, and the university investigators and the State Interagency Geothermal Council.

3. Deliverable Items

By the end of FY 79, the Division of Geology and Earth Resources will prepare and open-file the following reports:

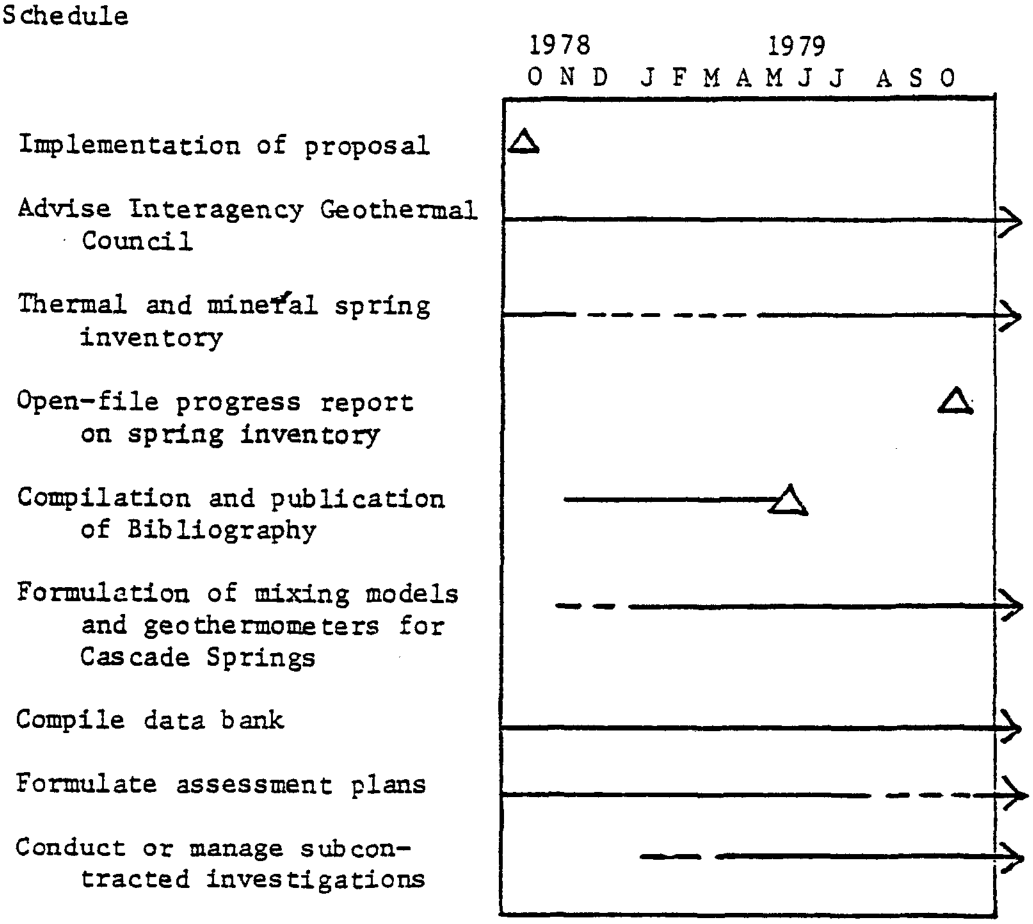
A. A progress report on the inventory of thermal and mineral springs in Washington. After the first year's investigations, 25 to 33 percent of the state's thermal and mineral springs is expected to have been sampled.

B. Selected annotated bibliography of geological, geophysical, hydrological, and geochemical reports that pertain to the assessment of geothermal resources in

Washington.

C. Five-year plan for the assessment of geothermal resources in Washington. This plan will include detailed reviews of future requirements for geologic mapping, lineament mapping, geochemistry, collection of hydrologic data, and geophysics including but not limited to heat-flow measurements, magnetotelluric and telluric measurements, and resistivity measurements.

4. Schedule



U. S. DEPARTMENT OF ENERG .

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-537
(1-78)

(See Instructions on Reverse)

FORM APPRO
OMB NO. 38R-0

1. IDENTIFICATION 03-79-ET-27014.000 Geo. Assess. & Reservoir Def. in Washington.	2. OBLIGATION INSTRUMENT: AE-1001020 35-AE-10 89X0201.91

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequen
1. ☒ Management Plan	O	1. ☒ Notice of Energy RD&D Project (SSIE)	O
2. ☒ Milestone Schedule & Status Report	OQ	2. ☒ Technical Progress Report	Q
3. ☒ Cost Plan	OY	3. ☒ Topical Report	A
4. ☐ Manpower Plan		4. ☒ Final Technical Report	F
5. ☒ Contract Management Summary Report	M	C. PMS/MINI-PMS	
6. ☒ Project Status Report	M	1. Cost Performance Report	
7. ☒ Cost Management Report Short Form	M	☐ Format 1 WBS	
8. ☐ Manpower Management Report		☐ Format 2 Functional	
9. ☒ Conference Record	A	☐ Format 3 Baseline	
10. ☒ Hot Line Report	A	☐ Format 5 Problem Analysis	
		2. ☐ Cost/Schedule Status Report	
		3. ☐ Management Control System Description	
		4. ☐ Summary System Description	
		5. ☐ WBS Dictionary	

FREQUENCY CODES:
A – As Required
C – Contract Change
F – Final (End of Contract)
M – Monthly
O – One Time (Soon After Contract Award)
Q – Quarterly
S – Semi-Annually
X – Mandatory for Delivery with Proposals/Bid
Y – Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

5. ATTACHED HEREWITH:

☐ Report Distribution List ☐
☐ WBS/Reporting Category ☐

6. PREPARED BY (Signature and date): [illegible]	7. REVIEWED BY (Signature and date): [illegible]

CONTRACT NO. 03-79-ET-27014.000

Geothermal Assessment and Reservoir Definition in Washington.

Addressees	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Instr[illegible]
Marshall Reed Program Manager **DGE/ Mail Stop 3122-C** DOE/HQ 20 Massachusetts Ave,NW Washington, D.C. 20545	1	1	1		1	1	1		1	1		1	1	5						
Dr. Martin W. Molloy Project Manager GED/SAN 1333 Broadway Oakland, CA 94612	1	1	1		1	1	1		1	1		1	1	10						
Finance Division/SAN							1													
Plans & Budget Division/SAN			1		1															
Procurement Division/SAN									1	1				1						
Office of Patent Counsel/SAN														1						
DOE Technical Information Center (TIC) P. O. Box 62 Oak Ridge, Tennessee 37830														1						Reproducibl[illegible] Master
Mr. S. M. Hansen, Chief MIS & Control Branch DOE/Div. of Program Res. Mgmt. 600 E Street, NW Washington, DC 20545					1							1								
David Williams, USGS **Denver Federal Center** **Denver, CO 80225**	1	1	1		1	1			1	1		1	1	1						
James Swanson/C. Bacon **USGS 345 Middlefield Rd.** **Palo Alto, CA 94025**	1	1	1		1	1			1	1		1	1	1						
Clay Nichols, IDO/DOE **550 2nd St.** **Idaho Falls, ID 83401**	1	1	1		1	1			1	1		1	1	1						

Robert M. Tomihiro, PRO, SAN

REQUEST FOR LETTER CONTRACT: STATE OF WASHINGTON, PR 03-79-ET-27014.000

As you are aware, there is an immediate need for contract coverage of the financial assistance for State-Coop Geothermal Resource Assessment of Washington State. For the reasons below, I urge you to prepare a letter contract for an approximately 120-day period effective November 1, 1978. The estimated costs (B/O) for this period are $65,000, consisting of $30K salaries and benefits, and $35K equipment. Total financial assistance for the contract year is $300,000, including $250K operating and $50K equipment.

A letter contract is requested by the Washington Department of Natural Resources for two reasons:

1) to pay salaries of State personnel, including a geochemist, who may be unique to this DOE project and not needed elsewhere in the Department. Washington has stated that if federal funds are not available by Jan. 15, these personnel must be laid off. Such a layoff would be an extreme blow to this resource assessment project, and to future working relationships with the State.

2) To order long lead-time equipment, including an atomic absorption spectrophotometer ($47.5K), required for analysis of thermal spring waters to estimate source temperature, critical information for performance of this project.

I fully endorse the State's request and the need for an immediate letter contract. I have been assured by Marshall Reed that no barriers to successful negotiation are forseen by DOE/HQ.

Dr. Martin W. Molloy
Technical Monitor
Geothermal Energy Division

cc: M. Reed, DOE/HQ

GED

Molloy:cp

1/ /79

Xc WSK
JWU
J3
File M 215
Note reporting requirements on last page!
J

Action - KKL
xc - D-EO
RF
11/3

Department of Energy
Richland Operations Office
P. O. Box 550
Richland, Washington 99352

NOV 1 1977

11/9/77 xc: NE Carter
AJ Haverfield
RP Marshall

Director
Battelle Memorial Institute
Pacific Northwest Laboratory
Richland, Washington

Dear Sir:

CONTRACT EY-76-C-06-1830 PROGRAM AUTHORIZATION - DIVISION OF GEOTHERMAL ENERGY

Pending receipt of an approved financial plan change, you are authorized FY 1978 operating funds of $875,000 and capital equipment funds of $165,000 for the programs described in the enclosed memorandums to A. G. Fremling from James C. Bresee, dated October 14, 1977.

These funds will be included in your next obligation letter and financial plan under the referenced budget categories.

Very truly yours,

Jack C. Cummings

Jack C. Cummings, Director
Contracts Division

CD:SSS

Enclosures:
2 memos Bresee/Fremling dtd
10/14/77

RECEIVED
NOV 10 1977
A J. HAVERFIELD

RECEIVED
NOV 04 1977
D. E. OLESEN

RECEIVED
NOV 3 - 1977
T. W. AMBROSE

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

V-B

JFB/File
(CWG)
(CCY)

OCT 14 1977

A. G. Fremling ,Manager

Richland Operations Office

FY 1978 CAPITAL EQUIPMENT PROGRAM LETTER NUMBER 1
Pacific Northwest LABORATORY/FIELD OFFICE

The next financial plan will contain a total of $ 165,000 in B/A and $165,000 in B/O for Pacific Northwest Laboratory.

The table attached to this letter (Attachment I) summarizes this pending change. You are authorized to proceed with the Geothermal program at Pacific Northwest Laboratory within the FY 1978 budget authority and cost ceiling allocations indicated in the "revised letter" column of the attached table. Please provide program guidance to the contractor in accordance with the details in Attachment 2 to this letter.

Rudolph A. Black
for James C. Bresee, Director
Division of Geothermal Energy

Enclosure:
As stated

cc: Chief, Budget Office

Attachment I to AE Operating Expenses Program Letter Number 1

(Dollars in Thousands)

	(A) Previous Letter B/A	(A) Previous Letter B/O	(B) Change B/A	(B) Change B/O	(C) Revised Letter B/A	(C) Revised Letter B/O
B&R Classifications						
35 AE 01 Engineering Research and Development					$ 165	$ 165

Attachment II to AE Capital Equipment Program Letter Number 1

(Dollars in Thousands)

Pacific Northwest Laboratory

B&R Classification	Program Guidance	FY 1978 B/A	FY 1978 B/O
AE 01 Engineering Research and Development			
		$ 65	$ 65
	Replacement autoclaves and auxiliary equipment		
		$ 100	$ 100
	Analytical equipment and downhole probe instrumentation.		

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

JT/File
(cc)
(ccx)

OCT 14 1977

X-A-3

A. G. Fremling ,Manager

Richland Operations Office

FY 1978 OPERATING EXPENSES PROGRAM LETTER NUMBER 1
Pacific Northwest LABORATORY/FIELD OFFICE

The next financial plan will contain a total of \$ 875,000 in B/A and \$ 875,000 in B/O for Pacific Northwest Laboratory. The table attached to this letter (Attachment I) summarizes this pending change. You are authorized to proceed with the Geothermal program at Pacific Northwest Laboratory within the FY 1978 budget authority and cost ceiling allocations indicated in the "revised letter" column of the attached table. Please provide program guidance to the contractor in accordance with the details in Attachment 2 to this letter. Reporting requirements are identified in Attachment 3 to this letter.

Rudolph A. Black
for James C. Bresee, Director
Division of Geothermal Energy

Enclosure:
As stated

cc: Chief, Budget Office

Attachment I to AE Operating Expenses Program Letter Number 1

(Dollars in Thousands)

B&R Classifications	(A) Previous Letter B/A	(A) Previous Letter B/O	(B) Change B/A	(B) Change B/O	(C) Revised Letter B/A	(C) Revised Letter B/O
AE 01 Engineering Research and Development						
AE 01 02 01 Geochemical Engineering					$ 625	$ 625
AE 02 Resource Exploration and Assessment						
AE 02 02 Reservoir Assessment					100	100
AE 06 Environmental Control and Institutional Studies						
AE 06 02 Economic, Policy, and Planning Analysis					150	150
Total AE					$ 875	$ 875

Attachment II to AE Operating Expenses Program Letter Number 1

(Dollars in Thousands)

Pacific Northwest Laboratory

B&R Classification		Program Guidance	FY 1978 B/A	FY 1978 B/O
AE 01 02 01	Geochemical Engineering		$ 275	$ 275

Program Manager

Keeber

Investigate Geothermal Corrosion - Study of Factors Limiting the Use of Iron Base Alloys vs. Alternate Materials in Mildly Acidic Geothermal Waters and Steam

The objective of this initiative is to determine why geothermal brines are so corrosive to economical iron-base alloys. The major goal of this activity is to identify corrosion factors which influence the selection of materials for geothermal plants. Another goal is the establishment of a relationship between a set of brine composition and temperature ranges and the associated corrosion rates for carbon steels. This information is to be utilized for selecting iron alloys or alternate metals for geothermal systems and for identifying protective measures.

Develop Standard Methods and Manual for Sampling and Analysis of Geothermal Fluids and Gases — $ 200 — $ 200

Keeber

The objective of this initiative is to develop standard methods and publish a manual for sampling and analyses of geothermal fluids and gases in order to assure accuracy, reliability, and intercomparability of reported results. The major goal is to assist the developing geothermal industry in meeting its analytical needs by reducing the analytical methods research required by individual organizations.

Development of Probes for Down Hole and In-Line Chemical Analysis of High Pressure, High Temperature Geothermal Fluids — $ 150 — $ 150

The main objective of this initiative is to develop electrical and electrochemical probes that can measure the chemical environment of geothermal water and steam under the high temperature conditions in a geothermal well, and associated piping. A major goal is to design probes for measuring ph, oxidation-reduction potential, conductivity, corrosivity, and some specific ion concentrations so that the data obtained may be used for controlling

Attachment II cont'd

B&R Classification	Program Guidance	FY 1978 B/A	FY 1978 B/O

AE 01 02 01 cont'd

corrosion, scaling and pollution in both newly explored, and established geothermal fluids as well as the associated generating equipment. A RFP will be issued for a ph glass probe.

AE 02 02	Reservoir Assessment	$ 100	$ 100

Washington State

Program Manager
.. Nichols

PNL will assist in the cooperative low temeprature survey with the State of Washington. Participation will include the reconnaisance assessment of the states'geothermal potential from existing information and the planning of joint state - PNL-USGS future field programs.

AE 06 02	Economic Policy and Planning Analysis	$ 150	$ 150

. Mansour

PNL's main effort for FY 1978 is to develop short run and long run supply schedules for geothermal energy. For the short run supply schedules , some of the existing supply curves will be re-examined in light of newly available information and updated accordingly. For the long-run supply schedules, PNL will have to examine all DGE programs and assess their impacts on the cost of geothermal energy prior to developing the schedules.

FORM ERDA 537
(/77)

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

REPORTING REQUIREMENTS CHECKLIST

(See Instructions on Reverse)

1. IDENTIFICATION	2. OBLIGATION INSTRUMENT:
National Laboratory Geothermal Projects	Lab Contract No.

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	A. PROJECT MANAGEMENT (CONT.)	Freque
a. ☒ Management Plan or LPAD	Y	k. ☒ Conference Record	A
b. ☒ Milestone Plan and Management Report	Y,M,C	l. ☒ Hot Line Report	A
c. ☒ Cost Plan	Y,C	m. ☐ PMS (Earned Value)	
d. ☒ Manpower Plan	Y,C	B. TECHNICAL INFORMATION REPORTING	
e. ☒ Contract Management Summary Report	M	a. ☐ Energy RD&D Work – In Progress (SSIE)	
f. ☒ Major Milestone Status Plot	M	b. ☒ Technical Progress Report	Q,Y
g. ☒ Technical Status Report	M	c. ☒ Topical Report	A
h. ☒ Cost Management Report	M	d. ☐ Final Technical Report	
i. ☒ Manpower Management Report	M,C	C. OTHER	
j. ☒ Funds Reconciliation Report	C	a. ☐ Travel Plan	

FREQUENCY CODES:
A – As Required
C – Contract Change
F – Final (End of Contract)
M – Monthly
O – One Time (Soon After Contract Award)
Q – Quarterly
S – Semi-Annually
X – Mandatory for Delivery with Proposals/Bid
Y – Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS:

The management plans or LPAD's should be detailed by tasks and/or subtasks under each ERDA Budget Subprogram Activity (i.e., AE 03 01, AE 03 02, etc.). Each task and/or subtask shall have specific objectives, descriptions of the effort, deliverables, schedules with specific milestones and budgets. The milestone plan, cost plan, manpower plan, and corresponding monthly, quarterly and yearly reports should be consistent with this work breakdown structure. Report's formats should be per ERDA Uniform Contractor Reporting Guidelines, ERHQ-0010.

A minimum of four copies of all reports should be sent to the appropriate DGE Program Manager for his approval or information. All correspondence on any Subprogram activity should be addressed to the appropriate DGE Program Manager responsible for that activity.

5. ATTACHED HEREWITH:

☐ Report Distribution List SEE SPECIAL INSTRUCTIONS ☐
☐ ☐

6. PREPARED BY (Signature and date):	7. REVIEWED BY (Signature and date):
James C. Bresee 10/14/77	

MARCH '82

Regional Gravity Survey of the Washington Cascades--A Progress Report

by

Z.F. Danes

University of Puget Sound

A regional gravity survey of the Washington Cascade Mountain range has been undertaken in order to delineate regional geological structures of possible relevance to the geothermal resources of the area. While gravity data alone cannot reveal geothermal systems, the technique, when coupled with bedrock geology and water geochemistry, can reveal target areas which can be explored with other more site specific and expensive ~~techniques~~ methods.

A regional gravity survey of the ~~ext~~ southern Cascades has been completed (Danes, 1981). Work in 1981-82 has concentrated on extending gravity coverage north of about 46°30'. Figure 1 shows field coverage to date (March, 1982). Coverage obtained in 1981-82 is indicated by blacked-out areas. and can be detailed as follows:

New regional stations inside survey area	450
New regional stations outside survey area	8
New detailed stations inside survey area	157
New detailed stations outside survey area	273
NEW STATIONS TOTAL	888

Note: New stations outside the survey area were obtained from students or others.

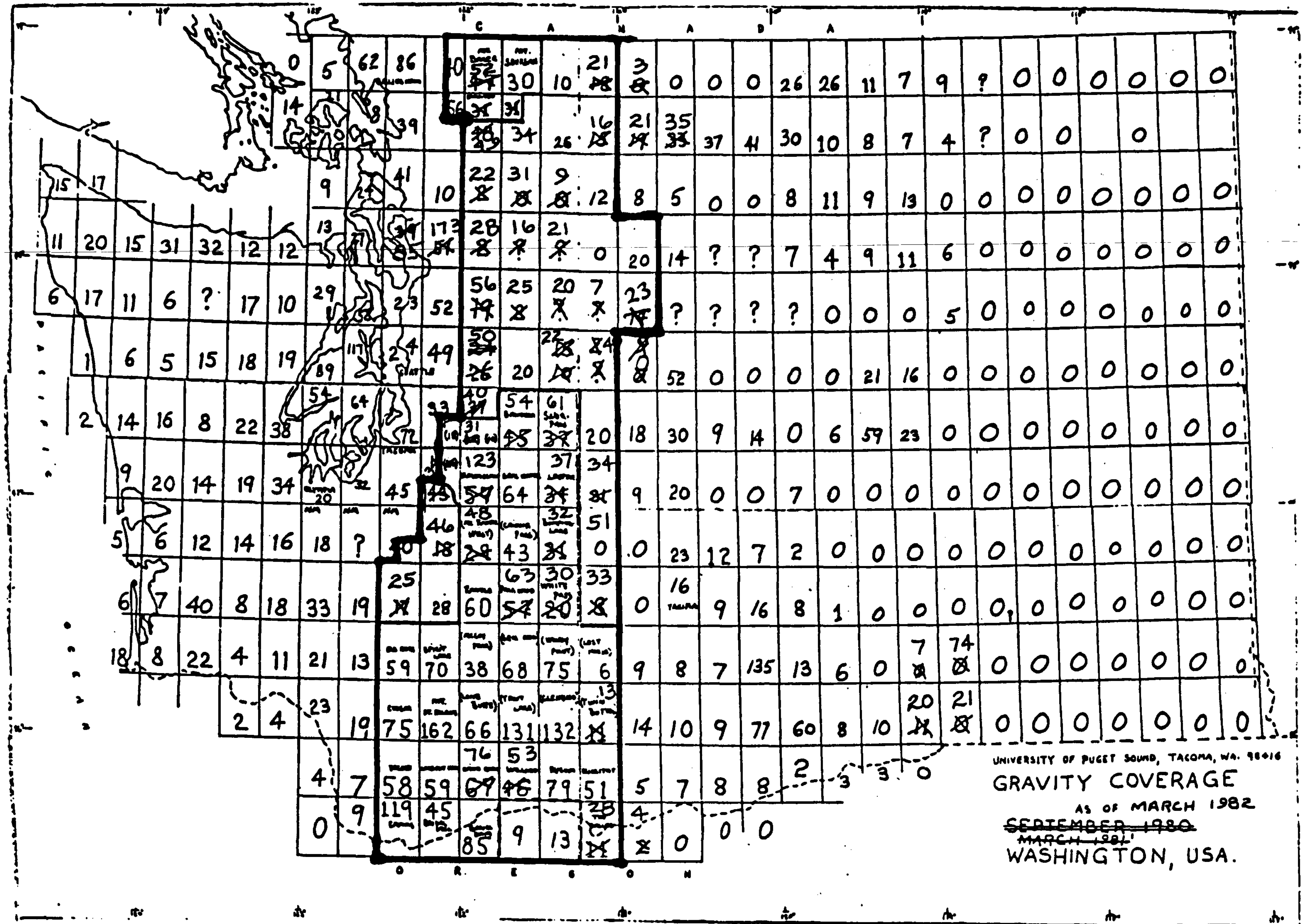
A total of 6882 gravity stations in Washington State are now contained within our data base, of which 3405 are in the Cascades survey area specified on the coverage map.

Stations in map districts south of 47° latitude are currently being processed for terrain corrections using digital elevation files supplied by the U.S.G.S.. ~~The near terrain correction is done by hand using Hammer's "D" zone, or a radius~~

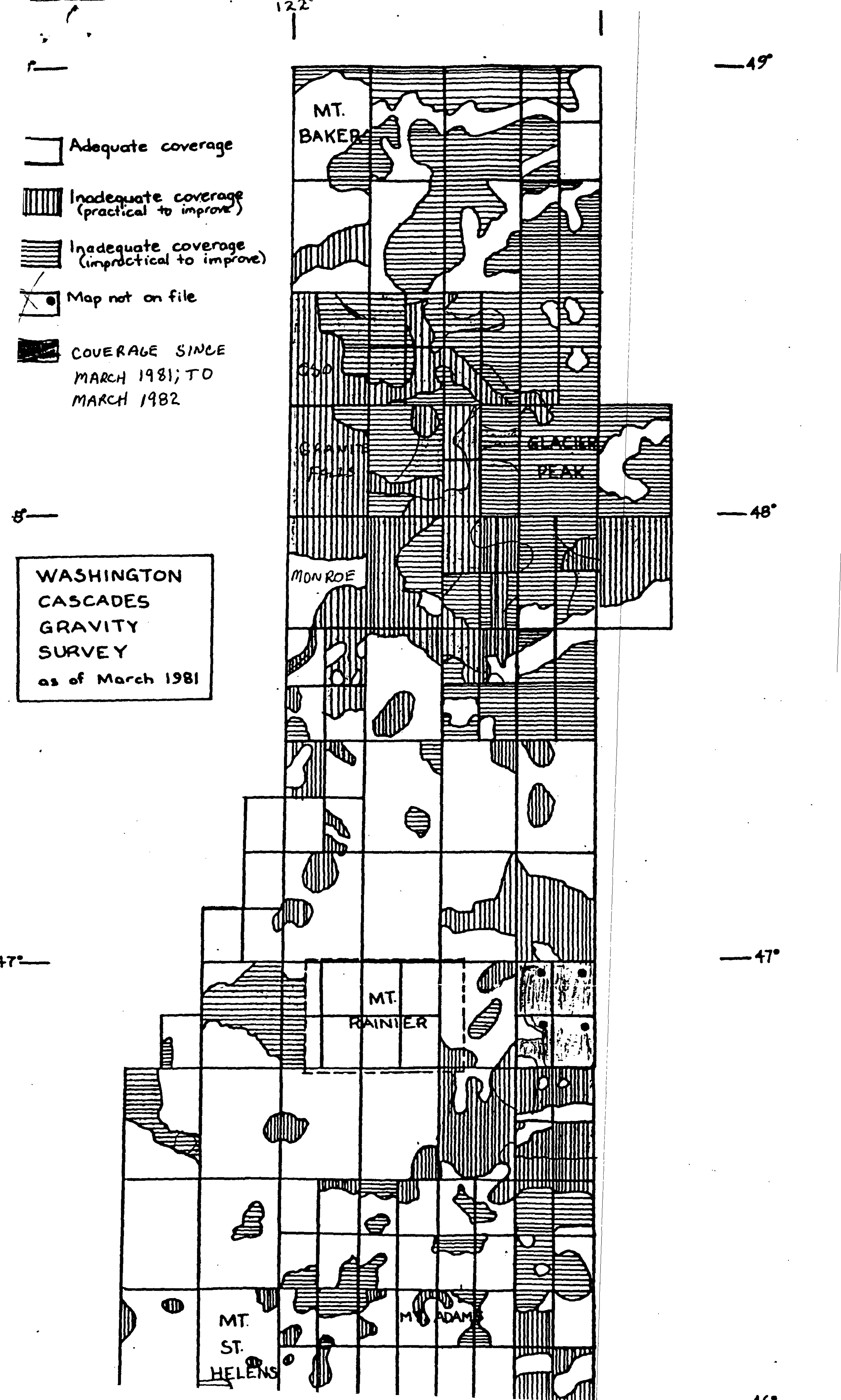
For each station, the effect of terrain is computed for blocks 4 degress latitude by 4 degrees longitude. Canadian digitized terrain files are required for complete evaluation of stations north of 47° latitude. It is hoped that the Canadian files will be available before May 1982.

At this time 1424 stations have been terrain corrected and about half that number have been plotted an contoured. Providing no unforseen difficulties are encountered, all stations north of 47° N. will have been corrected, posted and contoured (at a scale of 1:62500) by June 30, 1982.

82M



607 new stations in survey area acquired in 1981 } 3405 TOTAL (SURVEY AREA)


122°
49°
48°
47°
Adequate coverage
Inadequate coverage (practical to improve)
Inadequate coverage (impractical to improve)
Map not on file
COVERAGE SINCE MARCH 1981; TO MARCH 1982
WASHINGTON CASCADES GRAVITY SURVEY as of March 1981
MT. BAKER
MONROE
GLACIER PEAK
MT. RAINIER
MT. ST. HELENS
MT. ADAMS

Proposed Washington State

Geothermal Resource Assessment Program

for

August 1, 1981, to July 31, 1982

by

Washington State Department of

Natural Resources,

Division of Geology and Earth Resources,

Olympia, WA [illegible]

April 24, 1981

A proposed modification of U.S. Department of Energy Contract No. DE-AC07-7[illegible]ET27014

to

U.S. Department of Energy

Division of Geothermal Energy

[illegible]

TABLE OF CONTENTS

Page

Figures

Tables

SUMMARY

Work proposed herein runs from August 1, 1981 to July 31, 1982, with a total U.S. Department of Energy cost of $299,954 and a State of Washington contribution of $13,000.

Management of this work will be carried out by Washington Division of Geology and Earth Resources personnel including one assistant state geologist, two geologists, and one secretary. The geologists will also pursue technical objectives. Several subcontracts are proposed as follows:

1. Southern Methodist University; Dr. David D. Blackwell, principal investigator; temperature gradient—heat flow subcontract; $93,746. This subcontract will allow for collection of new subsurface temperature data in the Columbia Basin of southeastern Washington, processing of these data and existing data, and presentation of the results in a series of maps and tables with explanatory text. This work will be funded directly by USDOE, Idaho Falls.

2. Danes Research Associates; Dr. Z. F. Danes, principal investigator; Cascade Range-regional gravity subcontract; $25,700. The objective is to complete the Cascade Range regional gravity map with an average gravity station density of one station per five square miles. This is the third year of a three year program.

3. Washington State University; Professor James Crosby, principal investigator; John Biggane, investigator; Yakima Area Geothermal Investigations; $11,481. The objective is to collect both new and existing data on subsurface temperatures, hydrology, and geology of the Yakima area, and interpret these data sets to form a practical and technical guide to geothermal exploration and development. This is the second year of a two year program.

4. Portland State University; Dr. Paul E. Hammond, principal investigator; Wind River Geology; $22,003. The objective is to collect and interpret geologic data, age dates, and rock geochemistry as they pertain to the geothermal potential of the Wind River area, as well as contributing further information toward a space-time-composition model for South Cascade volcanism being formulated by Dr. Hammond. This is a project of one year duration.

In addition, the geothermal staff of the Division of Geology and Earth Resources proposes to pursue sampling and analysis of thermal and mineral springs, "closeout" collection, organization, and dissemination of several statewide geothermal-related geologic, geochemical, and geophysical data sets, and cooperative execution of a Mount St. Helens shot-hole seismic program with the University of Washington. Costs are as follows: Division of Geology and Earth Resources, $88,884; Mount St. Helens seismic investigations, $30,220; administrative overhead (charged at the rate of 15.66 percent of total costs except for the $93,746 Southern Methodist University subcontract), $27,920.

Priority - 1

Justification

During the past year and one-half a considerable amount of data has been accumulated regarding the occurrence of geothermal energy in the State of Washington. These data have been gathered from many sources, including our own in-house investigations, and they were compiled, in part, for the purpose of generating a "public" geothermal resources map for publication by the National Oceanic and Atmospheric Administration (NOAA). Types of data gathered include down-hole temperature data, geothermal lease applications in the Cascade Range (gathered by Washington State Energy Office), thermal and mineral spring data, gravity data, geologic data, distribution of young volcanic rocks, heat-flow data, faults and lineaments, seismic data, and aeromagnetic data. Although most of these data sets are still preliminary and incomplete, we have found that they, taken together, greatly expand our understanding of geothermal energy in this state.

Because the USDOE - sponsored resource assessment program is apparently in its final year, we propose to spend as much time as possible assembling, augmenting, and interpreting the above data sets and preparing them for rapid and convenient use by public and private geothermal investigators, explorationists, and developers.

Plan and Schedule

Work toward the objectives listed below will continue throughout the contract period, with preparation of data for distribution and/or open filing at intervals.

The objectives for the three geothermal employees of the Division of Geology and Earth Resources are as follows:

Geologist III:

A. Spring sampling

yes
1. Sample and analyze additional known thermal springs.
2. Search for rumored thermal springs.
3. Monitor springs in the Mount St. Helens area. [2 or 3 per year] T. [illegible]

lower priority define limits
4. Sample and analyze additional known mineral springs. ([illegible])
5. Search for rumored mineral springs. | Higher H. Flow terrane.
6. Interpret and report on geology, geochemistry, and recommendations for further work and/or development of the springs.

report by spring system - then unify by map & overall explanation.

B. Obtain and report on soil mercury determinations near selected thermal springs and near Mount St. Helens. 1-2 traverses- if positive, more work. breakdown ?

C. Assist with subcontract administration and directing the activities of the geothermal staff.

Geologist II:

A. Augment, interpret, and prepare for distribution data sets pertinent to assessment and exploration for geothermal energy in Washington. These data sets may include some or all of the following: geology, gravity, faults and lineaments, rock and water geochemistry, temperature gradients and heat flow, geothermal leasing, seismicity, and aeromagnetics. Assist in preparation of a state "scientific" geothermal map(s) if one is to be published by NOAA, transmit appropriate data to GEOTHERM, and prepare material for public dissemination.

B. Assist with field monitoring of subcontracts.

C. Temperature-gradient logging, mercury field measurements, assisting Geologist III in field, and other duties as required.

Clerk Typist II:

A. Assist geologists with the assembly, cataloging, and preparation for publication or other dissemination of geothermal data and reports.

B. Assist with correspondence and contract-related accounting and reporting.

Products

Year-end report detailing all findings during the contract period; open-file and/or published reports as appropriate; and material for a state "scientific" geothermal resource map if one is to be published by NOAA.

Budget

Salaries: 8/1/81 to 7/31/82		
Geologist III; @ $2029/mo.	$24,348	
Geologist II; @ $1839/mo.	$22,068	
Clerk-Typist II; @ $834/mo.	$10,008	
		$56,424
Benefits: 20 percent of salaries		$11,285

Travel:		
Per Diem: 125 days @ $35/day	$ 4,375	
Mileage: 8,000 mi. @ .20/mi.	$ 1,600	
Air Travel: to USDOE project mtgs.	$ 1,200	$ 7,175
Equipment, Supplies, and Services:		
Laboratory supplies	$ 4,000	
Reproduction and publication	$10,000	$14,000
Overhead:		
15.66 percent on Division of Geology and Earth Resources activities and subcontracts administered by DGER		$27,920
	TOTAL	$116,804.00

List what minimum guaranteed products and hoped for products (detailed) will result. Report, maps, forms it will take, etc.

Integration of all data/interpretations into a final report. Be most specific.

TEMPERATURE GRADIENT - HEAT FLOW SUBCONTRACT(?)

will be a contract out of DOE.

150-200 new holes

data will get to JES for final report.

Priority - 1

Justification

Temperature gradient data, collected over a period of about ten years by several organizations, are available for several hundred wells in the Columbia Basin, an agricultural area covering more than 20,000 square miles in south-eastern Washington. Density of temperature-gradient data points is better than for any other area of the state, but is still no better than one measured well, on the average, per twenty-five square miles.

The Columbia Basin is now known to contain widespread low-temperature (70°-100°F) geothermal resources at shallow depth (less than 2,000-3,000 feet). The anomalous areas are not well-defined as yet, nor are the limits of the broad region where anomalies might be found well known. Because there are many potential users of low temperature geothermal resources in the Columbia Basin, because this is the part of our state where geothermal resources can be put to use earliest, because knowledge of the resource is still inadequate to allow for planned development or modeling, and because we are faced with a phase-out of federal assessment programs after FY 81, we plan to place major emphasis on the collection and interpretation of downhole temperature data in the Columbia Basin. Without further funding beyond FY 81, whatever progress we make toward assessment of low temperature resources in this area will probably have to stand as the definitive data base for a number of years. We want to make sure that this data base is as good as we can make it in the year or so that is left in the assessment program.

Plan and Schedule

The work will be subcontracted to the Geophysics Laboratory at Southern Methodist University (D.D. Blackwell). The work will consist of well logging by two or three field workers between June 1 and October 31, 1981; with [illegible] interpretation, maintenance, management, and clerical support as needed between June 1, 1981 and May 31, 1982.

Eighty to ninety percent of the field work will be in the Columbia Basin and should result in the temperature logging of about 130 wells. The objectives will be to:

1. Determine the boundaries of the Columbia Basin anomalous area, especially in the northwest (Wenatchee-Quincy-Waterville area) and northeast (Spokane-Reardan-Davenport area) parts of the Basin, and
2. Define the resource with considerably closer well spacing in the Walla Walla and Moses Lake areas, as well as in other areas that will be selected as the study progresses.

<u>Products</u> : Be sure to check against [illegible]well proposal.

Products to be delivered by the subcontractor by May 31, 1982 include the following:

1. Depth to isotherm maps
   A. sketch map of entire state at 1:2,000,000
   B. Columbia Basin at 1:500,000
   C. more detailed maps in anomalous areas, such as Moses Lake, Walla Walla, [illegible] or Yakima, at scales of 1:250,000 or 1:100,000 as data quantity [illegible] permit.

NOTE: These maps might be formulated as depth-to-isotherm maps (probably [illegible] to 20°C and/or 30°C) and/or temperature-at-fixed-depth maps (such as [illegible] temperature at a depth of 1 kilometer).

2. Mean surface temperature maps for the areas listed under 1 a, b, and [illegible] as data quantity and quality permit.
3. Heat flow and gradient maps for the entire state at 1:1,000,000.
4. Tabulated and graphical temperature-depth data for all wells in the state from which these data are available.
5. Tabulated gradients, thermal conductivities, and heat flows (corrected [illegible] uncorrected) for all wells in the state from which these data are available.
6. An explanatory and interpretive text.

<u>Budget</u>

Salaries:

Scrounger - SMU logging truck operator 3 mo. @ $1500/mo.	$ 4,500
Scrounger - portable logging unit operator(s) 6 mo. @ $1000/mo.	$ 6,000
Lab Asst. - thermal conductivity measurements, etc., ½ time, 9 mo. @ $1000/mo.*	$ 4,500

Assistant - Gradient & heat flow interpretation, ½ time, 10 mo. @ $1946/mo.*	$ 9,730	
Maintenance asst. - upkeep of logging gear, 35% time, 12 mo. @ $1650/mo.	6,930	
Clerical, secretary, 30% time, 12 mo. @ $768/mo.*	2,766	
PI, D.D. Blackwell, 1 mo. @ $4666/mo.	4,666	
		$39,092
Benefits: 13% of salaries		5,082
Travel:		
Mileage: 40,000 mi. @ 22.5¢/mi.	$ 9,000	
Per Diem: Logging truck operator, 90 days; portable logging unit operator, 180 days; PI, 30 days @ $ $35/day	10,500	
Meetings: PI attendance at 1 assessment team meeting and 1 national professional meeting	1,500	
		$21,000
Other:		
Computer: 400 hours @ $12.50/hr*	$ 5,000	
Publication (report) preparation*	500	
Supplies and materials*	2,000	
		$ 7,500
SMU Overhead:		
40 percent on-campus (marked * above)	$ 9,798	
23.4 percent on all other items	11,274	
		$21,072
	TOTAL	$93,746

*Items on which SMU charges on-campus overhead at 40 percent.

CASCADE RANGE REGIONAL GRAVITY SUBCONTRACT

Priority - 1

Be more specific about study areas and resulting products. Clear matter with Danes.

Justification

Regional gravity surveying under subcontract has been underway in the Cascade Range since 1979. The project has been headed by Dr. Z.F. Danes, University of Puget Sound, Tacoma, Washington. The study area is shown on Figure 1. Work to date has been concentrated in the southern and central Cascades and in the area around Mount Baker in the northern Cascades.

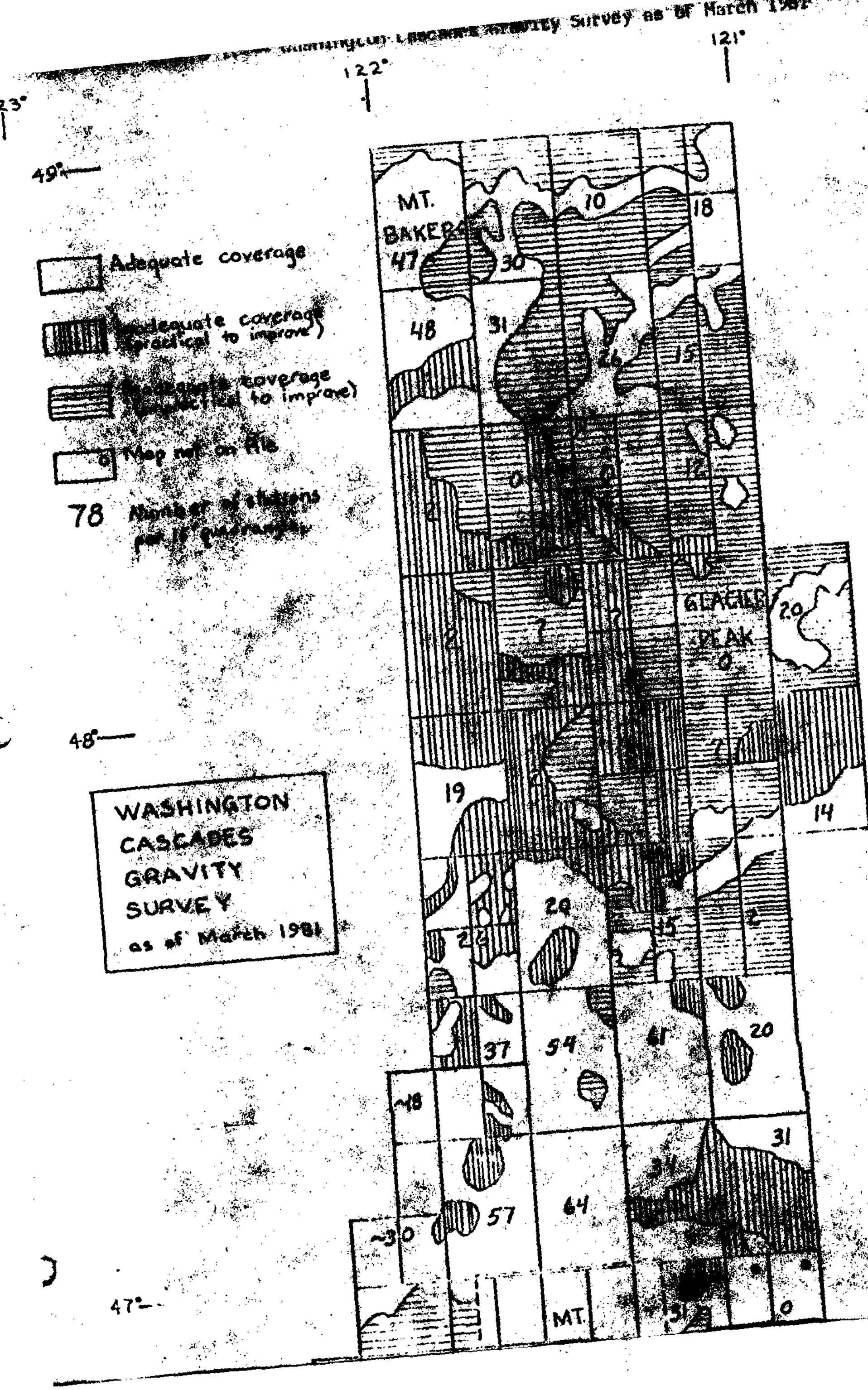
Status of gravity mapping is shown on Figure 1. Previous data and newly measured stations bring the total for the study area (about 14,070 square miles) to some 2620 gravity stations, or an average distribution of one station per 5.4 square miles. The distribution is not even throughout the Cascade range, however; in the part of the study area south of $47^{\circ}30'$ the station density is one per 3.8 square miles, with much heavier concentrations at Camas, North Bonneville, and Mount St. Helens. North of $47^{\circ}30'$ the station density is only one per 15.1 square miles.

Almost all of the gravity data gathered so far, including pre-existing data, has been reduced by the U.S. Geological Survey in Denver, through the use of their computer facilities. It is expected that preliminary gravity maps at a scale of 1:250,000 will be placed on open file by the Division of Geology and Earth Resources by May 31, 1981. These maps will be improved and updated, especially in the northern Cascades, following the 1981 field season. At the conclusion of the three-year gravity program we expect to publish a 1:250,000 scale gravity map for the bulk of the study area.

The UPS gravity work has already greatly expanded available coverage for the central and southern Cascades. By the end of the third year regional coverage will be available for most of the study area in sufficient detail to allow geothermal explorationists to integrate the gravity data into the evaluation of Cascade Range geothermal target areas, thus allowing for structural interpretations and tests of geothermal hypotheses not possible previously.

Plan and Schedule

Sufficient funds are available from the existing USDOE - State of Washington contract to support the gravity subcontract until July 31, 1981, provided that a



Survey as of March 1981
122°
121°
49°
48°
47°
MT. BAKER
GLACIER PEAK
MT.
Adequate coverage
Inadequate coverage (practical to improve)
Inadequate coverage (impractical to improve)
Map not on file
78 Number of stations per 15' quadrangle
WASHINGTON CASCADES GRAVITY SURVEY as of March 1981

no-cost time extension and permission to shift budgeted funds are granted by USDOE. If so, work under the contract resulting from this proposal will begin on August 1, 1981, and continue to May 31, 1982.

The objectives are as follows:

1. Obtain regional gravity coverage (one station per five square miles) in the area west of Glacier Peak in the White Chuck Mtn., Pugh Mtn., Bedal, Sloan Peak, Prairie Mtn., and Huckleberry Mtn. 7½' quadrangles where known elevations and road access permit. Gravity in this area will help to provide a "tie" between Mount Baker and Glacier Peak and provide the first significant data in an area where geothermal lease applications have been made by private industry.
2. Obtain regional gravity coverage for the approximately 10 by 8 mile area centered on Mount Baker, to the extent that access, known elevations, and ordinary prudence will allow.
3. Collect and incorporate all pre-existing gravity data available for the part of the study area north of $47^{\circ}30'$.
4. Obtain regional gravity coverage for the area southeast of Mount Rainier in the northern part of the Hamilton Buttes 7½' quadrangle, southeastern part of the Packwood 15' quadrangle, White Pass 15' quadrangle, Rimrock Lake 7½' quadrangle, and Tieton Basin 7½' quadrangle to the extent that known elevations and road access will allow. This work will provide better gravity data for an area of considerable Quaternary volcanic activity.
5. Obtain regional gravity coverage for the western ½ of the Golden Lakes 7½' quadrangle, western ½ of the Mount Wow 7½' quadrangle, and eastern ½ of the Kapowsin 15' quadrangle, all located to the west of Mount Rainier. Coverage here should be to the extent practical with regard to road access, known elevations, and landowner's permission. The transition between Puget Lowland type temperature gradients and Cascade type gradients is suspected to pass through this area, and gravity data may help to determine whether or not the transition in gradients is accompanied or caused by a transition in subsurface lithology and/or structure.
6. Obtain regional gravity coverage for the southeastern portion of the Wind River 15' quadrangle. Work here should largely complete regional coverage for two adjacent areas of potential geothermal significance, Wind River and Indian Heaven.
7. Remeasure gravity at a sufficient number of stations in the Mount St. Helens area to determine whether the 1980-81 eruptions and/or resulting geographic changes have caused significant changes in gravity. If so produce a map

at 1:62,500 scale which details the changes. New stations should be established to add detail to gravity anomalies which were previously defined by only one or two stations.

This objective must be considered tentative. Several factors must be favorable in order to carry out the work including:

A) Mount St. Helens must be in a "quiet" state,

B) Permits to work in the area must be obtainable,

C) Access to previously occupied gravity stations must be possible, and

D) The stations to be re-occupied must be recoverable with a reasonable assurance that their elevations have not changed significantly.

8) Obtain better-than-regional gravity coverage in the area of objective number 3 (Mount Baker). This objective is also tentative because of access problems and lack of known elevations.

Every effort should be made during the course of gravity surveying to insure that elevation errors are held to less than $\pm$ 10 feet (that reported gravity values are accurate to within about $\pm$ 0.6 milligals).

Objectives 1-6 should be completed in the order listed. The contractor is expected, within limitations imposed by lack of known elevations, road access, or landowner's permission, to allocate the time and finances available under this subcontract in such a way that good progress can be made toward completing each of objectives 1-6.

Objectives 7 and 8 are to be started only after objectives 1-6 have been completed to the extent that they can be completed without resorting to extensive backpacking or use of trail bikes for access to unroaded areas.

Note that these objectives specifically exclude gathering new gravity data in the northeastern part of the study area (in the area north of 47°30' and east of 121°15' as well as north of 48°22.5' and east of 121°37.5') because access to these areas is very difficult, the areas are of less geothermal importance (Glacier Peak is part of the excluded area, but it is a wilderness area and cannot be developed), and gravity data simply cannot be gathered there in an effective manner in the time and with the resources remaining. However, if all eight of the objectives listed above can be completed, any excess time and funds may be used by the contractor for gathering additional gravity data in these areas.

Products

Products to be delivered by May 31, 1982, are:

1) A complete Bouguer gravity anomaly map for the study area at a scale of 1:250,000. This map shall show locations of gravity stations and the contoured gravity values. It will include complete legend and explanation.

2) A text which describes the methods used to carry out the gravity survey, methods by which existing data have been incorporated, and major conclusions regarding geologic structure and geothermal resource potential in the study area.

3) A tabular listing of gravity stations showing station number, location, "raw" and reduced gravity values.

Budget

Salaries		
Principal Investigator:		
1.75 mo. @ $2000/mo.	$ 3,500	
Field Assistants:		
2 @ 7 mo. each, $5/hr., 170 hr./mo.	$11,900	
Key Punch Operator:		
2 wk. at 40 hr./week and $5/hr.	$ 400	
		$15,800
Travel		
Vehicle mileage and maintenance	$ 4,300	
Per Diem: 200 days @ $20/day	$ 4,000	
		$ 8,300
Other		
Office and Lab. supplies	$ 500	
Reproduction	$ 500	
Gravity meter calibration and repair	$ 600	
		$ 1,600
TOTAL		$25,700

SUBCONTRACT FOR GEOTHERMAL INVESTIGATIONS IN THE YAKIMA AREA

Priority - 2

Have investigator meet with Stuart Simpson (Seattle) to get ideas of "commercial" needs. Define products expected of the investigator in detail.

Justification

This work has been underway since August 1, 1980. The investigation is being carried out by John Biggane of the Washington State University Department of Civil and Environmental Engineering, Geological Engineering Section, under the direction of Professor James W. Crosby. The initial subcontract (under USDOE contract DE-AC07-79ET27014, Modification No. A003) runs until May 31, 1981.

The objectives of the current subcontract are:

1. To measure temperature gradients in existing wells in the Yakima County region, and in cooperation with Dr. D. D. Blackwell, determine heat flow in as many wells as possible.
2. To delineate areas that possess a potential for geothermal development (define areas where warm and/or hot water and/or sources of heat exist in the subsurface).
3. To relate occurrences or potential occurrences of geothermal energy to the geology and hydrology of the study area.
4. To explore the potential uses, economics, and problems associated with the use of geothermal energy in the Yakima region.

   Not part of RA work

5. To submit a report detailing work activities, pertinent data, and information relevant to the above objectives. This report shall contain appropriate geologic, temperature-gradient, heat-flow, and hydrologic maps and/or cross sections.

The initial study area was all of Yakima County — an area of 5,059 square miles. As the work progressed, the study area was to be reduced to the areas with the greatest potential for the occurrence of geothermal resources. The initial budget totalled $15,000.

The report from the initial subcontract will include the following:

I. Geologic Data and Stratigraphic Interpretations
   A. A review of the pertinent geological literature
      1. the occurrence and description of the geologic units.
      2. the previous geophysical surveys and their interpretations.

B. Stratigraphic interpretations obtained from the WSU geophysical well logs.

1. the correlation of geologic units, primarily along the trends of the irrigated valleys.
2. the relationships that exist between the stratigraphy and ground water hydrology and temperature.

II. Geothermal Information

A. Compilation of the available temperature-depth data.

1. the locations, gradients, chemical data, pumping test temperatures, etc. ? transmissivity, hydrologic data,
2. a review of the previous geothermal research for Yakima County and the Columbia Plateau.

B. Spatial distribution of the geothermal gradients

1. the variation in the gradients as predicted by the bottom hole temperature regression analysis
2. a comparison of the methods available for the interpretation of water well geothermal gradients.

III. Assessment of the Geothermal Resources of the Yakima Area

A. The areal relationship between aquifer temperatures and aquifer depths.

not RA work B. The potential uses of the low temperature ground water in the Yakima area.

This report will go a long way toward integrating many sources of data that bear on the development and use of low temperature geothermal resources in the Yakima County area. Continuation of this subcontract from June 1, 1981 through January 31, 1982 will allow for the development of firmer and more detailed interpretations regarding the resources and their potential uses, and it will allow the time necessary to produce a final report suitable for journal publication.

Objectives

June 1, 1981 - January 31, 1982 — This subcontracted task will conclude on January 31, 1982 and will complete the following objectives:

I. To refine the preliminary conclusions of the study by:

A. Additional stratigraphic correlation through the use of geophysical and driller's logs.

B. Additional stratigraphic interpretation by means of structural contour maps and fence diagrams.

C. The investigation in greater detail of the spatial relationship that exists between the aquifer depth and its temperature and stratigraphy.

II. To explore the economic feasibility of utilizing the low temperature ground water of the Yakima area by

Not RA work

A. Delineating regions according to their geothermal potential.

B. Identifying possible applications and preliminary cost estimates.

Schedule

Investigations will be continued between June 1, 1981 and January 31, 1982.

Products

A report detailing work activities, including all pertinent data and information relevant to the above objectives, shall be due on January 31, 1982. This report shall also incorporate the findings from the August 1, 1980 to May 31, 1981 contract period. The report shall contain appropriate geologic, temperature-gradient, heat-flow, and* hydrologic maps and/or corss-sections. The report shall be delivered in a format suitable for publication, and it shall be subject to review by the Division of Geology and Earth Resources prior to final acceptance. *Include probability of aquifer - drawdown, etc. available from pump data.

Budget

Be sure interim report published before end of contract period

Salaries:			
Research Assistant (8/1/81-1/31/82)			
0.5 FTE	$ 3,890		
Secretarial	583		
		$ 4,473	
Benefits:			
8 percent of Research Asst. salary	$ 311		
23 percent of secretarial salary	134		
		$ 445	
Goods and Services		$ 1,875	
Travel		$ 1,125	
Overhead: 45% of total modified direct costs		$3,563	
		TOTAL	$11,481

WIND RIVER GEOLOGIC SUBCONTRACT

Define study areas - which at what scale.
(done on Duncan's map).
1/62,500 overall geology of area.
* Re-scope or eliminate.

Priority - 3

Justification

The proposed study area includes one of the youngest volcanic zones in the state of Washington. Major thermal and mineral springs lie within or adjacent to the study area. The area is traversed by a recently recognized seismic zone which passes through Mount St. Helens to the northwest. The area lies along the western border of the Cascade Range hot spring zone, and there are potential users of low temperature geothermal energy in the area, namely a large evergreen nursery operated by the U.S. Forest Service and two schools in the town of Carson. These potential users have expressed interest in developing low-temperature geothermal resources, and they are being assisted by the Washington State Energy Office and Oregon Institute of Technology.

From a geologic viewpoint, the area has good potential for the occurrence of commercial geothermal energy, but it lacks comprehensive geologic, geophysical, and rock-geochemical evaluation. Data collected during this proposed study will be integrated into, and form an important part of, Paul Hammond's space-time-composition model for young south Cascades volcanism.

Objectives and Schedule

The study area is about 100 square miles in size, and is located in the south Cascades of Washington, about 10 miles north of the Skamania County town of Stevenson. The study area is in the northeastern part of the Lookout Mountain 15' quadrangle and northwestern part of the Wind River 15' quadrangle. Key features included in the area are Government Mineral Springs, Trout Creek Hill volcano (basalt), Bare Mountain (basalt and andesite crater), West Crater (basalt lava flows and andesite dome), Soda Peak (basalt-andesite volcanic center), and a northwest-trending fault zone along the Wind River, which may be an extension of the northwest-trending active fault zone which passes through Mount St. Helens.

Geologic mapping will be carried out by a graduate student at Portland State University, Portland, Oregon, under the direction of Dr. Paul E. Hammond. Analytical work will be done by commercial or university age dating and geochemical establishments.

Objectives are as follows:

1. Detailed mapping (1:24,000 scale) of extent, composition, and age of High Cascade Group volcanic rocks (younger than about 5 million years in this area and possibly younger than 1 million years).

2. Reconnaissance mapping (1:62,500 scale) of bedrock of Western Cascades Group, mostly Ohanapecosh Formation — its stratigraphy, structure, and location and composition of intrusions and alteration zones, principally for evidence of tectonic control of young volcanic centers and possible delineation of a deep north-northwest-trending seismic zone which has been interpreted by the University of Washington Geophysics Group to run from Port Angeles, Washington, beneath Mount St. Helens, to Mount Hood, Oregon.

Field work will be accomplished during the summer and fall of 1981; analytical and laboratory work during winter 1981-82; and a final report is to be delivered by June 30, 1982.

Products

1. Reconnaissance geologic map (1:62,500 scale) of the study area with 3-4 cross sections.

2. Detailed geologic map(s) and cross sections (1:24,000 scale) of specific areas with geothermal significance.

3. Written report summarizing the principal characteristics and ages of rock units, describing alteration zones and structures, and incorporating these data into the south Cascades space-time-composition model for young volcanism.

Budget

Salaries:		
1 graduate student research asst. 10 weeks @ 40 hr/wk @ $7/hr	$ 2,800	
1 field asst. 10 weeks @ 40 hr/wk @ $6/hr	2,400	
Dr. Hammond (PI), ½ mo. @ $2,000/mo.	1,000	
		$ 6,200
Benefits: 10.6% of salaries		657

Travel:		
Per Diem - 2 persons @ 50 days each and $25/day	$ 2,500	
PI @ 10 days and $25/day	250	
Mileage - 10 weeks @ 300 mi./week and 17¢/mi.	510	
PI @ 600 mi. and 17¢/mi.	102	
		$ 3,362
Analytical:		
Thin sections, 40 @ $5/each (to be done by DGER)	-0-	
C^{14} age analyses, 3 @ $300/each	900	
Fission-track age analyses 5 @ $350 each	1,750	
K-Ar age analyses, 5 @ $400/each	2,000	
Paleomagnetic determinations 20 @ $10/each	200	
Whole rock major element analyses 15 @ $5/each (sample preparation to be done as a state contribution of $750)	75	
Trace element analyses 15 @ $50/each	750	
		$ 5,675
Other:		
Maps and aerial photos	100	
Communication	100	
Report preparation	400	
		$ 600
SUBTOTAL		$16,494
Overhead: PSU overhead @ 33.4% of all costs		5,509
TOTAL		$22,003

MOUNT ST. HELENS SEISMIC INVESTIGATIONS

Priority - 4

Duplication of USGS work? Not really.

MNW] User interest so close to active volcano?

Introduction

JES: Must first come up with good target before user interest can be developed.

The most promising geothermal targets in the Cascade Range are the young stratovolcanoes. The five stratovolcanoes in Washington are reported to support fumaroles near their summits, and there are hot springs on or near the flanks of three of the volcanoes. Geologic studies have demonstrated the extreme youth of volcanic deposits produced by each of these volcanic systems, and there are records of historic eruptions on three of the peaks.

However, the most impressive demonstration of the energy potential of these volcanic systems is the 1980 series of eruptions of Mount St. Helens. The total energy released by this series of eruptions has been estimated at 2.0 X 10^{25} ergs, 90 percent of which was released in the cataclysmic eruption of May 18. The equivalent electrical energy is about 63,000 megawatt years, or roughly 100 years of power generation at The Geysers.

Tremendous energy sources probably exist beneath Cascade stratovolcanoes, even during periods between eruptions, but exploration has been hampered and slowed by a number of factors:

1. Several of the stratovolcanoes are included within Wilderness Areas or National Parks. This precludes or severely limits possibilities for exploration and development of geothermal resources on and near these volcanoes.
2. Most of the stratovolcanoes are highly regarded for their scenic and recreational values. These values conflict or seem to conflict with the preception of geothermal development as an industrial activity.
3. Geothermal exploration and development on a stratovolcano presents a number of difficult logistical problems.
4. Most Cascade stratovolcanoes lack robust surface manifestations of geothermal systems. Some investigators believe this is due to cooling and dilution by a "cold water blanket" which results from the heavy precipitation received by many parts of the Cascade Range. As a result, specific targets are lacking.

5. Secondary minerals resulting from hydrothermal alteration apparently seal many of the older fault and fracture zones. Even when moderately deep drill holes penetrate these zones and temperatures are encouraging, there may be no significant water flow from the hole.
6. There has been very little geothermal leasing of federal lands in the Cascades.

Progress toward exploration and development of geothermal resources near Cascade stratovolcanoes can be made if some of these problems can be avoided. Exploration for geothermal resources near stratovolcanoes must obviously take place in close enough proximity to the volcano to take advantage of the heat source that the volcano represents. At the same time, in order to proceed and be cost-effective, exploration must take place outside of National Parks and Wilderness Areas, outside of the areas where scenic and recreational values are so high, and away from the logistical problems presented by the peaks themselves. Furthermore, exploration probably should not depend heavily on surface manifestations as a means for locating targets. Active faults should be sought where hydrothermal alteration has not had time to precipitate secondary minerals to seal the system.

Recent experience at Mount St. Helens suggests that it may be possible to develop an exploration philosophy which incorporates many of these attributes. First, it is necessary to review what was known about geothermal energy in the Mount St. Helens area prior to 1980, and what has been learned as a result of the 1980 eruptions.

Mount St. Helens Prior to 1980

Prior to 1980 the geologic record of Mount St. Helens indicated a history of eruptions stretching back nearly 36,000 years. Historic records confirmed eruptions between 1832 and 1857. Mount St. Helens was believed to be the Cascade volcano most likely to erupt and the most likely to erupt explosively.

A seismic network had been operated in western Washington by the University of Washington for nearly a decade. Plots of about 20 earthquake epicenters recorded in the Mount St. Helens area prior to 1980 suggested the presence of a structure (fault or fault zone?) trending to the north-northwest from the mountain. Little was known about the nature of this structure or its relationship to volcanism at Mount St. Helens.

One mineral spring was known to exist along the trend of this structure; one shallow heat-flow hole drilled along this trend at a distance of 8 km from the volcano showed no anomalous temperatures; small fumaroles near the summit fell on or near the NNW trending structure. Young volcanic features were known to occur to the SSE of Mount St. Helens, including Marble Mountain, Soda Peaks, West Crater, and Trout Creek Hill volcano, but only Marble Mountain is located 15 km or less from the stratovolcano.

Mount St. Helens, 1980

During the 1980 eruptions, the relative seismic quiescence changed dramatically. Seismic evidence for a major active fault trending NNW-SSE through Mount St. Helens, and a lesser fault trending NE-SW and intersecting the major trend beneath the volcano, has become very convincing. Thousands of earthquakes, up to a Richter magnitude of 5.5, have occurred. A significant number of these earthquakes have occurred along the NNW-SSE trending fault at distances up to 30 km from the volcano and at depths as shallow as 5 km or less.

The 1980 volcanism has not generated new hot springs or other surface manifestations except for those related to the central vent and the hot pyroclastic deposits filling the valley to the north. Neither have changes been observed in the cold springs surrounding the base of the mountain, nor in the temperatures of two remaining heat-flow holes near the mountain (a third hole, mentioned above, was destroyed by the May 18 Toutle River debris flow). The "cold water blanket" over the Mount St. Helens area appears, then, to have thus far remained unaffected by the eruptions, except for the area near the central vent.

Exploration Philosophy

The 1980 seismicity and the interpretations which are beginning to grow out of the recent studies of Mount St. Helens may be the key to developing a philosophy for geothermal exploration around Mount St. Helens, and perhaps other Cascade stratovolcanoes as well.

The seismic activity can be interpreted as follows:

1. An active fault zone which is intimately related to volcanic activity extends through Mount St. Helens.
2. The fact that the fault zone is active means that permeabilities along it are good, allowing for fluid movement.
3. Hypocenter depths are, at least in part, within reach of a deep drill hole.
4. Fluids migrating along the fault zone may be hot water or even magma.

5. The fault zone extends beyond Mount St. Helens far enough so that exploration may be able to avoid the serious logistical and environmental problems associated with the mountain.

In the case of Mount St. Helens, geothermal exploration should first concentrate on the development of a better seismic velocity model. This will allow more precise calculation of earthquake hypocenter locations and, therefore, more precise definition of the width, trend, dip and mechanics of the NNW-SSE trending fault zone. This will require shot-hole refraction seismic work. An additional objective of shot-hole work would be to test for the presence, shape, size, and depth of a magma chamber beneath Mount St. Helens.

Seismic work might be supplemented by additional geologic, geochemical, or geophysical work focused toward determining the nature of the fault zone and whether heated fluids are, indeed, present. Further study will be required to determine which additional studies would be most appropriate.

Once the fault zone has been defined as well as practical by surface methods, the zone should be explored by deep drilling.

Proposed Seismic Investigation

University of Washington seismic investigations around Mount St. Helens will continue during 1981-82, with support from the National Science Foundation and the U.S. Geological Survey. A prime objective will be the refinement of the seismic velocity model for the area. As many as 100 seismometers will be used. Under their present funding the University of Washington will be dependent upon natural earthquakes and distant quarry blasts as seismic sources. Velocity modeling will be much more successful if a few shot-hole sources can be employed. This would also allow for investigation of a magma chamber beneath the mountain.

Therefore, the Division of Geology and Earth Resources proposes to:

1. Subcontract the drilling of three shot-holes to depths of 180 feet within 10-30 km of Mount St. Helens.
2. Obtain explosives and the services of an explosives expert for three 2000 pound shots.
3. Provide 10 hours of helicopter time to allow University of Washington personnel to place, move, and service seismometers.
4. Coordinate the acquisition of the shot-hole seismic data with the University of Washington.

The University of Washington will be responsible for all data recording, data handling, and interpretation. Field activities will take place in September or October, 1981. The Division and the University will cooperate to obtain all necessary permits and permissions.

Products

Dr. Robert Crosson, University of Washington, will prepare a report by July 1, 1982, to include the following:

All pertinent data and interpretations relative to seismicity of the Mount St. Helens area; trend, width, dip, and nature of the NNW-SSE structure passing through the volcano; size, shape, and depth of magma chamber; and details on the refined velocity-structural model.

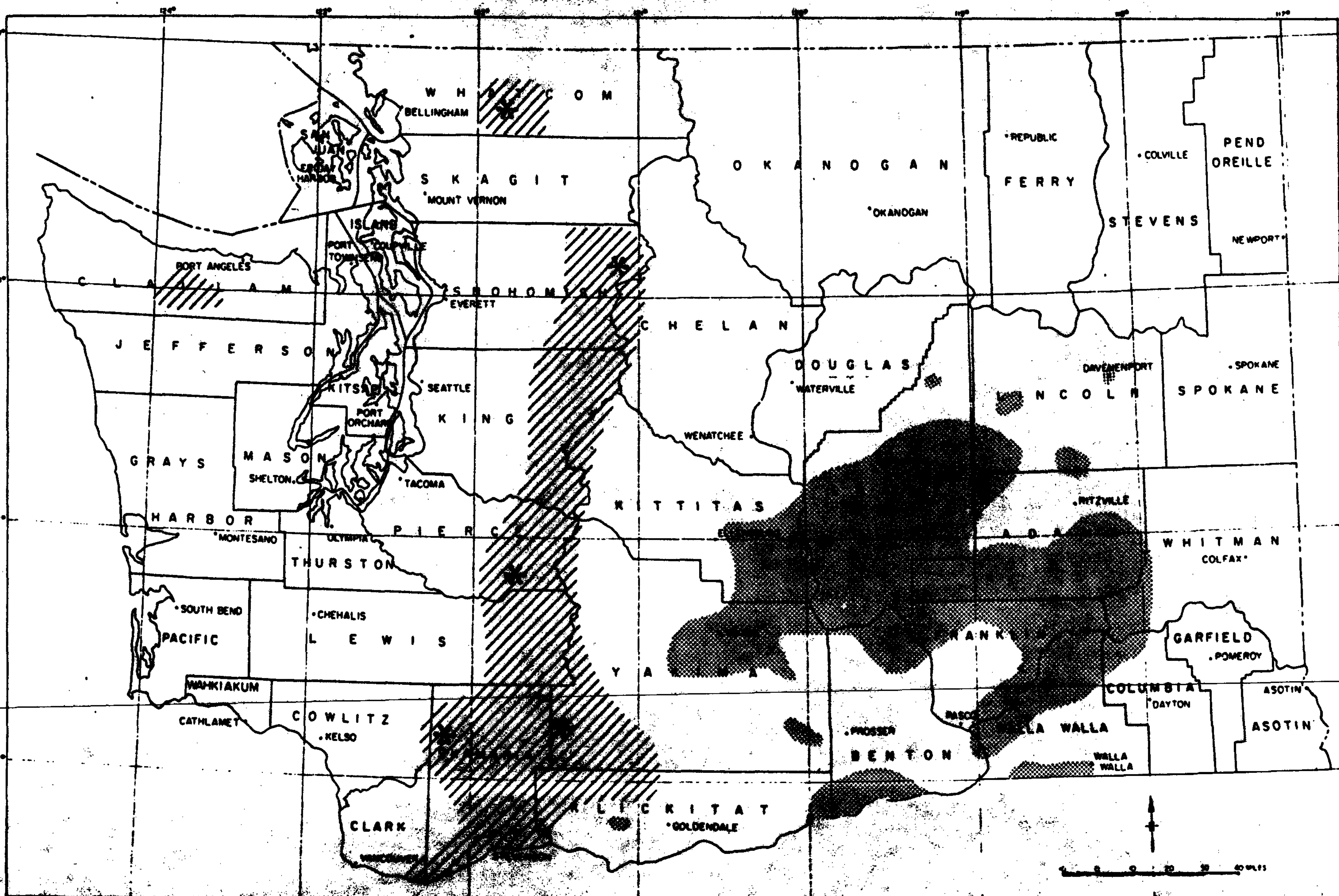
Budget

Drilling - 3 holes, 180 feet deep @ $33/ft., including mobilization and demobilization	$17,820.00
Explosives - 6,000 lb. of high pressure Tovex or equivalent, with all necessary detonating materials, @ $1.15/lb.	$ 6,900.00
"Powder man" - 3 days @ $500/day	$ 1,500.00
Helicopter time - 10 hours @ $400/hr.	$ 4,000.00
TOTAL	$30,220.00

STATUS OF GEOTHERMAL ASSESSMENT IN WASHINGTON

The Washington State Geothermal Resource Assessment team has been operating under U.S. Department of Energy sponsorship for nearly three years. In that time considerable progress has been made toward identifying and understanding the state's geothermal resources. This progress is summarized in the following figures and table. Figures 2 and 4 and Table 1 were compiled jointly by the Washington State Resource Assessment and Commercialization Teams (Washington State Division of Geology and Earth Resources and Washington State Energy Office, respectively), while Figure 3, Geothermal Leases in Washington, was prepared entirely by the Commercialization Team.

Figure 2. — **POTENTIAL GEOTHERMAL RESOURCE AREAS IN WASHINGTON**



Areas depict regions where several [illegible] temperature gradients higher than 40° C/km, although there [illegible] within these areas. Low-to moderate-temperature [illegible] of these regions. Further exploration is needed to [illegible] the resource.

Areas with high potential for low-to high-temperature geothermal resources. Typical temperature gradients are in the range of 45° to 85° C/km. Favorable indicators are young igneous rocks, hot springs, or fumaroles.

Figure 3. — **GEOTHERMAL LEASES IN WASHINGTON**

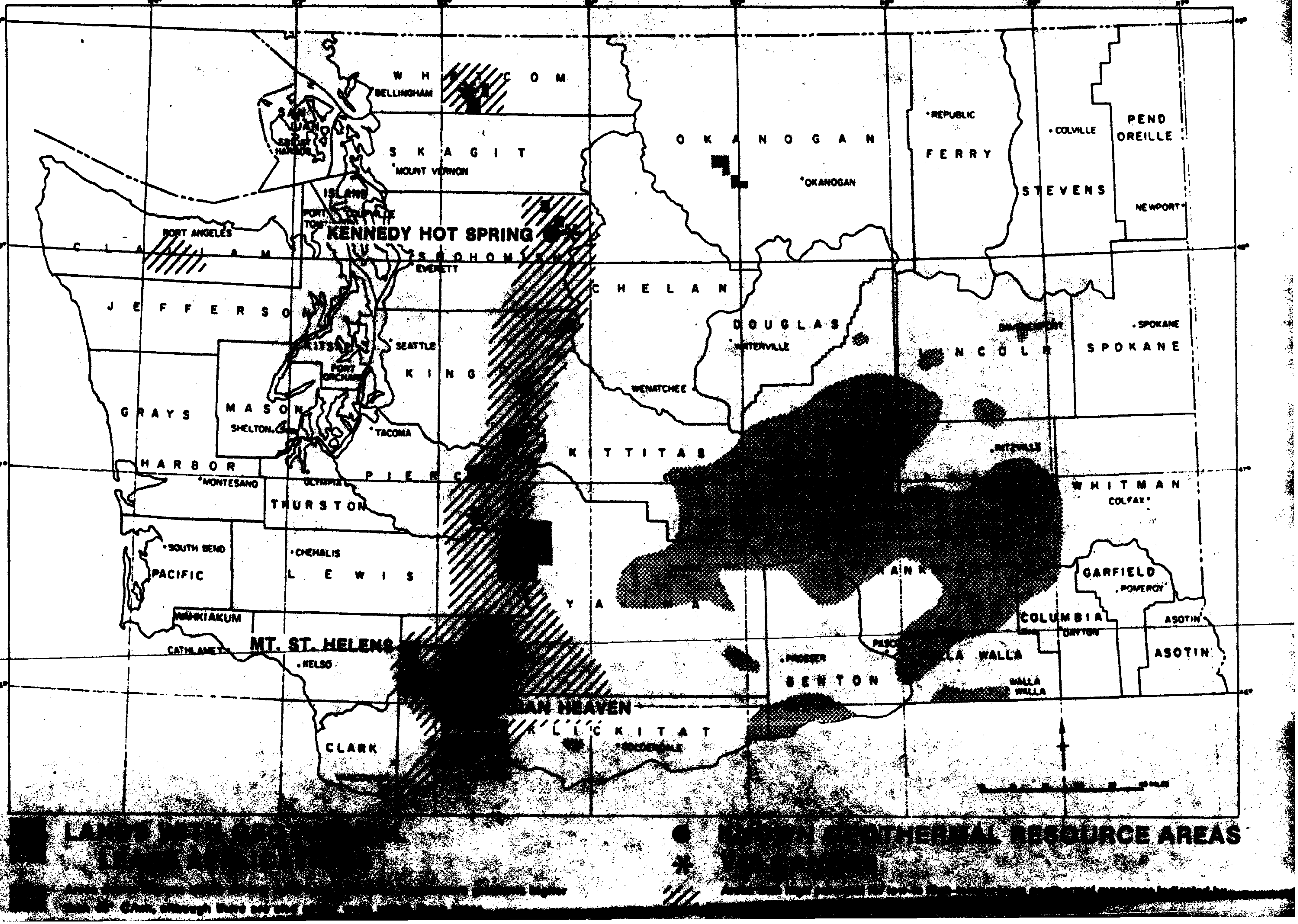


Figure 4. — WASHINGTON GEOTHERMAL RESOURCE ASSESSMENT MAP

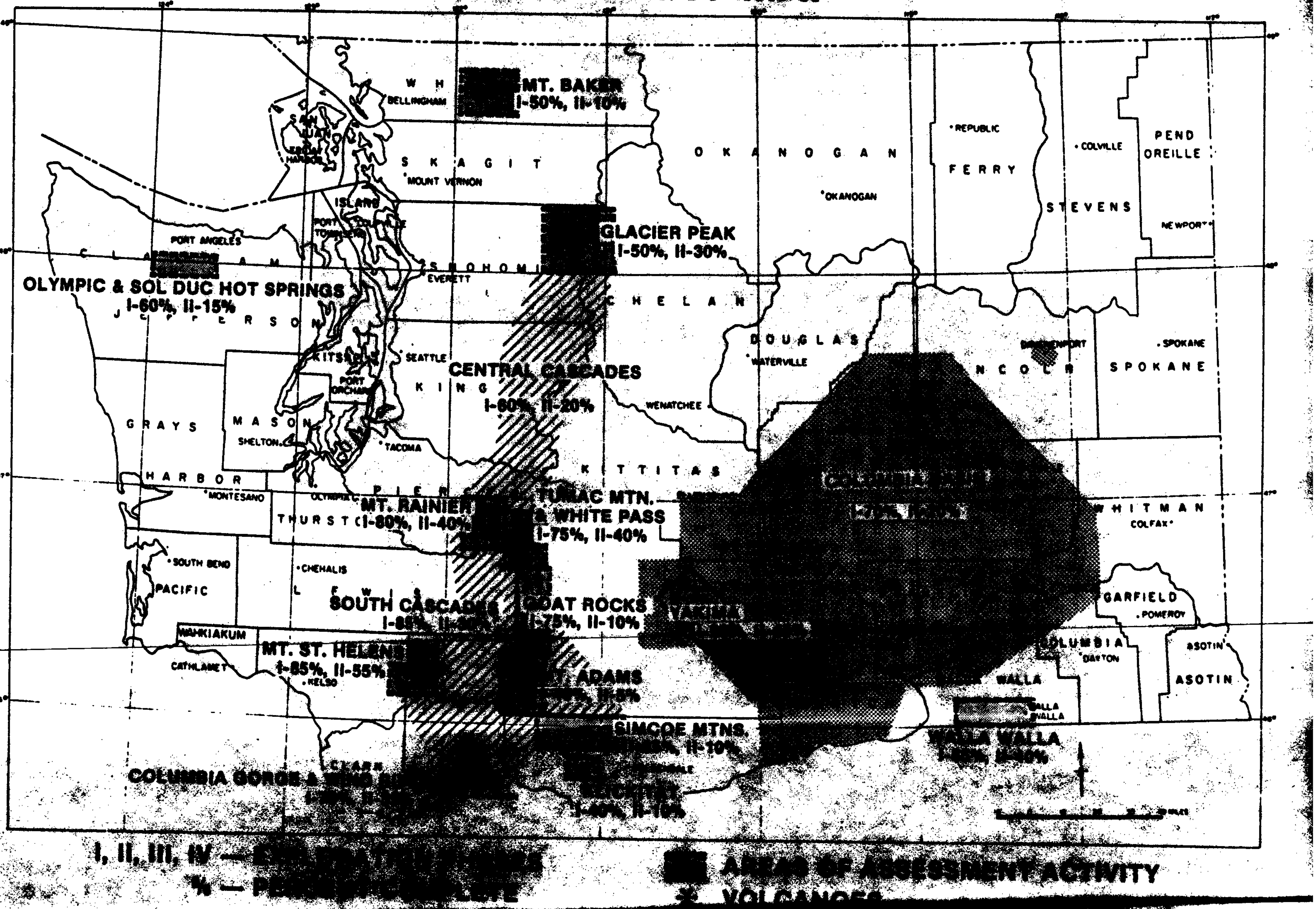


Table 1. — Status of Geothermal Energy Assessment in Washington, March 1981.

Status of Geothermal Energy Assessment in Washington, 3/81 NA = Not Applicable Numbers represent percent of work completed	PHASE I Regional Reconnaissance	Literature search	Temperature gradient measurement in existing wells - wide spacing	Spring & well sampling of ground water - wide spacing	Broad reconnaissance geologic mapping, 1:100,000 scale or smaller	Regional geophysical studies - wide spacing. Including gravity, seismic, and aeromagnetic surveys	Regional heat flow	PHASE II Initial direct exploration of identified resources	Temperature gradient measurement in all available wells	Spring and well sampling of water in all available wells and springs	Detailed geologic mapping, 1:62,500 scale or larger	Shallow drilling of 500' temperature gradient wells to define heat flow anomalies	Detailed geophysical exploration close spacing. Including gravity, seismic, and aeromagnetic surveys	Qualitative and quantitative hydrologic analysis	PHASE III Direct exploration of thermal anomalies	Intermediate depth drilling of 2000' wells to define thermal anomalies	Geophysical exploration	Quantitative hydrologic modeling of the geothermal system	PHASE IV Direct testing of geothermal resource at depth	Deep drilling of 3000' to 6000' wells to test geothermal aquifers	Reservoir testing engineering evaluation including pump testing	Quantitative reservoir estimation
Olympic & Sol Duc Hot Springs	80	100	NA	100	100	0	0	15	NA	75	0	0	0	0	0	0	0	0	0	0	0	0
Glacier Peak	50	80	NA	80	100	10	0	30	NA	60	100	0	0	0	0	0	0	0	0	0	0	0
Mt. Baker	50	80	NA	60	60	40	0	10	NA	80	20	0	0	0	0	0	0	0	0	0	0	0
Central Cascades	60	50	NA	80	100	40	20	20	NA	60	40	0	0	0	0	0	0	0	0	0	0	0
South Cascades	85	100	NA	100	100	80	40	30	NA	80	40	20	5	0	0	0	0	0	0	0	0	0
Columbia Gorge Wind River	70	100	60	60	100	65	30	35	40	60	60	20	40	0	0	0	0	0	0	0	0	0
Goat Rocks	75	80	NA	0	60	50	0	10	NA	0	20	0	20	0	0	0	0	0	0	0	0	0
Klickitat	40	60	30	20	100	20	0	10	40	20	0	0	0	0	0	0	0	0	0	0	0	0
Mt. Adams	40	60	NA	0	80	60	0	5	NA	0	20	0	0	0	0	0	0	0	0	0	0	0
Mt. Rainier	80	100	NA	100	100	60	40	40	NA	80	100	20	0	0	0	0	0	0	0	0	0	0
Mt. St. Helens	85	100	NA	100	100	90	40	65	NA	100	100	30	40	10?	0	0	0	0	0	0	0	0
Simcoe Mtns.	35	60	NA	0	100	20	0	10	NA	0	60	0	0	0	0	0	0	0	0	0	0	0
Tumac Mtn. White Pass	75	100	NA	100	100	50	20	40	NA	80	100	20	0	0	0	0	0	0	0	0	0	0
Columbia Basin	20	80	40	100	100	50	40	20	20	20	[illegible]	0	20?	10?	0	0	0	0	0	0	0	0
Walla Walla	85	80	100	100	100	90	50	40	[illegible]	60	[illegible]	0	20?	10?	0	0	0	0	0	0	0	0
Yakima	90	100	100	100	100	90	50	45	75	60	100	0	20?	20?	0	0	0	0	0	0	0	0

OVERALL PROPOSED BUDGET

Subcontracts:	
Heat flow and temperature gradient investigations by Southern Methodist University	$ 93,746
Cascade Range regional gravity by Danes Research Assoc.	25,700
Geothermal Investigations in the Yakima area by Washington State University	11,481
Wind River geologic investigations by Portland State University	22,003
Division of Geology and Earth Resources:	
Salaries, benefits, travel, equipment, supplies, and services	88,884
Mount St. Helens seismic investigations, in cooperation with University of Washington	30,220
Overhead - 15.66 percent on Division of Geology and Earth Resources administered activities (excludes the Southern Methodist University subcontract)	27,920
USDOE CONTRIBUTION	$299,954
STATE OF WASHINGTON CONTRIBUTION	13,000
	$312,954

Department of Geological Sciences
Institute for the Study of Earth and Man
Southern Methodist University
Dallas, Texas 75275

April 28, 1981

CONTINUATION PROPOSAL

Heat Flow and Geothermal Evaluation

of Oregon and Washington

Submitted to

Ms. Maggie Widmayer
U.S. Department of Energy
550 Second Avenue
Idaho Falls, Idaho 83401

Period of Grant: June 1, 1981 through May 31, 1982

Amount Requested: $163,653

David D. Blackwell
Principal Investigator
S.S. #449-62-6377
Tel. (214) 692-2745

Michael J. Holdaway
Chairman, Dept. of Geol. Sci.
S.S. #471-38-2275
Tel. (214) 692-2270

Truman F. Cook
Director, Office of Research Administration
S.S. #456-12-6041
Tel. (214) 692-2030

SMU Proposal Number 11101

HEAT FLOW AND GEOTHERMAL EVALUATION OF OREGON AND WASHINGTON

ABSTRACT

This proposal is for the third year of a program of cooperative heat flow studies and geothermal evaluation of Oregon and Washington. Personnel of the Geothermal Laboratory at SMU, as outlined in the accompanying budget, will perform field and laboratory tasks dealing with geothermal measurements and evaluation in cooperation with the low-temperature assessment studies of the Oregon Department of Geology and Mineral Industries and the Washington Department of Natural Resources, Division of Geology. The specific SMU tasks include the following.

Based on extensive geothermal experience in the Pacific Northwest, consultation on the nature of the field program of the two states and interpretation of final results will be a major task. In addition, three people will be supplied and supervised for field operations in the state of Washington during the summer of 1981. One person will operate a motorized logging system and the other two will operate hand-powered equipment (9 man-months total). Most of the field program in Oregon will be carried out by personnel of the Department of Geology and Mineral Industries. Approximately 1 1/2 man-months of SMU effort will be involved in the field aspects of the Oregon program.

Five sets of portable temperature logging equipment for support of the field temperature-gradient heat-flow study aspects of the state programs will be supplied and maintained by SMU. Two motorized logging systems, one capable of measuring temperatures to 110°C at 1050 m and the other capable

of measuring temperatures to 150°C at 3000 m will also be supplied and maintained. Gamma-ray, SP, and resistivity logs will be recorded in wells for which such information would be useful in interpretation or evaluation. Thermal conductivity measurements will be made on cuttings and core samples collected from the wells in which temperature logs have been made and from surrounding outcrops, etc. The samples will be collected by SMU, WDNR and DOGAMI personnel. The thermal conductivity apparatus is operated and maintained by SMU. As needed, heat production studies involving measurement of the uranium, thorium and potassium content of rocks will be carried out on samples collected by field personnel. This equipment is maintained and operated by SMU. The results of current and past temperature-depth logging, geothermal gradient calculations, etc., will be maintained on computerized data files at SMU. Computer-processed temperature-depth data in the form of listings and plots will be supplied, based on data collected by the field parties, for inclusion in open-file reports following completion of the field season. Summary reports and maps will be supplied using the data base available. Included will be tabulated lists of all geothermal data in each state; or just thermal gradient data? maps at a scale of 1:1,000,000 detailing heat flow measurements in the states of Oregon and Washington, with accompanying reports; and a contour map of temperatures and/or depth of certain temperatures in the Columbia Basin. Reports on local geothermal systems and detailed studies will be prepared at the request of the states, on a manpower-available basis.

INTRODUCTION

During the past two years there has been a continued program of investigation of low-temperature geothermal resources in the Pacific Northwest, sponsored by DOE and carried out by state organizations. One of the major techniques used in this resource evaluation-investigation program is the collection of geothermal gradient-heat flow data. The object of work during this contract period is to provide a third year of logistical, technical, analytical and report preparation support relating to geothermal gradient-heat flow data for the low-temperature geothermal programs in the states of Oregon and Washington. During the period of this contract (June 1, 1981 through May 31, 1982), the work effort in Oregon and Washington will be focused on specific areas and problems of completion of the statewide studies. The overall objective of the project will be to bring to completion several parts of the study which have been in progress for some time.

PROPOSED WORK

Oregon

The program of the Oregon Department of Geology and Mineral Industries (DOE contract) for the 1981-82 season includes a minimum amount of drilling, an extensive collection of free hole (scrounge) data, and consolidation and interpretation of existing information. Services to be provided by SMU include supply and maintenance of two sets of portable temperature logging gear. In addition, the state owns a third set, so that the three field parties will be active during the summer collecting drill hole data. A truck with a motorized winch capable of measuring temperatures to a depth of 3000 m and a truck capable of measuring temperatures to 1000 m as well as gamma-ray, SP and resistivity logs in wells, will be supplied and maintained for joint use by the states of Oregon and Washington. Each truck will be available approximately 50% of the time in each state during the field season. Personnel from the state of Oregon will collect the field data, which will be sent to SMU to be collated and combined with an extensive computer file of existing data from the state of Oregon (the file already totals over 500 holes). With the several parties in the field it is estimated that between 100 and 200 new holes will be logged during the 1981 field season.

Copies of computer-processed temperature-depth information and plots for each hole will be submitted to the state of Oregon for open-file in the fall of 1981, for ready access by the geothermal community. Thermal conductivity measurements will be made on samples collected by the field parties in order to calculate heat flow values for holes, where possible, and to obtain better information on thermal properties of geothermal areas. Radioactivity measurement on well and surface samples, as well as terrain corrections, will be made as needed.

Reports will be prepared and personnel from the geothermal laboratory will consult with personnel from the state of Oregon in the interpretation and reporting of the geothermal results. Special areas of study are listed in the DOGAMI contract. Specific publications to be submitted by May 31, 1982, include: a report of geothermal gradient data, geothermal gradient and heat flow summary for special papers on high-priority resource areas;

a geothermal gradient and heat flow summary for a special paper summarizing the geothermal resource potential of all of the study areas; and a new edition of the statewide 1:1,000,000 heat flow map. good

Washington

Under contract to DOE, the Washington Department of Natural Resources (WDNR) plans to drill approximately 10 holes specifically for geothermal graident-heat flow determinations in the southeastern Washington Cascade Range. SMU will log temperatures, gamma-ray, SP and resistivity in these holes as they are drilled. In addition, SMU will supply 9 man-months of field effort in support of the state of Washington program; 6 man-months of field effort will be involved with geothermal gradient scrounge studies, and 3 man-months will be involved in operating one of the mobilized logging systems. Two sets of portable temperature-depth equipment will be supplied for the field studies. The areas to be emphasized are the eastern border of the Cascade Range, the Columbia Plateau, and the boundary between the Columbia Plateau and Okanogan Highlands. These areas afford a combination of population centers and geothermal potential such that they are the areas most likely to be utilized for low-temperature geothermal applications in the state of Washington. In the field effort, approximately 100 to 150 holes will be logged, in addition to the holes which are to be drilled. All of the off-campus budget is devoted to the field effort in the state of Washington, with the exception of one budget month of the principal investigator's time and 1/2 month of the research associate's time.

Upon return to Dallas, the temperature-depth data will be computer processed and returned to the state for open-file in the early fall, as is the case in Oregon. Products to be delivered by May 31, 1982, include the following:

1. Depth-to-isotherm maps
   a) sketch map of entire state at 1:2,000,000
   b) Columbia Basin at 1:500,000
   c) more detailed maps in anomalous areas, such as Moses Lake, Walla Walla, or Yakima, at scales of 1:250,000 or 1:100,000 as data quantity and quality permit.

   [NOTE: These maps might be formulated as depth-to-isotherm maps (probably depth to 20°C and/or 30°C) and/or temperature-at-fixed-depth maps (such as temperature at a depth of 1 km).]

2. Mean surface temperature maps for the areas listed under 1a, 1b and 1c, where data quantity and quality permit.

3. Heat flow and gradient maps for the entire state at 1:1,000,000.

4. Tabulated and graphical temperature-depth data for all wells in the state from which these data are available.

5. Tabulated gradients, thermal conductivities and heat flow (corrected and uncorrected) for all wells in the state from which these data are available.

6. An explanatory and interpretative text.

BUDGET NOTES

The on-campus budget breakdown is 50-50 between the states of Oregon and Washington, so the supplies, publication, computer and on-campus travel line-items, as well as the on-campus direct costs, are evenly divided. The maintenance and repair of the field equipment (truck and portable logging gear) will occupy approximately 50% of a technician's time for 12 months (25% for the state of Oregon and 25% for the state of Washington). The laboratory aspects relating to the state of Oregon studies will occupy approximately 45% of the time of the research associate and 15% of the time of the principal investigator; 50% of the time of the laboratory assistants, 30% of the secretary's time for report preparation, and approximately $200 of undergraduate assistants' time. The technician will spend 10% of time on maintenance of the laboratory equipment. Similar on-campus effort will be directed to the state of Washington program.

Half-time for the two logging trucks will be spent in the state of Washington to obtain information in deeper holes; also, resistivity, SP and gamma-ray information on selected holes of special interest.

All of the off-campus budget is devoted to the field effort of the state of Washington with the exception of one month of the principal investigator's time and 1/2 month of the research associate's time. The breakdown of the budget items devoted to support of the Oregon program comes to a total of $70,000; that devoted to support of the Washington program comes to a total of $93,653. The field aspect represents the only difference in the level of budgeted effort between the states of Oregon and Washington.

OFF CAMPUS BUDGET

Salaries	TOTAL	DOE	SMU
Principal Investigator, David Blackwell			
100% of 2 months @ $4,666/month	9,332	9,332	
Research Associate, John Steele			
100% of 3 months @ $1946/month	5,838	5,838	
Field Assistants			
100% of 6 months @ $1000/month	6,000	6,000	
TOTAL SALARIES	21,170	21,170	
Employee Benefits			
Blackwell @ 13% of salary	1,214	1,214	
Research Associate @ 15.1%	882	882	
Field Assistants @ .8% of salary	48	48	
TOTAL BENEFITS	2,144	2,144	
Supplies	2,000	2,000	
Travel			
11 man-months @ $35/day	11,550	11,550	
60,000 miles @ 22.5¢/mile	13,500	13,500	
TOTAL DIRECT COSTS	50,364	50,364	
INDIRECT COSTS -23.4% of MTDC	11,786	11,786	
TOTAL OFF CAMPUS PROJECT COSTS	62,150	62,150	

ON CAMPUS BUDGET

Salaries	TOTAL	DOE	SMU
Principal Investigator, David Blackwell			
30% of AY 1981/82 @ $44,520/AY	13,356	4,452	8,904
Research Associate, John Steele			
90% of 9 months @ $23,353/CY	15,764	15,764	
Technician			
70% of 12 months @ $1650/month	13,860	13,860	
Lab Assistant			
100% of 9 months @ $1000/month	9,000	9,000	
Secretary			
60% of 12 months @ $800/month	5,760	5,760	
Undergraduate Assistant			
400 hours @ $4/hour	1,600	1,600	
TOTAL SALARIES	59,340	50,436	8,904

	Total	DOE	SMU
Employee Benefits			
Blackwell @ 13%	1,736	578	1,158
Research Assoc & Technician @ 15.1%	4,474	4,474	
Secretary @ 9.2%	530	530	
Others @ .8%	84	84	
TOTAL BENEFITS	6,824	5,666	1,158
Supplies	2,000	2,000	
Publication	1,500	1,500	
Computer - 800 hours @ $12.50/hour	10,000	10,000	
Travel			
2 professional meetings @ $750/mtg	1,500	1,500	
2 contractor's meetings @ $700/mtg	1,400	1,400	
TOTAL DIRECT COSTS	82,564	72,502	10,062
INDIRECT COSTS -40% of MTDC	33,026	29,001	4,025
TOTAL ON CAMPUS PROJECT COSTS	/ 115,590	101,503	14,087

BUDGET SUMMARY

Salaries	80,510	71,606	8,904
Employee Benefits	8,968	7,810	1,158
Supplies	4,000	4,000	
Travel	27,950	27,950	
Computer	10,000	10,000	
Publication	1,500	1,500	
TOTAL DIRECT COSTS	132,928	122,866	10,062
INDIRECT COSTS	44,812	40,787	4,025
TOTAL PROJECT COSTS	177,355	163,653	14,087

CONTRACTING AGENCY: WASHINGTON DEPARTMENT OF NATURAL RESOURCES
CONTRACT NUMBER(S): DE-AC03-79ET27014
PRINCIPAL INVESTIGATOR:

CONTRACT PERIOD	$ CONTRIBUTION DOE	$ CONTRIBUTION STATE	WORK DESCRIPTION	LOCATION	REMARKS
11/1/78 - 10/31/79	296,894	12,984	THERMAL SPRING INVENTORY PUBLICATION OF BIBLIOGRAPHY GEOTHERMOMETERS COMPILE DATA BANK	GENERAL	
4/1/80 - 3/31/81	293,406	-0-	HEAT FLOW DRILLING TEMPERATURE MEASUREMENTS GEOLOGIC MAPPING GRAVITY SURVEY GEOCHEMISTRY FAULT LINEAMENT MAP	SOUTHERN CASCADES 3 AREAS MT. ADAMS OR MT. BAKER CENTRAL AND NORTHERN CASCADES. 4 AREAS SOUTHERN CASCADES & SOUTHWEST COLUMBIA BASALTS.	8 HOLES DRILLED, 3 UNDER VOLCANIC ASH.

(a) The total estimated cost of the work under this contract is $309,878. Of this estimated cost, the Government will fund a maximum amount of $296,894.

(b) The Contractor and the Government have agreed to share the cost of all work performed in accordance with the provisions of this Contract in a ratio of 95.810 percent by the Government and 4.190 percent by the Contractor of all operating-funded costs determined to be allowable in accordance with the Clause of the General Provisions entitled "Allowable Cost and Payment." The Contractor will not share in the cost of the capital equipment. The Contractor shall be paid no fee for the work performed under this contract.

M.2.15

E FORM PR-799A (TEST)
AUGUST 1979

DEPARTMENT OF ENERGY

PROCUREMENT/FINANCIAL ASSISTANCE REQUEST-AUTHORIZATION

1. TO: J. P. Anderson Contract Administration

2. FROM INITIATING OFFICE: R. E. Wood Energy Technology

3. INITIAL: [ ] UPDATE: [X] 4. PROCUREMENT: [ ] FINANCIAL ASSISTANCE: [ ]

5. PR NUMBER: ________ 6. PR CORRECTION LETTER: _ 7. RELATED PR NUMBER: ________

ACTION IDENTIFICATION

8. TITLE: Washington Geothermal Assessment Program

9. UNSOLICITED PROPOSAL NO: ________ 10. PROJECT NO: ________ 11. CFDA NO: ____

12. PRODUCT OR SERVICE:* A63X 13. SUPPORT SERVICES: YES [ ] NO [X] 14. CONSULTANT AWARD: YES [ ] NO [ ]

15. CONTROLLED DELIVERABLE:* A6Y 16. REPORT/DRAWING REQ: YES [X] NO [ ] IF YES, ATTACH DETAILS.

17. CLASSIFICATION OF MATERIALS/WORK: U U — UNCLASSIFIED C — CONFIDENTIAL S — SECRET T — TOP SECRET

18. GOVERNMENT PROPERTY: P F — FURNISHED P — PURCHASED N — NOT INVOLVED IF CODE F OR P, ATTACH DETAILS.

AWARD PLANNING

19. AWARD AS ORDER UNDER BIN: DE-AC07-79ET27014 IF CODE T, ATTACH DETAILS.

20. DESIRED AWARD DATE: 04 01 80 (MONTH DAY YEAR) 21. KIND OF AWARD ACTION:* 1P 22. TYPE OF AWARD:* T

23. IF MULTI-YEAR AWARD, INDICATE NUMBER OF YEARS: _ 24. TYPE SOLICITATION INSTRUMENT * __

25. EXTENT OF COMPETITION:* __ IF COMPETITIVE, ATTACH TECHNICAL EVALUATION PLAN. IF NON-COMPETITIVE, ATTACH JUSTIFICATION. REF: DOE-PR 9-3.305.51 or 9-4.909(?).

26. SOURCE SELECTION PROCEDURE: 4 1 — A-E 2 — SEB 3 — OTHER 4 — NONE

27. FOR A-E, SHOW ESTIMATED CONSTRUCTION COST IN DOLLARS: ________

AWARDEE

IF COMPETITIVE, HAS LIST OF SOURCES BEEN ATTACHED? YES [ ] NO [ ] IF NON-COMPETITIVE, COMPLETE 28-31.

28. NAME: State of Washington 29. ADDRESS: Olympia Wash 98504

30. DIVISION: Dept of Natural Resources

31. GOCO/LAB: _ A — GOCO/LAB B — GOCO/NON-LAB C — NON-GOCO/LAB D — NOT APPLICABLE

FINANCIAL

AWARD VALUE — DOLLAR AMOUNT

32. GOV'T SHARE 311,284

33. TOTAL 311,084

34. CONSIDERATION IN KIND, LOAN, OR LOAN GUARANTEE DATA REPORTED ON PR-799C: [ ]

35. PROJECT PERIOD: FROM 04 01 80 THRU 03 31 81

CURRENT FY FUNDS COMMITTED

36. B&R NUMBER	37. FUND CLASS	38. DOLLAR AMOUNT
AM1510	E	299,084
35AM15	-	12,000
________	-	________

update of cost Amounts

39. FROM PR-799B (PART A) ________

40. TOTAL THIS PR ________

41. FUNDING PERIOD: FROM 04 01 80 THRU 03 31 81

42. APPROPRIATION SYMBOL: ________

43. ALLOTMENT SYMBOL: ________

44. OBJECT CLASS. ____

PROJECT MANAGER

45. NAME: M. A. Widmayer

46. SIGNATURE: Margaret A. Widmayer

47. DATE: 04 14 80 48. OFFICE CODE: ________

49. FTS TELEPHONE NUMBER: ________

PROGRAM OFFICIAL

50. NAME: R. E. Wood

51. SIGNATURE:

52. DATE: 04 14 80

CERTIFYING OFFICIAL

53. NAME: F. S. Smith

I HEREBY CERTIFY THAT THE FUNDS CITED IN ITEM 40 ARE AVAILABLE.

54. SIGNATURE:

55. DATE (MONTH DAY YEAR)

SEE BACK OF FORM FOR CODES

Contract # DE - A[illegible]07 - 79ET27014

State of Washington

Department of Natural Resources

Action — Modification of existing contract with a new definitive statement of work, and more money

Period — Effective 04-01-80 to 03-31-81

Finance — DOE share: $281,406 from AM 15-10
12,000 from capital equip
total $293,406

Capital Equip — (1) Downhole temperature probe ($4,000); (1) Radon emanometer ($4,000); (1) Mercury detector ($4,000)

Statement of Work

1. Heat Flow Drilling - eight heat flow holes to a maximum depth of 500 feet will be drilled in the Southern Cascades: Two holes will be drilled east of Mt. Saint Helens, one hole will be drilled in the Cowlitz Valley in the Puget Lowland, one hole will be drilled near St. Martins Hot Springs, and one hole will be located in the North Bonneville area. Changes in drilling location and/or number of holes must receive DOE approval prior to effective change. Drilling will be accomplished by a subcontract, which will have DOE approval prior to issuance by State of Washington.

2. Temperature Measurements - temperature measurements and thermal gradients will be obtained for all available existing wells in the southeastern Cascades, Yakima Valley, and southwestern Columbia Basin. A preliminary map and interpretation of these data, and existing data on file with this program, will be produced.

3. Geologic Mapping - Detailed geologic mapping of lithology and structures, rock analysis, and age dating will be conducted on one of the stratovolcanoes (i.e. Mt Adams or Mt. Baker). The study area to be studied will be approved by DOE prior to beginning work. Preliminary maps and interpretations of geothermal potential of the study area will be produced.

4. Gravity Survey - A subcontract will be issued to perform gravity surveys (one station per five square miles density) in the central and northern Cascades. Data reduction and preliminary interpretations will be produced. A gravity map of the Cascades of Washington will be prepared by 1982. This subcontract must have prior DOE approval prior to issuance.

5. Geophysical Interpretations - a task within this program is to assist in the evaluation of data as it relates to geothermal development in the state of Washington. It is understood that $5,000 will be available this year to buy consultant time, as required, to aid in the interpretation of geothermal information associated with this program.

6. Geochemistry - Water samples will be collected from thermal springs and wells along the Columbia and Wind Rivers, in the southeast Cascades, and in eastern Washington. Geochemical analyses will be performed on the samples as outlined in the participant's proposal, herein incorporated as part of this modification. Soil mercury and radon studies will

be conducted in these areas to help delineate faults associated with geothermal fluids. Preliminary maps and results of these surveys will be presented in the year end report.

7. Fault-lineament Map - Construct a well documented lineament map of south Cascades and southwest Columbia Basin areas. Field verification of lineaments and faults will be accomplished.

8. USGS GEOTHERM File - All pertinent information on geothermal resources will be transmitted to the USGS GEOTHERM File for encorporation.

9. Reports - Monthly Technical Progress reports, monthly budget summary reports, and year end topical and final reports will be prepared in accordance with DOE Form CR 537.

Capital Equipment will be a part of this award. The Government will supply CE funds for the contractor to purchase one temperature probe, one radon emanometer, and one mercury detector. Title to these pieces of equipment will rest with the Government.

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

MEMORANDUM

February 23, 1981

TO: Maggie A. Widmayer

FROM: Duncan Foley

SUBJECT: Washington geothermal map

Table 1, attached to this memo, is a summary of the status of thermal and mineral springs depicted on the Washington map. There are 61 springs shown on Table 1. Of these, the symbols for 19 indicate that temperature, flow, and tds data are known. 40 springs have temperature data (21 of which are not measured, but are only reported as "less than" or "greater than"). Two springs have intermediate data sets.

It is my feeling that the map, in its present state, is an inadequate representation of the geothermal potential of Washington. I suggest that rather than proceed with immediate publication, we delay publication until those sites listed in the Washington proposal have been analyzed for water chemistry and until all the sites have measured temperatures. This delay will probably be until the end of June, when their current funding expires.

Duncan

DF:jr

attachment

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA AND INFORMATION SERVICE
National Geophysical and Solar-Terrestrial Data Center
Boulder, Colorado 80303

2/17/81

Duncan Foley
UURI/ERL
420 Chipeta Way
Salt Lake City, UT 84108

Dear Duncan,

Please check the Washington proof for errors, changes, or whatever and make appropriate notes on the mylar overlay. I outlined the light gray areas on the overlay so that you could find the boundaries more easily.

After you have looked the proof over,please send it to Idaho Falls for their comments. At this point there are only minor changes to be made. Therefore, as soon as we get the proof back, we should be ready to go to GPO for a printing contract within two to three weeks. The faster we get the proof back, the sooner we will have a printed map.

Thanks.

Sincerely,
Ron Smith
Ron Smith
Data Mapping Group

Washington Geothermal Map
Spring Symbol Status
Proof Map

D. Foley
20 Feb 81

Reading N-S, W-E, in groups where appropriate

	SPRING NAME	UNDONE	PARTIAL	DONE	LISTED DEC '79 (FY 80)	COMMENTS
1	Dorr Fumerole Field	✓				
2	Sherman Crater Fumeroles	✓				
3	Baker HS		✓			
4	Sulphur Creek HS			✓		
5	Suiattle R. Min. Seep			✓		
6	Gamma HS			✓		
7	Kennedy HS			✓		
8	Piedmont Sulfur Sp.	✓				no measured T
9	Sol Duc HS			✓		
10	Olympic HS			✓		
11	Garland Min. Sp.		✓			
12	Little Wenatchee Soda Sp.	✓				no T
13	Skykomish Soda Sp.	✓			✓	no T
14	Money Creek Soda Sp.	✓			✓	no T
15	Scenic HS			✓	ok	
16	Medicine Sp.	✓				no T
17	Ravenna Park Sulfur Sp.	✓				no T
18	Bremerton Sulf. Sp.	✓				no T
19	Goldmeyer HS	✓			✓	
20	Diamond Mineral Sp.	✓			✓	
21	Flaming Geyser Sp.	✓			✓	
22	Lester Hs			✓		
23	Medicine Creek Mineral Sp.			✓		
24	Newskah Mineral Sp.			✓		
25	Alpha Mineral Sp.	✓				no T
26	Bumping River Soda Sp.	✓			✓	no T
27	Mt. Rainier Fumeroles	✓				
28	St. Andrews Soda Sp.	✓				no T
29	Indian Mineral Sp.	✓			✓	no T
30	Longmire Mineral Sp.			✓		
31	Ohanapecosh HS			✓		

D. Foley
20 Feb 81

Spring Name	Undone	Partial	Done		Listed	Comments
Summit Creek Soda Sp.			✓			
Packwood HS	✓				✓	
Little Rattlesnake Soda Sp.	✓					no T
Goose Egg Soda Springs			✓			
Ahtanum Soda Sp.	✓				✓	no T
Green River Soda Sp.	✓				✓	
Vance Mineral Sp.	✓				✓	no T
Orr Creek Wm Sp.			✓			
Klickitat Meadow Sp.			✓			
McCormick Meadow Soda Sp.			✓		ok	
Simcoe Soda Sp.	✓				✓	no T (>20?)
Pigeon Sp.	✓					no T
Mt. St. Helens Fumeroles	✓					appropriate?
Mt. Adams Fumeroles	✓					no T (>50listed
Soda Springs Creek Soda Sp.	✓				✓	no T
Fish Hatch(ery) Warm Sp.			✓		ok	
Government Mineral Sp.	✓				✓	
Little Soda Sp.	✓				✓	
Bonneville HS			✓			
Rock Creek HS	✓				✓	no T (on a HS!)
Shiperds HS	✓				✓	
St. Martins HS	✓				✓	
Collins HS	✓					
Little Wind River Min. Seep	✓				✓	no T
Klickitat Soda Sp.	✓				✓	
Klickitat Mineral Sp.	✓				✓	
Blockhouse Mineral Sp.	✓				✓	no T
Poison Lake	✓					belong @ top of list
Hot Lake	✓					" " " "
Warm Springs Canyon	✓					

67990

23 Feb., 1981

MEMORANDUM

TO: M.A. Widmayer

FROM: D. Foley

RE: Washington geothermal map.

Table 1, attached to this memo, is a summary of the status of thermal and mineral springs depicted on the Washington map. there are 61 springs shown on Table 1. Of these, the symbols for 19 indicate that temperature, flow, and tds data are known. 40 springs have temperature data (21 of which are not measured, but are only reported as "less than" or "greater than"). two springs have intermediate data sets.

It is my feeling that the map, in its present state, in is an inadaquate representation of the geothermal potential of washington. I suggest that rather than proceed with immediate publication, we delay publication until those sites listed in the Washington proposal have been analyzed for water chemistry and until all the sites have measured temperatures. This delay will probably be until the end of June, when their current funding expires.

Duncan - FYI

If any of these names need to be put back onto the map, let me know. - Ron Smith

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA AND INFORMATION SERVICE
National Geophysical and Solar-Terrestrial Data Center
Boulder, Colorado 80303

Geothermal Resources of Washington 1980

Deletions from USGS Base Map to eliminate squib overprinting

Columbia Basin
- Rattlesnake Flat
- UP BN
- Lind Coulee (drn)
- Cow Creek (drn)

Ephrata
- Moses Coulee (drn)
- Lynch Coulee (drn)

Yakima
- Umtanum Ridge
- Hog Ranch Buttes
- Squaw Creek (drn)
- Selah Creek (drn)
- Selah Springs (drn)

Cascade Range
- * Cliffdell
- Old Scab Mtn
- Bumping River (drn)
- Naches River (drn)
- Nile Cr (drn)
- Rattlesnake Creek (drn)
- North Fork (drn)

Mt. Rainier
- Dalles Ridge
- Arch Rock
- Greenwater River (drn)
- Grow Creek (drn)
- American River (drn)
- White River (drn)

Puget Lowland
- CMSTP&P
- * Kapowsin
- 3 4 (township)
- Tanwax Cr (drn)
- Ohop Cr (drn)

Mt. Adams
- Lakeview Mtn
- Walupt Lake (drn)
- Two Lakes (drn)
- Spring Creek (drn)

Indian Heaven
- Steamboat Mtn
- Trout Lake Cr (drn)

Mt. St. Helens
- Mt. Mitchell
- Siouxon Peak
- Yale Dam
- Green Knob
- Gumboot Mtn
- Spotted Deer Mtn
- Silver Star Mtn
- Bobs Mtn
- Larch Mtn
- Pyramid Rock
- * Vernorsborg
- Siouxon Cr (drn)
- Canyon Cr (drn)
- East Fork (drn)
- West Fork (drn)

Kennedy H. S.
- Pugh Mtn
- Twin Peaks
- S Fork (drn)
- North Fork (drn)

Mt. Baker
- Twin Sisters Mtn
- Sister Divide
- Bald Mtn
- Loomis Mtn
- Upper Baker Dam
- Mt. Josephine
- * Grassmere
- BN
- Sulphur Cr (drn)

Olympic H. S.
- Steamboat Mtn
- Spruce Mtn
- Slide Peak
- 9 10 (township)
- N. Fork (drn)
- South Fork (drn)
- Solleks R (drn)
- Hoh River (drn)
- Happy Lake Ridge

Physiographic Province Map
- Bachelor Island

* - city, town name
(drn) - drainage name
(township) - township-range number

Check base map (sent under separate cover) for specific locations.

Washington Geothermal Map
Spring Symbol Status
Proof Map

D. Foley
20 Feb 81

Reading N-S, W-E, in groups where appropriate

	1 SPRING 2 NAME	3	4 UNDONE	5 PARTIAL	6 DONE	7	8 LISTED DEC 79 (FY80)	9 Comments	
1	Dorr Fumerole Field		✓						
2	Sherman Crater Fumeroles		✓						
3	Baker HS			✓				data in IC 62	
4	Sulphur Creek HS				✓				
5	Suiattle R. Min. Seep				✓				
6	Gamma HS				✓				
7	Kennedy HS				✓				
8	Piedmont Sulfur Sp.		✓					no measured T	
9	Sol Duc HS				✓				
10	Olympic HS				✓				
11	Garland Min. Sp.			✓					
12	Little Wenatchee Soda Sp		✓					no T	
13	Skykomish Soda Sp		✓				✓	no T	
14	Money Creek Soda Sp		✓				✓	no T	
15	Scenic HS				✓		ok		
16	Medicine Sp		✓					no T	
17	Ravenna Park Sulfur Sp		✓					no T	
18	Bremerton Sulf. Sp.		✓					no T	
19	Goldmeyer HS		✓				✓		
20	Diamond Mineral Sp		✓				✓	data in IC 62	incomplete
21	Flaming Geyser Sp		✓				✓	data in IC 62	incomplete
22	Lester HS				✓				
23	Medicine Creek Mineral Sp				✓				
24	Newaukum Mineral Sp				✓				
25	Alpha Mineral Sp		✓					no T	
26	Bumping River Soda Sp		✓				✓	no T	
27	Mt. Rainier Fumeroles		✓						
28	St. Andrews Soda Sp		✓					no T	
29	Indian Mineral Sp		✓				✓	NO T	
30	Longmire Mineral Sp				✓				
31	Ohanapecosh HS				✓				

NOTE TO TYPIST
IGNORE ALL
CIRCLED WORDS
COMMENTS
COLUMN

D Foley
20 Feb 81
p2

	1 Spring	2 Name	3	4 Undone	5 Partial	6 Done	7	8 Listed	9 Comments
1	Summit Creek Soda Sp					✓			
2	Packwood HS			✓				✓	
3	Little Rattlesnake Soda Sp			✓					no T
4	Goose Egg Soda Springs					✓			
5	Ahtanum Soda Sp			✓				✓	no T
6	Green River Soda Sp			✓				✓	
7	Vance Mineral Sp			✓				✓	No T
8	Orr Creek Wm Sp					✓			
9	Klickitat Meadow Sp					✓			
10	McCormick Meadow Soda Sp					✓		ok	
11	Simcoe Soda Sp			✓				✓	no T (>20?)
12	Pigeon Sp			✓					no T
13	Mt. St. Helens Fumeroles			✓					appropriate?
14	Mt. Adams Fumeroles			✓					no T (>50 listed?)
15	Soda Springs Creek Soda Sp			✓				✓	no T
16	Fish Hatchery) Warm Sp					✓		ok	
17	Government Mineral Sp			✓				✓	
18	Little Soda Sp			✓				✓	partial chem in IC 62 incomplete
19	Bonneville HS					✓			
20	Rock Creek HS			✓				✓	no T (on a HS!)
21	Shipherds HS			✓				✓	
22	St. Martins HS			✓				✓	
23	Collins HS			✓					
24	Little Whind River Min. Seep			✓				✓	no T IC 62? incomplete
25	Klickitat Soda Sp			✓				✓	
26	Klickitat Mineral Sp			✓				✓	
27	Blockhouse Mineral Sp			✓				✓	no T
28	Poison Lake			✓					belong @ top of list (Sorry)
29	Hot Lake			✓					" " " " "
30	Warm Springs Canyon			✓					
31								3-ok 22 undone 2-not found	
				40	2	19			

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 most likely number in the hundreds.

done

done

?

its a swamp, DLN pers comm 1981

done

?

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, Cl^-, F^-, $SO_4^=$, Alk, and 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, SiO_2, Li, B, Fe, Hg, As, Cl^-, Br^-, F^-, and I^-.

Indian Soda
Mt. Hyak S
Scenic Madison HS
~~Gol Wheat Rvr~~
Bass LK
Fish Hat
McCormick Meadow

20 Feb 81
& comments

Washington Geothermal Map

Total 58 springs listed

Spring [redacted] status on [redacted] symbols

Undone	37	64%
Partial	2	3
Complete	19	33
	(Σ = 58)	100

Missing measured temperatures – 21 (36%)

(including 1 hot spring and 1 > 50°C fumerole field !)

listed + done (in Dec. 79) — McCormick Meadow Scenic
Fish Hatchery WS

2 springs listed – Mt Hyak
Bass Lake } not on map

27 [redacted] total
22 undone
3 done

2 can't find

Mt. Hyak (Cent. Cascades)

Bass Lake (along Col. Rvr.)

Campbell & others NW Sci v 44 no 1 p 1-11

Thermal Sp in Wash

Van Denburgh & Santos '65 WA Div H_2O Res H_2O Supp Bull 24

Grnd H_2O in WA

Taba & Crowder 69 PP604

ask Eric about mineral springs w/o analyses
Goldmeyer
why cold mineral springs
what is geothermometry on these?

>51°C

HS w/o Chem.

Shiperds HS	—
St. Martins HS	—
Collins HS	
Lil Wind River	—
Rock Creek	—
Packwood HS	—
Goldmeyer	—

6/7 listed

on table
24 >20°C
13 have geochem data

double check	listed in 79 (FY80) prog
Pigeon Sp	
Green River Soda Springs	—
Alpha Mineral Spring	
Flaming Geyser	—
Diamond Mineral	—
Bremerton Sulphur	
Ravenna Park Sulf. Sp.	
Government Min. Sp.	—
Little Soda Spring	—
Soda Spring Creek Soda Spring	—
Indian Mineral Spring	
Simcoe Soda	—
Ahtanum	—
Lil Rattlesnake	
Klickitat Soda Sp	—
Blockhouse Mineral Sp	—
Klickitat Mineral Spring	—
Vance Mineral Sp	—
St. Andrews Soda Spring	
Bumping River Soda Spring	—
Money Creek Soda Sp	—
Skykomish Soda	—
Little Wenatchee	
Garland	
× Piedmont Sulf Sp	

15/25 listed

29 Jan 81

w/ Wa teams • Dave Blackwell, MAW, f

regional basis - grav • T scrounging

7 areas S. Casc.

Yakima

Wood River

Tomac Plat.

Yakima Bsn.

Walla Walla

Cent. Col. Bsn.

Mt. St. H.

MK leaving out geoch. + geophys. expln.

ES on priorities - hi - finish reg. gravity - add detail

T scroung • work up interps

salaries - keeping spring anals. going

- geol. mapping 2ND priority - WSU, Hammond

Mt. Baker #5

Heat flo Drilling #3

#4 prin. - additional geolst.

ES - scrounging etc. will Σ 90K

DB - this summer ~75-100 holes in Yakima

Col. Bsn - hard data to 300-400m

lev eff - colln q ~ 100 new holes

N'n col bsn

move to Spokane

f - requested a prog. rev. -

proh. last wk in March

heat flow $ + scrounging $
might be balanced
more

heat flow yields only 8
data pts

WA @ pt of philos
detn of res -

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 a 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 wichwhich 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 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.

gradient ok, but heat flow?

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 (± 30° 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 conitinue 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. More widely distrib.

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~~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.

long term, but low cost

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 19~~3~~80 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).

<u>Contracted Geophysical Advice</u>

or stick w/, & make Sill a task of this?

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 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, Cl^-, F^-, $SO_4^=$, Alk, and 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, SiO_2, Li, B, Fe, Hg, As, Cl^-, Br^-, F^-, and I^-.

set up program w/ESL

With the acquisition of a field-portable mercury spectrophotometer with gold foil collector (included in the 1980 budget request under Capital Equipment), the 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 of 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 division as a bulletin.

more open distrib.

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 (Glennda 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 Washinnton team members.

CAPITAL EQUIPMENT

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

Most of the captial 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 ~~each~~ 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, temperture 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.
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 Salaries	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:	5,000
SUBTOTAL	$250,783
Overhead (17.85% on noncapital items)	42,623
TOTAL	$293,406

RAMADA INN

WA write up

Mike- hadn't done much -

role in prog. should he eval by DOE
a problem

ask before write up

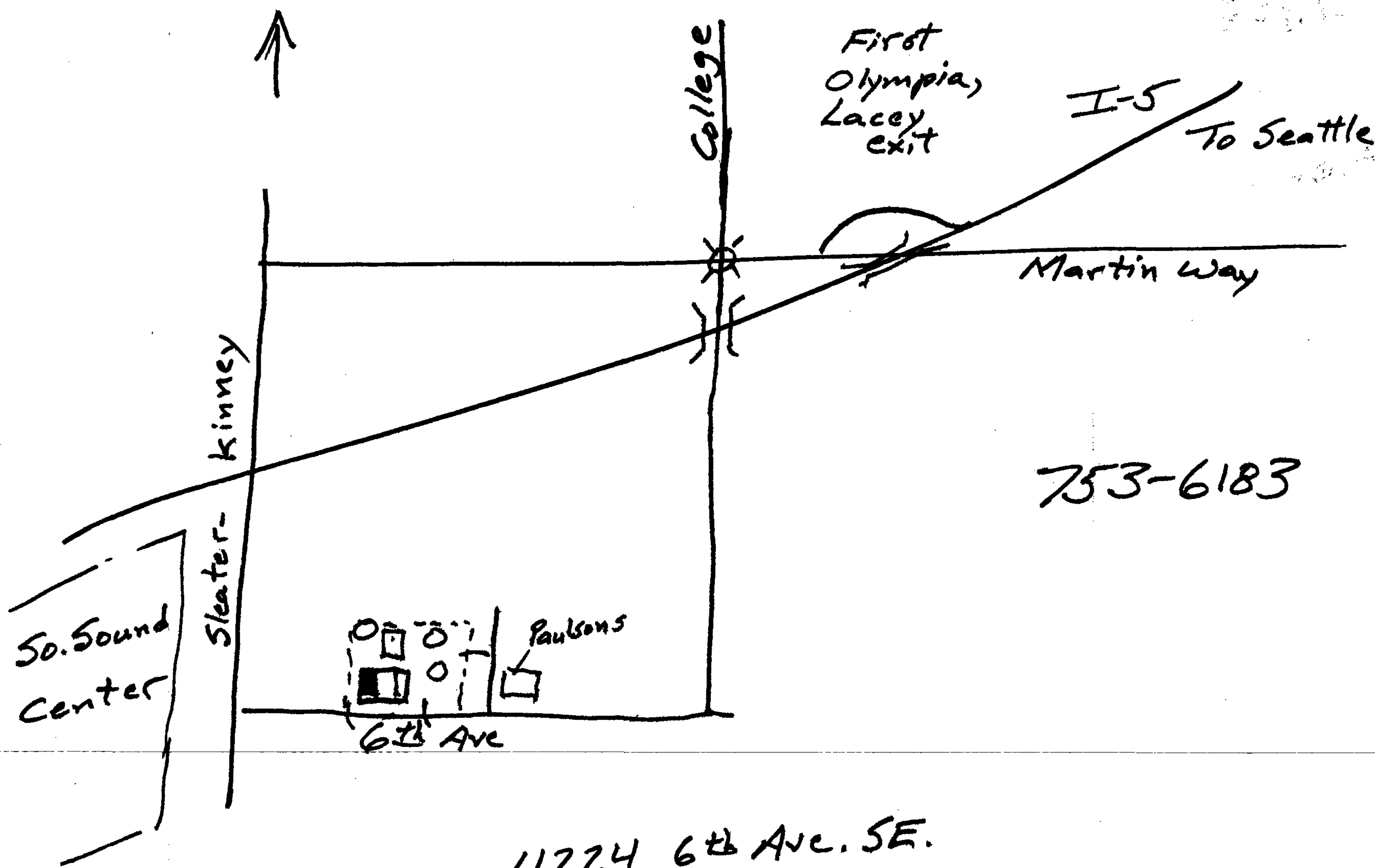
eric - list of Mt. St. Helens work
— have MAW ask

Glenna
Geoff
other sub

ask before write-up

Status of drilling —

i.e. — not done much



4224 6th Ave. SE.
Lacey

28 Oct. 80

DUNCAN,

SEATTLE FOLKDANCE

WEDNESDAY P.M. 7:30 - 9:00 pm
mixer afterwards 9:00 - 11:00 pm

@ THE WEBSTER ELEMENTARY SCHOOL

corner of 30th AVENUE NW
& NW 67th St.

ENJOY!

29 Oct. 80 ④

now - bslt + dacite in same area that Plio was only bslt.

Glenda - linems. - delay - St. Helens - working on ash

- imagery slow

has done linems. SLAR + Landsat., U2 (mostly drainage)

started St. Helens 1:100k on U-2 imagry

field, etc.

also topo map, regular air photos

not going E of 121°30 (PNL has done)

not enhancing much - getting own

olde state linem. map exists

PNL continuing along Col. Rvr gorge

→ send copy of Woodruff's lineament paper

tie in w/ mineralhs

has been in touch w/ Corps, etc.

problem - loss of gear @ Yakima

ESL find out about Chapman, etc.

mayhaps work out master order for tools/cable

does Chapman have design specs.

29 Oct. 80

Eric, Glenda, Mike, F, Geoff Clayton, Roald, Gordon

F-talked, w/o specifics, 'bout Mkt. Sh. Estim proj.
ES- reviewed Cascades mtg., regional mapping (1^{st})
gravity, aeromag, heat flo (2^{nd})
hydrology (3^{rd})
MAW split yesterday - power-on-line

ES- target defined already, but not recog. - i.e. Wind River

RB-DF: payoff targets } way to split, w/ unspec. %ages
longer term }
rather than E'n Wash vs Cascades

ES wants to incl. $ for publications
Dave's gravity is ongoing
Geoff

⟹ send Roald a copy of USGS agreement

St. Map - back to NOAA w/in a couple weeks
larger gray areas - will be expanded to lt. gry halos, dk gry
re-calc. gradients
Q-beds in Cascades

29 Oct. 80 (5)

this year - USFS probs w/ access @ St. Helens
- stas S, W, N of Mt. Ranier
- not yet subm. to USGS
Green River, Cedar R. 47'30" to S
this year also in Mt. Baker area (w/o M.Bak. proper)
Geoff - started w/ grant, USGS, extramural prog.
Pliocene - activity } volc
Pleisto - mid to upper
Wht. Pass - time vs composition
WA Casc - being uplifted
area - see Eocene rx up
Pliocene still exposed
highly silicic
now - dating
Gld into strat for explo } impression - volc not restricted to strata-volcs
Oligo Mio Plio Pleisto geoch. trends
2 groups of rx bslts
dacite → siliceous andes
migrating N w/ time
Plio. - struct. @ depth dikes & sills, similar to below 65±5% SiO_2
can see 3-D struct. filling
will be gathering Don Swanson's & Paul Hammond's work on geoch.
K_2O-age-depth rel'n too
1 mineralogy @ 1 SiO_2 comp.
- most probable location for silicic magma

29 Oct. 80 ②

Mike - Annual Report - submitted to MAW ~~last~~ @ GRC, no comments back

subcontracts plus in-house

13 spring repts

gravity

Geoff's open file

Camus resis. + holes

Mt. St. Helens - prelim. holes, lack of spgs.

bibliog. Blackwells tables missing

this year - geoch. & reg. hyd. "never has started up"

will follow drill to investig. thermal sites around

Wind River

Scenic - √'d 1 only, are more in region

Snoq. - rumor spg supposedly tiled off @ ski area

White pass region & to E

some may hit fault

volcs. in region < 500kybp

AMAX in '75 drilled SE of Mt Rainier

Burl. N'n drilling in Grn. Rvr.

indef. time sched, waiting

ZFD. Gravity - 1 sta/5 □ mi in Cascades

3 yr proj. - pretty well on sched

79 121-122½ Ore → Kowlitz (46°30)

data to GS in May for reduction, only got returned last Fri.

(shipping probs.

~50% ~~a~~ innac. (keypunching

Ephrata - 86°F H_2O in water mains - all the resource
N. Bonne. -
Yakima - hospital - warm wells
highschool
city park swimg pool } might go together
Wind River - U.S.F.S.

prob - size of projs. in WA is smaller (hospital)
might not be funded

WA 7 April 80

Well T >20°C
>140m
>50°C/km

ident as anom

variable T elim - shallow spokane

other dots - warm w/o meeting criteria

volc units - quat (most < 35) (dmi)
heat flow
spgs list - incl Fumeroles
faults map
cult connections
squibs
lease status

ES-interested in St Helens projects

Shell-going 15-20k N of Pomona
permit: Glen

Well-pred 50°C/km

Jack Mase w/Shell on deep T } ES's rave

→ ask Ted - who among commercial loggers could handle hi T best

band 8 - Glenna Landsat 3
rk. procedures @ UUPS

ES- USGS cascades - window dressing
what volcs-tics)
OW - EQ on St. Helen - what do data mean
'bout Cascades —
worthwhile of data

St. Funding - detailed work on specific areas
- salary for Mike, etc.

ES why cascades are where they are
subsurf. ~~Bg~~ structs.

nature of buried heat sources
discovery
economic
use

Sol Duc + Olympic -
Thrust Faults

UURI [redacted] support -

- assmt of projs & Advice - geophys esp, since none on staff
- would like genl geophys approaches to expln.

Models - needed for Col. Bsn.

→ A.A. data

RFPs on E.T. - to state teams

WA -

too much heat flow (all states)

tied in too much w/ long term (i.e. thesis) projects

need to "up" visibility of publications (all states)

✓ other components - coop w/ USGS
map
user inquiries

compare w/ presentation

MEMO ROUTE SLIP Form ERDA-93 (1-75) ERDAM 0240		See me about this. Note and return.		For concurrence. For signature.		For action. For information.

TO (Name and unit)	INITIALS / DATE	REMARKS
Duncan Foley	INITIALS DATE	Enclosed is a copy of draft FY 80 proposal for the State of WASHINGTON
TO (Name and unit)	INITIALS DATE	Please review and provide me comments by FEB 15, 1980 Thanx,
TO (Name and unit)	INITIALS DATE	Maggie

FROM (Name and unit)		REMARKS
M. A. Wromayer DOE-ID		
PHONE NO.	DATE 1/29/80	

USE OTHER SIDE FOR ADDITIONAL REMARKS

c43—16—83488-1 gpo

TO: State Coupled Program Core Group

FROM: Duncan Foley

SUBJECT: Meeting with Washington Resource Assessment Team

Date of Trip: 7 April, 1980

Place: offices of Washington Geology and Earth Resources Division; Department of Natural Resources, Olympia, Wa.

Purpose: Discussion of program direc State Coupled and User Coupled Program Interfaces

Attendees: Ted Livingston, Eric Schuster, Mike Korosec, Glennda McLucas Washington DNR
Gordon Bloomquist, WA. Planning and Commercialization team
Duncan Foley, ESL/UURI

General and Business

1. The Washington team has been keeping track of volcanic activity at Mt. St. Helens. They plan on resampling springs when the snow melts, and will also remeasure their thermal gradient holes.

2. Foley presented the discussion of the interface between the State Coupled Program and the User Coupled Confirmation Drilling Program.

Technical

1. The Washington team is aware of plans by Shell Oil to drill to 15-20,000 ft depths west of Yakima this summer, and they are interested in obtaining thermal data from this hole. Shell seems willing to share the hole, especially if it turnes up dry. The Washington team predicts a regional gradient in excess of 50°C/km at the site.

2. Data sent to NOAA for inclusion of the public map include:
   a. thermal springs and fumeroles, with supporting chemical data.
   b. Wells, separated into two catagories; the first [illegible] anomalous sites, where the temperature is about above 22°C, the depth is greater than 140 m, and the gradient is above 50°C/km, and [illegible] wells with an anomalous temperature that do not meet the other criteria.
   c. Cultural corrections to the base map.

d. Areas of Quaternary volcanic vents and flows.

e. Faults

f. Lease Status

g. Squibs

Action Items

1. ESL will report to Washington on loggers capable of 20,000 ft depth.

2. ESL will provide analytic proceedure data for rock analyses.

3. WDNR is interested in an evaluation of Band 8 Landsat images.

Mount St. Helens is the youngest and historically most active of the Cascade stratovolcanoes. At the time of this writing (March, 1980) Mount St. Helens had displayed a week-long series of earthquakes which were followed by eruptive activity of ash and steam. The area surrounding Mount St. Helens has been designated a Known Geothermal Resource Area by the U.S. Geological Survey on the basis of geology and competitive lease interest. Preliminary geological and geophysical studies including heat flow drilling have not yet established the geothermal potential of the area, and assessment activities are expected to continue over the next several years.

Geothermal gradients calculated from numerous wells located throughout the Columbia Basin indicate that extensive areas of southeastern Washington may be underlain by low temperature geothermal resources. These resources, either used directly or in conjunction with heat recovery systems, may be useful for space heating, industrial processing, and for many agricultural and aquacultural applications. As assessment of these potential resources is being conducted by the Washington Division of Geology and Earth Resources, with support from the U.S. Department of Energy.

The Cascade Mountains contain many youthful andesitic stratovolcanoes, smaller volcanoes, cinder cones, basaltic lava fields, and numerous thermal and mineral springs. In the future, this geologic province may provide large quantities of geothermal fluids to help meet the energy needs of the area. Present studies by the U.S. Geological Survey and the Washington Division of Geology and Earth Resources are aimed at assessing the geothermal potential of the area.

Mount Adams is the second largest Quaternary stratovolcano in Washington, but no eruptive activity has been reported during historic times. The geothermal potential of the area is poorly defined, due in part to land status situations which restrict accessibility for assessment activities. Mount Adams is divided into the Mount Adams Wilderness Area, where development is prohibited, and the Yakima Indian Reservation, where development is restricted to projects initiated or approved by the Yakima Nation.

Kennedy Hot Springs, which has been designated as a Known Geothermal Resource Area by the U.S. Geological Survey, is closed to development because of its location within the Glacier Peak Wilderness Area.

The City of Ephrata is presently designing heat recovery systems which will utilize $30^{0}C$ water from city wells to heat several public buildings. Preliminary engineering and economic studies indicate that energy use from present sources could be reduced by two-thirds, cutting energy costs by more than 50 percent.

Olympic and Sol Duc Hot Springs, once developed into extensive spas in the early 1900's, are now part of the Olympic National Park. The facilities at Olympic Hot Springs have been removed and the springs have returned to a natural state. The facilities at Sol Duc are now operated by the Park Service. Because both spring systems are in a national park, they are withdrawn from exploration for geothermal energy by the private sector. The Park Service is reviewing plans to upgrade the facilities at Sol Duc which would include a more extensive use of the geothermal resource.

The Puget Lowland is a region of below average heat flow and geothermal gradient. Heat flow values range from 20 to 40 milli watts/m^2. The geothermal gradient of the region ranges between $10^{\circ}C/km$ and $30^{\circ}C/km$. Gradients increase to the east in the Cascades, and to the west as the East Pacific Rise is approached.

Thermal activity at Mount Baker increased dramatically in 1975. The venting of large amounts of steam from fumaroles in the summit crater is estimated to have an energy equivalent as high as 30 megawatts, about 15 times the pre-1975 level. The last eruptive activity occurred in 1870, when great volumes of smoke issued from the summit crater. The area surrounding Mount Baker may have the potential for providing cities to the west with high temperature geothermal energy.

Several warm water irrigation wells have been drilled in and around the City of Yakima. A preliminary economic and engineering study, funded by the U.S. Department of Energy, is presently assessing the potential for the economic utilization of this water for space heating and possibly industrial application.

The town of North Bonneville, located in an area of thermal springs, is investigating (with assistance from the U.S. Department of Energy and the Washington Interagency Geothermal Development Council) the potential for the development of a geothermal heating district.

The Indian Heaven Known Geothermal Resource Area was established by the U.S. Geological Survey on the basis of competitive lease interest. Heat flow drilling by the Washington Division of Geology and Earth Resources in 1975 failed to establish the existence of a large scale heat source within the area.

Mount Rainier, the largest and most famous of the Cascade stratovolcanoes, had its last reported eruption in 1870. Thermal springs are present at Longmire and Ohanapecosh, and steam caves are found near the summit. Because it is a national park, Mount Rainier is withdrawn from exploration for and development of geothermal resources. Areas surrounding the park, however, have received considerable attention by exploration companies.

To: Oct. 31, '79

Duncan Foley
Earth Science Lab of the Univ of Utah Res Inst
420 Chipeta Way
Salt Lake City, Utah, 84108

Dear Duncan

Here are the rock samples I have selected for K-Ar dating. I have sent 10 samples altogether, which I have numbered by priority from 1-7. Sample 1-A has the highest priority, sample 7 the lowest. Samples with priority rating 1, 3, and 5 are ~~~~ A + B paired. If sample A is not suitable for dating then sample ~~the~~ B is a different rock believed to be of similar age that is perhaps more suitable for dating. Here is a description of each sample:

Priority - 1-A, Sample PWC-2; Basalt, SiO_2 49.5%, K_2O 0.58% alteration minor, Reversed polarity, believed to be middle Pleistocene in age.

Priority - 1-B, Sample PWC-4b, Andesite - Basaltic, SiO_2 55.3, K_2O 1.81% alteration minor, Reversed polarity, believed to be middle Pleistocene, stratigraphically above PWC-2 though contact between them is not exposed.

Priority - 2, Sample GR-DH; Olivine basalt, magmatic resorption of olivine w alteration to Iddingsite, otherwise fresh. No chemical data yet. Magnetic polarity Normal? Previously mapped as Quaternary - could be much older.

Priority - 3-A, Sample McN-g; Rhyodacite, large biotites and hornblende are found in this unit. I've hopefully sent enough for a crystal separation. This sample will be checked for zircon for fission track dating this winter. Fresh except for magmatic resorption of biotites. Biotites are poikilitic. Previously mapped as Oligocene to Miocene - I believe it could be much younger - Pliocene.

Priority - 3-B, Sample McN-h; hornblende porphyry, large hornblendes may be suitable for separation. Hornblendes appear fresh in T.S. This is believed to be an intrusive phase of McN-g or an associated pluton

Priority - 4, Sample HM-5P; basaltic andesite, Normal magnetic polarity, fresh, either early or late Pleistocene.

Priority - 5A Sample TP-TS-2; andesite, no ~~thin~~ this section or chemistry yet but appears altered. Previously mapped as middle Pleistocene I believe it is much older.

Priority - 5-B, Sample GR-TP; andesite, no T.S or chem yet, stratigraphically below 5-A. Could be as old as Oligocene.

Priority 6, - Sample RM-5: fresh fine grained andesite SiO_2 58.5% K_2O 1.20%. fresh plagioclase phenocrysts. Quaternary - Pliocene age.

Priority 7 - Sample SFCCF-66. basalt, very fresh, ambiguous magnetics, SiO_2 53.5% K_2O 0.87%. Late Pleistocene.

Marshall Reed originally O.K.'d 3-5 samples. Since I am using alternative support for my major element geochemistry some extra support for K-Ar work seems resonable I'll ~~tto~~ double check this with him. ~~but samples 1-5 or 6 or 7~~ Good luck with the samples, they were selected and collected with great care. There is more of all of them and thin sections and geochemical data for all of them will be ready in one month.

thanks and good luck

Geoff Clayton

Geoff Clayton
Dept. of Geology
Univ. of Washington
Seattle, 98195
206-543-1772

4757 18th Ave N.E.
Seattle, Washington
98105
206-523-7393

31 Mar 80

Duncan Foley
Univ. of Utah Research Inst.
Salt Lake City, Utah.

Dear Duncan,

Included are a few more pounds of rock. These samples include remnants from the thin section making process. All cut surfaces were made with a water lubricated thin section saw. Below I will again summarize the sample material I have sent you and update the priority status of each sample. This is the fourth set of samples I've sent you.

PLC - 2 or 3 Penoyer Lake Creek olivine basalt
.58% K_2O, 1.09% L.O.I. (x-ray fluorescence, Loss On Ignition)
RRMP (Reversed remnant magnetic polarity)
minor alteration of olivine to Iddingsite - fresh
topographically below and very close geographically to PLC-4

PLC - 4 or 5 Penoyer Lake Creek andesite (plag-pyroxene)
1.81% K_2O, .89% L.O.I.
RRMP
minor alteration of matrix but overall - fresh

The PLC pair of samples are # 1 priority. As soon as data on their ages is available please send it to me. PLC 2 or 3 should be older than PLC-4 or 5 but I doubt their ages difference will be resolvable. I have sent samples of this material in 3 previous parcels. None is included in this parcel but more is available if you need it.

McN-h McNeil Peak hornblende porphyry
1.43% K_2O 1.62% L.O.I.
RRMP? weak signals
minor post magmatic alteration - med. fresh
occurs as ridge capping unit due to inversion of relief or resistance to erosion - Pliocene is my inference but possibly as old as early Miocene

McN-q McNiel Peak quartz phase @ biotite, hbld, plag, phenocrysts
1.62% K_2O 1.23% LOI
RRMP ?
magmatic resorption of biotite but little subsequent weathering. - fresh
the extrusive phase of McN-h? Bulk major element geochem of two very similar

The McN-q-h pair of samples are now #2 priority. I would be surprised if a difference in age is resolvable between the two - but one offers hbld for crystal separate dating and the other biotite (and hornblende). More of McN-q is available, I will send a bit more here and all of the remaining McN-h.

HM-SP-1, Hogback Mtn, Shoe Peak -1. basalt
$.89\%$ K_2O, 1.00% LOI
NRMP (normal)
fresh flow in a ridge top position
less than 700,000 years.

This basalt is now #3 priority. It is fresh and fine grained from a massive part of the flow. I'm sending you all that I have of this sample. I didn't send any of this in parcel #3.

RM-5, Round Mtn. andesite
2.89% K_2O $.56\%$ L.O.I.
NRMP ? weak
fresh flow from mtn top.
This I have inferred to belong to a small middle Pleistocene andesite cone. From 1 million to 500,000 years old?

this andesite has high K_2O and I have good control on its stratigraphic position. I'll send you all I have, if that is not adequate I can send you an alternative sample from lower in the section. Listed here as priority #4

6'

SFCCF - 6mm (etc.) South Fork Clear Creek Falls basalt.
$.87\%\ K_2O$ $.10\%$ L.O.I.
NRMP
very fresh
overlies and underlies glacial till and ?
a hornblende andesite flow. Maybe 100,000
years old or less

This basalt may be the youngest sample I've sent you but its unique stratigraphic position and possible ice contact relationships make it very important. I have many more pounds of this, I'll include some more here since it is young and has low K_2O. I put it at priority #5 because it may be too young and mafic to get a good date off of but its very important. All of these first 5 samples are high priority since these dates are supposed to be included in my thesis and the state report to the D.O.E. The middle of May is the deadline for inclusion of this data in either report, the sooner the better.

DH-2, GR-DH-2, Devils Horns - 2 basalt.
$.60\%\ K_2O$ $.23\%$ L.O.I.
?
fresh - olivine little altered
late Oligocene to middle Miocene age

#6 priority basalt, important date for expanded regional mapping to be done this summer.

IC-12 + 13, Indian Creek, hornblende andesite
$2.72\%\ K_2O$ $.35\%$ L.O.I.
NRMP
fresh but @ many fine cracks, some amygdules
a hornblende andesite @ anomalously high
K_2O.

I included this to substitute for the Tieton Peak andesite.

TP-1 & TP-2 are deeply weathered except for the cores which I sent to you in parcels 1 + 2. Since I have no further sample for these two units I substituted IC-12 or 13 (Indian Creek) for it. However I have since reconsidered the IC samples, and due to alteration, vesicularity and their unexplained anomalously high K_2O content I think dating of this sample should be deferred. Perhaps you could send TP-1, TP-2, and the IC samples back to me.

To summarize:

With all possible haste please date:

	PLC - 2 + 3	parcels 1, 2, 3,	none here more available
	PLC - 3 + 4	" " " "	" " " "
	McN - h	" " " "	some included no more
fission track control (check)	→ McN - g	" " " "	some included more avail
	HM-SP-1	parcels 1 + 2	all remaining included
	RM-5	parcels 1 + 2 + 3	" " "
	SFCCF - (bm)	parcels 1 + 2 + 3	some included - more avail

With no particular rush please date:

DH-2	parcels 1 + 2	some included no more

Do not proceed with:

TP-1
TP-2 } please return
IC-12 + 13 Indian Creek

included some RM-4 - although the outcrop is not continuous between these two samples they are probably the same flow (petrographically & geochemically similar) and stratigraphically they occupy the same position so any age difference would be negligible.

Lastly - if you could send me a note acknowledging that you've received the last two parcels of rocks I'd appreciate it.

Sincerely, [illegible]

2 Nov. 79 ①

w/: LLMink, MA Widmayer
E. Schuster
f
@ Id Falls

Michael Jackson WRD Tac. @ Blackwell student
└ calibration was off, so can use as gradients but not as absol. temps
~70 useful gradients, mostly in Columbia Basin, on a few in Puget Sound
~6 @ > 100°C/Km
in Col. Bsn., ~~temperatures~~ blackwell grads. all ≤ 45°C/km
Jim Crosby WSU, has ~400± logs in Col. bsn - can put on map
once data are accum. - ES wants to ident.

@ present, map - will emphasize gradients

GEOTHERM - ES feels "worthless" - is Battelle's version (Gary Lane)
└ uncomfortable about calc., rather than meas., gradients
ES - could cover same area w/ his stuff
WATSTOR - MKor. has printouts - has looked @ some geoch., Temps.,
└ calcs. show gradients 2°C/km → 1000°C/km; i.e. not particularly
Hunting & Jackson meas 89 gradients in vicinity of I5 S of Olympia, to eop Longview
Castle - Camas
trying to catch gradients @ W'n rise of Cascade higher heat flow
transition zone, on I 19°C/km gradient, or due to regional hydrology
└ thru St. Helens?
emphasis now on defining transition by heat flow

2 Nov 79 (2)

next year - will do scrounging as emphasis, not as much drilling
Yakima Valley → Tri-Cities
drilling @ Camas - will start soon
Tonns legal release
ES - finding coming up, from old timers, lots of new spgs.

G. Clayton - Tumac mtn / wht. Pass area
mapping almost finished - rk. geoch., etc.

Dan's gravity - 743 stas., tied into previous surveys
will fill in next year w/ heliocopter help from USGS
big map from ZFD due by 1 June 80
elevations - getting photogram
also N. Bonne. gravity
Dave Williams - will be doing

Map - might use T ~ 20°C ground H_2O as new def'n of 790 lo T areas
will adapt symbols

Next yr - 8 holes - continue traverse E of White Pass to Scrounge holes in Yakima
Oly - WW linem - lots of warm wells
Ephrata - warms
are other sites @ HS
@ Wind River, too
N. Bonne support

ES - "we'd rather stick w/ regional"

10-26-79

Proposed Budget: USDOE Washington State Geothermal Resource Assessment Program, Calendar 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	18,460
Thesis Support: a) Mt. Baker or Mt. Adams geology, U of Wa., Kevin Kennedy	15,000
b) Columbia Basin geothermal resource assessment using water-well gradient data, WSU, under Dr. Crosby	15,000
*Central & North Cascades Regional Gravity: Z. F. Danes	30,000
Contracted Geophysical Advice	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) Downhole temperature gear	4,000
b) Radon Emanometer	4,000
Lab. Operating Expenses, Rent, Goods, Services, Lineament Mapping Imagery:	10,000
SUBTOTAL	$251,783
Overhead (17.85% on non-capital items)	43,515
TOTAL	$295,298

Progress Report,
Washington State Geothermal Resource
Assessment Program

Oct. 29, 1979

Temperature Gradients and Heat Flow

A. Early in the summer Michael Jackson, an employee of Dr. D. D. Blackwell, digitized temperature logs from some 215 water wells. These wells were logged by the USGS Water Resources office in Tacoma. Most of the measured wells are located in the Columbia Basin. A preliminary examination of these temperature logs indicates that about 70 of the logs are usable. Of these there are a few with gradients above 100°C/km. Most gradients are in the 30 to 50°C/km range. Dr. Blackwell has these data and will further analyze them.

B. We have examined the temperature gradient data in GEOTHERM and find that the gradients were calculated on the basis of bottom-hole temperatures and mean annual surface temperatures. In our opinion the GEOTHERM data are worthless. We will soon be prepared to replace the GEOTHERM data with measured gradients, thereby eliminating most of the uncertainty that diminishes the usefulness and accuracy of the present GEOTHERM gradients.

C. We have examined a portion of the USGS WATSTORE data as well, and find that water temperatures and well depths are often reported. However, gradients calculated from such data are subject to the same problems as the current GEOTHERM data, or worse, so we will not attempt to report gradients from the WATSTORE data.
We will, however, use the water temperature and chemical data from WATSTORE in an attempt to identify anomalous areas in which we could do gradient measurements and water sampling.

D. Dr. J. W. Crosby, Washington State University, has been measuring temperature gradients in the Columbia Basin for several years. We are making arrangements with Dr. Crosby to have his 400-500 gradients reproduced and sent to us.

E. During the summer, Marshall Huntting and Michael Jackson measured gradients in 89 existing wells in the southwestern Cascades and adjoining Puget Lowland. About 52 of these gradients appear to be useful.

F. We are sending all of the above temperature data to Dr. Blackwell as we accumulate them. We anticipate that he will be conducting further analyses on the gradients with the aim of producing a set of gradient, heat-flow, and mean surface temperature maps that are much more detailed than any done previously. A preliminary set of such maps, based on data now in hand, is being prepared by Dr. Blackwell for use in compiling a "public" geothermal resources map for NOAA.

DRILLING

Seven heat-flow holes have now been completed by our contractor, Soil Sampling Service. Holes that reached the 500-foot target depth are White Pass (sec. 2, T. 13 N., R. 11 E.), Packwood (sec. 16, T. 13 N., R. 9 E.), and Davis Mountain (sec. 3, T. 12 N., R. 8 E.). Completed holes that failed to reach 500 feet are Longmire (325 ft., sec. 6, T. 14 N., R. 8 E.), Ohanapecosh (375 ft., sec. 8, T. 14 N., R. 10 E.), Randle (421 ft., sec. 16, T. 12 N., R. 7 E.), and Mount St. Helens No. 1 (404 ft., sec. 18, T. 9 N., R. 5 E.).

Gradients are as follows:

Longmire - $64^{o}C/km$, 265' to 325', disturbed.

Ohanapecosh - $45^{o}C/km$, 200' to 365', not entirely equilibrated

White Pass - $51^{o}C/km$, 70' to 480', two linear segments with similar gradients; $51^{o}C/km$ is an average.

Packwood - $48^{o}C/km$, 110' to 335', nearly the same gradient from 350' 495'. Reasonably linear.

Davis Mountain - Isothermal; we appear to have drilled the hole in a "thermally decoupled" block.

Randle - $42^{o}C/km$, 35' to 415', not entirely equilibrated.

St. Helens No. 1 - $19^{o}C/km$, 90' to 404', gradient still disturbed from cementing and drilling but is undoubtedly "real".

Drilling is still in progress at St. Helens Nos. 2 & 3, and the two holes at Camas are yet to be drilled. A hole between Morton and Randle is still needed to complete the Cowlitz Valley profile and more closely define the nature of the transition between the low gradients to the west and the "High Cascades gradients" ($\pm 50^{o}C/km$) to the east. However, because of extensive time overruns in the drilling, we don't plan to drill this hole until next year.

WATER GEOCHEMISTRY

Our geochemistry lab is almost fully functional now, and Mike Korosec has sampled and analyzed 37 waters from 20 different spring systems. No previous analyses have been published for 8 of these spring systems. Elements, chemical species, and properties being measured include conductivity, pH, temperature, chloride, alkalinity, sulfate, silica, sodium, potassium, calcium, magnesium, lithium, flouride, bromide, and iodide.

Since the lab. has become fully operational only recently we expect to be able to turn out a considerably larger number of analyses next year.

GEOLOGIC MAPPING

Geoff. Clayton, U of WA graduate student, is on a subcontract to map the geology in the Tumac Mountain-White Pass area to the south and east of Rainier National Park. He has completed all of the field mapping except for a few "fringe areas" and is now engaged in lab. studies including petrography, age dating, and rock geochemistry.

CAMAS

A D.C. resistivity survey was completed by Dr. Bob McEuen and SAI, Inc. Results show a low resistivity area (10-15 ohm-meters) at the northwest end of Lacamas Lake and another fairly low resistivity area (ca. 50 ohm-meters) at the southeast end of the lake. Other resistivities are ±150 ohm-meters.

A moderately detailed gravity map for the Camas area has been completed by Dr. Z. F. Danes. An interpretation of the regional aeromagnetics has been made by Dave Williams and a couple of low-temperature non-mineral springs have been sampled by SAI, Inc., and analyzed by Crown Zellerbach.

Two drill sites have been selected to test the two resistivity anomalies.

REGIONAL GRAVITY

Dr. Z. F. Danes has measured gravity at 743 stations in the south Cascades and has tied into previous gravity surveys. The study area is now adequately covered except for a few inaccessible areas. These will be covered next year with the aid of a USGS helicopter (courtesy of Dave Williams). Computations will continue through the winter with the expectation that a south Cascades gravity map and report will be ready by June 1, 1980. Dr. Danes has also produced relatively detailed gravity maps for the Camas and North Bonneville areas, the former under his subcontract from the Department of Natural Resources and the latter through an arrangement with the City of North Bonneville.

"PUBLIC" GEOTHERMAL RESOURCES MAP

Planning and data acquisition for a public geothermal resources map of Washington has been progressing in cooperation with Duncan Foley of UURI (University of Utah Research Institute), Rod Smith of NOAA (National Oceanic and Atmospheric Administration), and Gordon Bloomquist and Stuart Simpson of OIT (Oregon Institute of Technology). We intend to have "Camera ready" materials ready for printing by NOAA by the end of calendar 1979.

SOL DUC HOT SPRINGS

We have kept in contact with the National Park Service through Gordon Bloomquist and have collected water samples, and run preliminary magnetic and shallow resistivity soundings at Sol Duc Hot Springs. The magnetic and resistivity surveys have yet to be interpreted.

GEOTHERMAL BIBLIOGRAPHY

The bibliography contains approximately 100 citations of publications pertinent to the State of Washington. It will soon be open-filed and will continue to be updated.

COORDINATION WITH OTHER GROUPS

We are keeping abreast of the geothermal-related activities of the USGS, State Energy Office, Oregon Institute of Technology, Seattle City Light, Crown Zellerbach, Burlington Northern, and City of North Bonneville. We will continue to cooperate with such organizations and provide basic data to them whenever possible.

J. Eric Schuster

FROM
J.E. SCHUSTER, GEOTHERMAL ENERGY POTENTIAL OF WASHINGTON,
WASHINGTON DEPT. OF NATURAL RESOURCES,
DIVISION OF GEOLOGY AND EARTH RESOURCES, INFORMATION CIRC. No. 50,
1974

DUNCAN

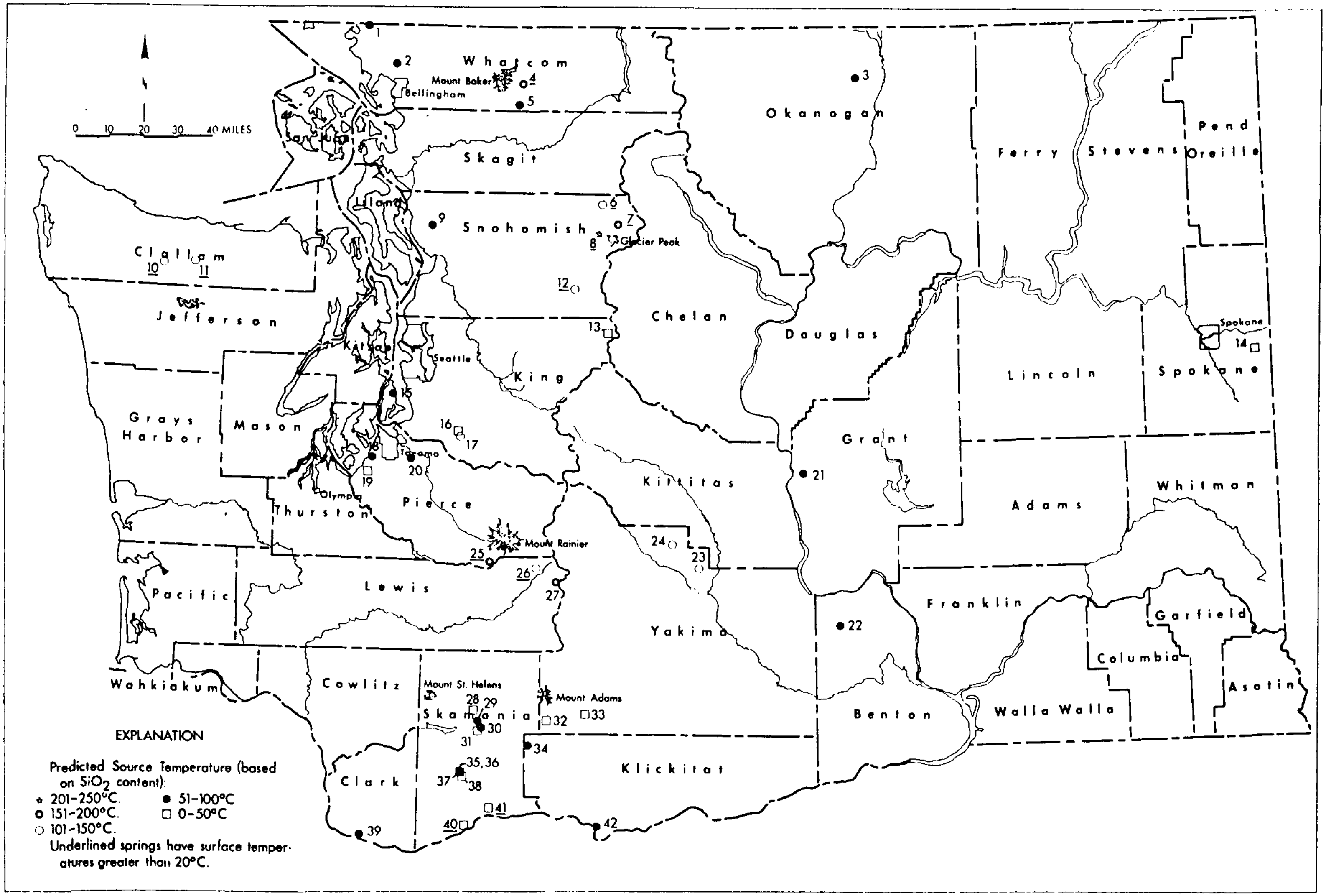


FIGURE 2.— Selected springs in Washington. (See table 1 for analytical data and predicted source

TABLE 1.--Estimated source temperatures for spring water, Washington. (For spring locations see figure 2.)

Map number	Spring name	Location	County	Temperature (°C)	Flow (gpm)	pH	Cl	SiO_2	Na	K	Na/K, Atomic ratio	Predicted Source Temperature (° C) SiO_2	Na/K	Source of data [1]
							(parts per million)							
	THERMAL SPRINGS (OVER 20° C)													
8	Kennedy	NE¼ 1, (30-12E)	Snohomish	34	30	7	612	380	808	67.8	20	227	170	Campbell and others, 1970
	Do ---	--------- do ---------	--- do ---	est. 30	est. 3-5	7.7	643	136	655	64	17	154	188	Tabor and Crowder, 1969
	Do ---	--------- do ---------	--- do ---	----------	--------	6.5	676	0	660	75	15	---	200	Div. Mines and Geology files, 1971
25	Longmire	Near SE cor. 29, (15-8E)	Pierce	21	--------	6	615	170	402	37.2	19	168	175	Campbell and others, 1970
7	Gamma	est. SE cor. 24, (31-13E)	Snohomish	est. 60	est. 3-4	7.9	728	150	491	77	11	160	238	Tabor and Crowder, 1969
4	Mount Baker	SW¼ 20, (38-9E)	Whatcom	42	7	8	108	140	165	10	27	157	142	Campbell and others, 1970
12	Garland	NW¼ 25, (28-11E)	Snohomish	21	--------	6	2671	120	1592	130	20	148	170	Do
	Do ---	--------- do ---------	--- do ---	7	25	6	461	BDL	358	28	22	<50?	160	Do
11	Olympic	SW¼ 27, (29-8W)	Clallam	46	135	7.5	0.5	120	74	1.3	97	148	<80	Do
	Do ---	--------- do ---------	--- do ---	38	--------	7.5	0.5	90	65	1.1	100	132	<80	Do
	Do ---	--------- do ---------	--- do ---	47	--------	7.5	0.7	80	78	1.3	102	125	<80	Do
	Do ---	--------- do ---------	--- do ---	46	--------	7.5	0.7	70	77	1.3	100	118	<80	Do
	Do ---	--------- do ---------	--- do ---	43	--------	7.5	0.6	70	73	1.3	95	118	<80	Do
	Do ---	--------- do ---------	--- do ---	47	--------	7.5	0.7	60	77	1.4	94	110	<80	Do
	Do ---	--------- do ---------	--- do ---	30.5	--------	7	0.4	30	51	0.9	97	75	<80	Do
	Do ---	--------- do ---------	--- do ---	26	--------	6-7	BDL [2]	BDL	39	0.7	95	<50?	<80	Do
	Do ---	--------- do ---------	--- do ---	48	--------	7.5	BDL	BDL	79	1.5	90	<50?	<80	Do
10	Sol Duc	NW¼ 32, (29-9W)	Clallam	50	50	7.5	1.7	120	84	1.6	88	148	<80	Do
	Do ---	--------- do ---------	--- do ---	42	--------	7.5	1.7	70	81	1.2	116	118	<80	Do
	Do ---	--------- do ---------	--- do ---	56	--------	9.2	17	58	80	2.6	52	105	95	Van Denburg and Santos, 1965
	Do ---	--------- do ---------	--- do ---	8.5	--------	4.5	BDL	BDL	BDL	BDL	---	<50?	---	Campbell and others, 1970
6	Sulphur	NW¼ 19, (32-13E)	Snohomish	37	4	8	52	120	108	2.4	77	148	<80	Do
	Do ---	--------- do ---------	--- do ---	est. 30	est. 1-2	7.8	54	75	103	1.7	103	122	<80	Tabor and Crowder, 1969
	Do ---	--------- do ---------	--- do ---	----------	--------	8.6	100	0	96	2	82	---	<80	Div. Mines and Geology files, 1971
26	Ohanapecosh	NW¼ 4, (14-10E)	Lewis	40	60	7	869	80	981	51	32	125	128	Campbell and others, 1970
40	Bonneville	SW¼ 16, (2-7E)	Skamania	32	20	9.5	151	BDL	126	1.5	143	<50?	<80	Do
41	St. Martin's	SE cor. 21, (3-8E)	--- do ---	49	--------	7	636	BDL	291	6.2	80	<50?	<80	Do
	NONTHERMAL SPRINGS (UNDER 20° C)													
27	Summit Creek	Near cen. 13, (14-11E)	Lewis	13	--------	6	1552	170	1790	87	36	168	120	Campbell and others, 1970
17	Flaming Geyser	SE¼ 27, (21-6E)	King	12.5	--------	8.5	5600	90	4640	35	226	132	<80	Do
23	H. E. Mulford	SW¼ 3, (14-18E)	Yakima	15	--------	7.6	9.1	66	13	5.8	4	114	>300	Van Denburgh and Santos, 1965
24	Malotte	SE¼ 32, (16-17E)	--- do ---	17	--------	7.7	1.8	53	17	4.3	7	103	>300	Do
36	Bubbling Mike	31, (5-7E)	Skamania	8.5	--------	6.5	276	50	176	5.1	58	100	88	Campbell and others, 1970
39	City of Vancouver	SW¼ 33, (2-2E)	Clark	10	--------	----	2.9	50	4.2	5.6	1	100	>300	Van Denburgh and Santos, 1965
42	M. A. Leonardo	NW¼ 21, (2-13E)	Klickitat	14	--------	----	5.0	48	7.8	2.1	6	98	>300	Do
21	Unknown	NW¼ 32, (19-23E)	Grant	----------	--------	----	6.0	47	------	----	-----	97	---	Do
35	Iron Mike	31, (5-7E)	Skamania	10	--------	7	318	40	211	6.2	58	90	88	Campbell and others, 1970
22	Rattlesnake	NE¼ 29, (12-25E)	Benton	----------	--------	7.8	2.8	36	7.2	1.7	7	82	>300	Van Denburgh and Santos, 1965
9	Edwards	SW¼ 24, (31-4E)	Snohomish	10	--------	7.5	3.6	31	5.6	1.4	7	77	>300	Do
20	Maplewood	SE¼ 32, (20-4E)	Pierce	8	--------	----	2.1	30	4.5	1.6	5	75	>300	Do
15	King County Water Dist. 19	SE¼ 29, (23-3E)	King	8	--------	7.3	6.0	28	6.0	1.2	8.5	70	275	Do
34	Bear Creek	SE¼ 20, (6-10E)	Klickitat	13	--------	7.1	1	24	5.4	0.6	15	68	200	Div. Mines and Geology files, 1972
30	Lonesome Sale Road	NW¼ 30, (7-8E)	Skamania	4.5	--------	7.2	6	24	6.0	0.6	17	68	187	Do
1	City of Blaine	SW¼ 3, (40-1E)	Whatcom	----------	--------	7.3	3.3	24	5.8	2.0	5	65	>300	Van Denburgh and Santos, 1965
5	U.S. Forest Service	NW¼ 25, (37-8E)	--- do ---	12	--------	7.3	4.0	23	6.4	2.4	5	65	>300	Do
29	Spring 72	SE¼ 13, (7-7E)	Skamania	4	--------	6.9	1	19	3.4	0.6	10	55	252	Div. Mines and Geology files, 1972
18	State of Washington	NE¼ 33, (20-2E)	Pierce	12	--------	----	3.0	19	5.0	1.4	6	55	>300	Van Denburgh and Santos, 1965
2	Larabee	NW¼ 36, (39-2E)	Whatcom	----------	--------	7.3	22	19	18	3.0	10	55	250	Do
3	S. R. Burbery	NW¼ 20, (38-26E)	Okanogan	12	--------	7.7	1.5	18	9.1	2.8	5.5	53	>300	Do
33	Bacon Creek	SE¼ 1, (7-12E)	Yakima	55	--------	6.9	1	17	59	1.2	84	50	<80	Div. Mines and Geology files, 1972
32	Gotchen Creek	SW¼ 18, (7-11E)	--- do ---	3	--------	6.9	1	17	3.4	0.2	29	50	136	Do
16	Diamond	SW¼ 21, (21-6E)	King	11	--------	8	574	BDL	1280	5.5	396	<50?	<80	Campbell and others, 1970
28	Landslide	SW¼ 34, (8-7E)	Skamania	5.5	--------	6.9	<1	9	3.4	0.2	29	<50	136	Div. Mines and Geology files, 1972
37	Little Iron Mike	31, (5-7E)	--- do ---	10	--------	6.5	561	BDL	404	9.6	71	<50?	80	Campbell and others, 1970
38	Little Soda	SE¼ 5, (4-7E)	--- do ---	8	--------	6	36	BDL	28	13.6	3.4	<50	>300	Do
13	Scenic	28, (26-13E)	King	10	30	5	BDL	BDL	BLD	1.2	-----	<50?	---	Do
19	Sequalitchew	SE¼ 19, (19-2E)	Pierce	13	--------	6.9	3.4	9.8	4.8	1.1	7.4	<50	>300	Van Denburgh and Santos, 1965
31	Spring 710	NE¼ 36, (7-7E)	Skamania	4	--------	7.1	1	15	2.6	0.3	15	<50	200	Div. Mines and Geology files, 1972
8	Upper Kennedy	NE¼ 1, (30-12E)	Snohomish	----------	--------	6.6	681	10	626	79	13.5	<50	213	Div. Mines and Geology files, 1971
14	U.S. Air Force	4, (24-45E)	Spokane	2	--------	6.0	1.2	11.5	1.8	0.4	8	<50	290	Van Denburgh and Santos, 1965

1/ Listed in Selected References.

2/ BDL, Below detection limit.

ARRIVED 20 Sept. 79

September 17, 1979

Dr. Howard Ross,
Senior Geophysicist
Earth Science Laboratory
University of Utah - Research Institute
Research Park
391A Chipeta Way
Salt Lake City, Utah 84108

Dear Howard:

Enclosed are two pseudo sections from the work completed for the State of Washington.

The dipole length used along profile AA' was 500 meters; that used along BB', 250 meters. As you recall, UURI agreed to invert these data using a two-dimensional modeling. When an approximate inversion has been completed, please send a copy to my attention at the address on this letterhead so that it can be included and properly acknowledged in our final report.

Thank you again for your co-operation, and I look forward to seeing you at the GRC meeting in Reno.

Respectfully,

Robert McEuen
by J.A. Rigby

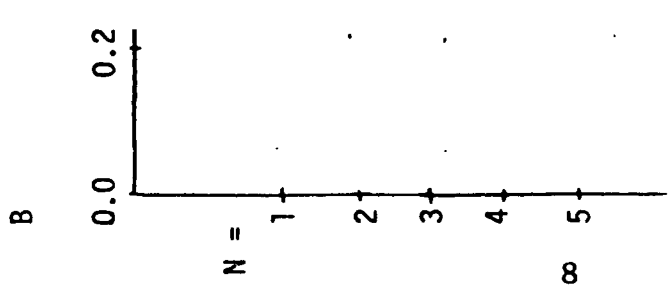
Robert B. McEuen
Consultant to SAI

/jmh

Enc.
cc: J. Eric Schuster

Science Applications, Inc. 1200 Prospect St., P.O. Box 2351, La Jolla, CA 92038, (714) 454-3811

Other SAI Offices: Albuquerque, Ann Arbor, Arlington, Atlanta, Boston, Chicago, Huntsville, Los Angeles, McLean, Palo Alto, San Diego, Sunnyvale, and Tucson.



6 June 1978

TO: State Coop Core Group

FROM: Duncan Foley

SUBJECT: Trip Report - Battelle Pacific Northwest Labs

Date of Trip: May 31, 1978

Place: Batelle offices, Richland, Wash.

Purpose: Discussion of State Coop Project

Attendees: Joe Upton, Jimmy Joe Jacobson - PNL
Duncan Foley - ESL/UURI

1. PNL is checking GEOTHERM, and ~~[illegible]~~ feel they can meet July 1 deadline

2. PNL is investigating about 600 well records in the files of Jim Crosby at WSU; at present ~~[illegible]~~ it is not known how many of these records will have temperature data.

3. Eric Schuster (with State of Washington) is reported by PNL to have identified several new springs.

4. OIT has been in touch with resource assessment team

7-7-78

J.J. Jacobson PNL mt 509-946-3653

mtg on 0 → # task, 26 July, aft, IN Tac-

F- could call back on 25TH, bout

lat-long

7-11-78

1) "are jumping gun" - JJJ will be in Hilo

letter

J. Doetsch committee, Bob Thorne - commercial waste mgmt. statement

time tied up til mid Aug: Sept.

Eric's contract won't be avail

got bout ½ of Crosby's wells in E'n Wash - are reviewed

"Gary" will finish up next wk -

NAS "Geophys Predictions" Lane - could show

stuff from Blackwell - any shaking losse(?)

JJJ has WIPS, incl 4x6" map on Wash, Ore, Id.

also has gravity - over Wash, etc areas

" " aeromag - tricities to Yakima to Cascades

Carl Donn

25 July

~~ph~~ Gary Lane

mtg tomorrow will be @ USGS (Ed McGavock)
1201 Pacific Ave, Tac.
206-593-6510

31 May 78 1

Larry Ball is from Antioch

State doing wells - WSU Gary Lane - reviewing records
↳ Jim Crosbey - @ WSU
} Water Well Records

Crosby has data on ~ 600 wells
└ quality, types unkn.

Eric Schuster - has several new spgs.

Mtg w/ J.J. Jacob -
are √'in Geoth, & informed of July 1 deadline
Gary Lane - person working on GEOTH, is checking ~ 600 well records @ WSU,
working w/ Jim Crosby, a prof @ WSU, on
- an unknown # of these wells have records incl temp

Eric Schuster (w/ Wash st geolst?) has identified
OIT person (?) is coordinating w/ team in Wash

JJJ, & Joe Upton, haven't seen sens (Jackson) in DC (?)
└ feels val. can be on line, w/ report to USGS, by 1 July
leaving of drug task

31 May 78 (a)

mtg @ PNL, topics 726 bring up to date on lo T

GEOTHERM - checking - progress, probs.?

entry - any thoughts on when? 1 July

short form

Map - Berry Spgs.

heat flow

-circles

wells, if 1) >5°C, 2) outside, 3) gradient > 35°C/km 1 Sept

mtg later to draw

ESL - PI

[redacted] - [redacted]

22 May

Call to JJJ - PNL
509-946-3653

To Duncan

Date 7-20 Time 2:20

WHILE YOU WERE OUT

M Gary Lane

of Battelle NW

Phone 509-946-2130

Area Code Number Extension

TELEPHONED		PLEASE CALL	
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	

RETURNED YOUR CALL

Message Call before Noon Tues
Time & Place of Meeting
& background & seminar
in Tacoma – sitting in for
Jim J. Jacobson

Operator

w/ Eric Schuster

14 Aug. 79

✓- dil spl fr silica (?) 50ppm

→ ✓- plates on shaded relief →

1:500k ok

Gordon "will" be tied in

Blackwell will have gradient data

end of Dec to printers

no TRS - lat low changes

no state areas

have NOAA print base stable map & send to ERIC fr printing

will be free

Duncan

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

August 25, 1980

Mr. Eric Schuster
Washington Division of Geology
Olympia, Washington 98504

Dear Eric,

As per our previous telephone conversations, and also correspondence dated August 4, 1980 (attached), I would like to take this time to remind you of the upcoming meeting of State Coupled Program participants at the GRC annual meeting in Salt Lake City on September 9. It is highly recommended that all members of Resource Assessment teams attend this meeting as several key topics pertinent to program direction and goals will be discussed.

Sincerely,

Duncan

Duncan Foley
Project Manager/Geologist

DF/cw

August 4, 1980

MEMORANDUM

TO: State Coupled Program Resource Assessment Teams

FROM: Duncan Foley

SUBJECT: GRC meeting in Salt Lake City

The Geothermal Resources Council annual meeting is being held in Salt Lake City on September 9, 10, and 11. .As at last years meeting in Reno, there will be a brief gathering of the State Coupled Program participants in Salt Lake. This year the meeting will be held at 11 AM on Tuesday, September 9, in Room 250 of the Hotel Utah.

Please mark this time down, as the meeting will not appear on the calendar of events for the resources council.

See you next month.

Duncan

Duncan Foley

DF:srm

STATE OF WASHINGTON
Department of
Natural Resources

COMMISSIONER
BERT L. COLE

R. A. BESWICK
SUPERVISOR

OLYMPIA, WASHINGTON
98504

HARBOR AREA

May 17, 1979

Duncan Foley
UURI
Earth Science Laboratory
420 Chipeta Way, Suite 120
Salt Lake City, Utah 84108

Dear Duncan:

In regard to your letter concerning the effects of the National Energy Act of 1978. Eric asked me to respond in his behalf and I buried your letter.

As of this date we have not seen that the Act has had any affect in stimulating exploration for geothermal resources in Washington. On the other hand I do not feel that the lack of effect is relatable to problems with or omissions from the Act but merely the result of the lack of basic resource definition. Once we are to the point where drilling would be desirable, I feel that the Act will encourage drilling.

At present I feel that passage of many of the provisions of the Geothermal Energy Omnibus Bill would have a much greater impact upon geothermal exploration in Washington.

Sincerely,

BERT L. COLE
Commissioner of Public Lands

R. Gordan Bloomquist

R. Gordan Bloomquist
Division of Geology and
Earth Resources

RGB:ks

11 July 78

Eric Schuster — 206-754-1216

USGS[redacted]726
I.T areas -

Eric has general

has start - on maps 1:1mil geoth

F - will call back

25 July

Eric Schuster

informed of [redacted] meeting time tomorrow in Tacoma

MONTHLY REPORT FOR MARCH, 1979, ON
GEOTHERMAL ASSESSMENT AND RESOURCE
DEFINITION IN WASHINGTON

Washington State Department of Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504

J. Eric Schuster
Project Manager

Identification DE-AC03-79ET27014

Contract Negotiation Progress

The full contract (No. DE-AC03-79ET27014) for $309,878 was received from the San Francisco operations office on April 18, 1979. About ten working days will elapse before we can legally expend funds under the contract, during which time we must obtain state legislative budget committee approval of the contract and enter the contract into the Department of Natural Resource's fiscal accounting and budgetary systems. If all goes well, we should have personal services contracts in force for gravity surveys, drilling supervision, and temperature logging in existing wells by May 4, 1979.

Planning

A planning meeting was held in Olympia on March 14, 1979. It was attended by Marty Molloy and Roy Mink of USDOE, Frank Danes and Al Eggers of University of Puget Sound, Gordon Bloomquist of Oregon Institute of Technology, and Mike Korosec, Ted Livingston, and Eric Schuster of Department of Natural Resources. DNR plans for geothermal assessment were presented and discussed. Major planning accomplishments are:

1. Cost to drill each 500 foot heat-flow hole was estimated at $11,000. Order of priority and planned order of drilling is: a) first hole at Camas, b) first hole at Mount St. Helens, c) second hole at Mount St. Helens, d) Longmire, e) Ohanapecosh, f) Packwood, g) Randle, h) Morton, i) Glenoma, j) second hole at Camas.

2. All unsupported costs were discussed and agreement reached as to the anticipated expenditure levels for subcontracts during FY79. They are as follows: a) heat flow drilling, $110,000, b) consultant to supervise drilling (Marshall Huntting), $5,400, c) heat flow calculations and conductivity measurements (D. D. Blackwell), $5,000, d) regional gravity in south Cascades from Columbia River north to 46°30' N. and from 121° W. to 122°30' W. by Frank Danes and Al Eggers of University of Puget Sound, $30,500, e) gradient measurements in existing wells (Marshall Huntting) $4,600, f) petrology, rock geochemistry, and age dating at Camas, $5,000, g) geologic studies in Tumac Mountain area by Geoff Clayton, University of Washington, $5,000, h) out-of-state travel, $3,000, and i) modification of existing space for water geochemistry laboratory, $2,000. Total subcontracts and other negotiated costs

$170,500. This total is $1,000 higher than the total agreed upon at the March 14 meeting because of the addition of $5,000 support for Geoff Clayton's work which was requested by Marshall Reed in late March ($4,000 for unspecified consulting work which was in the March 14 estimate will be applied to Clayton).

3. Dr. Molloy requested more detailed and longer range management plans, schedules, and list of deliverables. To date, I have generated the attached flowsheet, about which you should feel free to make comments or suggestions for improvement. A chart showing schedule details for each subcontract and project and the products to be generated from each, is on the drawing board and should be ready for distribution with the April monthly report.

4. Dr. Molloy reported that USDOE San Francisco Operations Office plans to transfer administration of this contract to Roy Mink at the Idaho USDOE office as soon as the initial contract set-up has been completed. We favor this change and look forward to working closely with Roy.

Gravity Studies

Drs. Frank Danes and Al Eggers plan to run both a regional gravity survey with station density of one per five square miles in the south Cascades (study area noted above) and a detailed survey of the Camas area with a station density of approximately two per square mile (stations will be placed wherever spot elevations are known). The boundaries of the Camas gravity survey will be the Columbia River on the south, 45^{o}40' on the north, 122^{o}20' on the east, and 122^{o} 30' on the west. Dick Couch will be contacted regarding gravity data to the south in Oregon with a view toward obtaining gravity data that would help to determine whether the Lacamas Fault extends into Oregon or whether major structures exist along the Columbia River. The Camas gravity map will be ready by November 1, 1979.

The south Cascade regional gravity map(s) and report will be ready by June 1, 1980. The central and northern Cascades areas will be surveyed as a unit. Danes and Eggers feel that this is more practical than surveying the northern and central Cascades as two or three separate map areas because of the short field season and difficult access in much of the area.

Lab. Construction and Equipment

Modification of existing space for conversion to a water chemistry lab is progressing well. All structural modifications have been completed and painting and cabinet installation is under way.

Bids have been received on an AA unit and negotiations are under way with the state purchasing division to determine which instrument will be purchased (bids were received for a Perkin-Elmer model 560 and a Varian model 575).

Heat-Flow Site Selection

Mike Korosec and Gordon Bloomquist have visited the prospective drill sites at Morton and Randle. The Morton site looks good, but additional scouting must be done in the Randle area. Visits to the other sites will be made before final site selection.

Sol Duc Hot Springs

Korosec, Bloomquist, Schuster, and Dave McClain (State of Idaho) visited Sol Duc Hot Springs on April 11 and 12. Preliminary magnetic and resistivity sounding surveys were run; a survey of thermal seeps (temperature and conductivity were measured at each) was made, and additional water samples from the main springs were collected. The magnetic and resistivity results have not yet been rigorously interpreted, but will hopefully be reported as part of the next monthly report.

Other

The geothermal assessment plans for FY79 were presented to the State Interagency Geothermal Development Council on April 2. As a result the other state agencies with interest in geothermal are now aware of our plans.

A geothermal bill (SB 2191) granting ownership of geothermal resources, from which it is technologically practical to generate electricity, to the owner of the surface estate has passed both House and Senate and was signed into law by the Governor on April 13.

Geoff Clayton, University of Washington, has been contacted about support for geological studies in the Tumac Mounatin area southeast of Mount Rainier. Generalized objectives for Clayton's work have been discussed with Charlie Bacon, USGS. I expect to complete negotiations with Geoff within the next 30 days, in order to enable him to go to work at the beginning of the field season.

The Camas investigations were discussed with R. G. Bowen on March 19, at which time I invited Dick to participate as fully as possible, as a representative of Crown Zellerbach and Science Applications, Inc., in the siting of the Camas heat-flow holes, and the design of geologic, geochemical, and geophysical surveys in the area. Dick reiterated Crown Z's strong interest in getting the geothermal resource evaluation done, and said he would arrange for access to Crown Z land when studies get under way.

During a preliminary discussion with Roland Petit of Los Alamos, I learned that Chandler Swanberg at New Mexico State University has written computer programs for sorting and processing WATSTORE data so as to make it yield temperature gradients. Petit is to check with Swanberg about the possibility of applying these methods to Washington's 40,000 WATSTORE entries. I am enthusiastic about the possibility because of the value of such data for geothermal assessment and the production of "public" and "scientific" geothermal resource maps. Especially since a preliminary examination of some of the WATSTORE and GEOTHERM data indicates that there are at least 240 wells in the Columbia Basin with gradients that exceed 39^{o} C/km. Some "believable" gradients exceed 100^{o} C/km.

J.E.S.
4/20/79

Agenda
Washington State Geothermal Assessment
Planning Meeting

Time: 10:30 a.m. to 4:30 p.m., March 14, 1979.

Place: Room 2F22, State Department of Transportation Building, Olympia, WA.

10:30 a.m.	Background and Introductions, Eric Schuster
10:45 a.m.	Preparation of Water Analysis Lab. and the Water Sampling and the Water Sampling and Analysis Program - Mike Korosec
11:10 a.m.	Heat-Flow Drilling and Gradient Measurements in Existing Wells - Eric Schuster and Mike Korosec
11:40 a.m.	Sol Duc Hot Springs Resistivity and Seismic Plans - Eric Schuster
11:45 a.m.	Geologic and Age Dating Studies in the Camas Area - Eric Schuster
Noon --	Catered Lunch
12:30 p.m.	Regional and Mount Saint Helens Gravity Studies - Frank Danes and Al Eggers
1:00 p.m.	The Oregon Institute of Technology Program in Washington --Gordon Bloomquist
1:20 p.m.	Discussion
3:00 p.m.	Finalization of Scheduling, Management, and Fiscal Plans.
4:30 p.m.	Adjournment

Distribution - Ted Livingston, Eric Schuster, Mike Korosec, Gordon Bloomquist (DGER)
Dr. Z.F. Danes and Dr. Al Eggers, UPS, Dr. Martin W. Molloy and
Dr. Roy Mink, USDOE

R. E. S.

Monthly Report for February, 1979, on
Geothermal Assessment and Resource
Definition in Washington

Washington State Department of Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504

J. Eric Schuster,
Project Manager

Identification 03-79-ET-27014.000

Introduction

This is the first monthly report to USDOE on the state-coupled geothermal assessment and resource definition project in the State of Washington. It is intended to serve most of the purposes of the management plan, milestone schedule, status report, cost plan, contract management summary report, project status report, cost management report, and technical progress report which are to be submitted to USDOE from time to time. Since the project is still in its initial stages and many of the planned activities have not begun as yet, many of the requirements of the above-mentioned reports will not be met by this report. Suggestions for improvements in our reporting will be gratefully welcomed.

Contract Negotiation Progress

We are currently operating under a letter contract for $65,000, with which we are to purchase water chemistry analytical equipment (primarily an atomic absorption spectrophotometer) and pay the salary and expenses of our geochemist, Mike Korosec. This contract was received February 2, 1977, signed and returned to USDOE on February 9, 1979. We are currently awaiting (by state law) approval to spend the money from the State Legislature Budget Committee. Approval is expected by mid-March, at which time we will order the analytical equipment. We anticipate that one month will be required for the state purchasing agency to award bids for the analytical equipment, and up to 90 days delivery. Therefore, mid-July is the earliest we can expect to have a functional geochemical lab.

Meanwhile, negotiation on the remainder of the contract is still in progress. Further data on objectives and estimated costs for subcontractors will follow this report, and a meeting with Marty Molloy and Roy Mink on March 14 will be aimed at finalizing overall objectives, objectives for subcontractors, and methods for reporting the results of the geothermal assessment work.

A letter has been sent to Gerald Brophy, Marshall Reed, and Marty Molloy requesting additional funds for purchase of a set of temperature gradient measurement gear.

Our Dunn and Bradstreet number, requested by USDOE, is 079248936.

Progress on Program Objectives

Bibliography - Bibliographic data have been accumulated during the past several months by Mike Korosec and Gordon Bloomquist (Oregon Institute of Technology). The bibliography contains just over one hundred references to potential geothermal areas in Washington, concentrating on geological, geophysical, and geochemical aspects. The bibliography will soon be available as an open-file report, and it will continue to be revised throughout the contract period.

Field Projects - Preparatory work continues on the field projects to be carried out this summer. Sixty target areas (thermal and mineral springs, warm water wells, "snow-free" areas, zones of hydrothermal alteration, and areas of Pleistocene and Recent volcanism) which warrant further investigation have been identified. In the coming months field visitations will confirm these occurrences, and the bulk of the springs will be sampled for chemical analysis. In fact, several of the better-known springs have already been sampled and either analyzed for us by Battelle Northwest or await analysis at our laboratory. Acquisition of analytical equipment, salaries, and travel associated with the geochemical studies will cost about $65,000 during FY 79.

Preliminary sites for heat-flow drill holes have been selected. Geological data are being assembled for these sites, and the necessary permit applications are being completed for submission to the U.S. Forest Service. The preliminary sites are:

1. near Ohanapecosh Hot Spring, just outside of Rainier National Park,
2. near the town of Packwood near Packwood Hot Spring,
3. near Longmire Hot Spring, just outside of Rainier National Park (both Ohanapecosh and Longmire Springs are within the park),
4. south of the town of Randle near Vance mineral spring,
5. east of the town of Glenoma,
6. north of the town of Morton,

7. 3 to 4 miles west of the summit of Mount Saint Helens,

8. 3 to 4 miles ENE of the summit of Mount Saint Helens,

9. & 10. near the town of Camas (2 holes).

These heat-flow holes are to be 500 feet deep, air-rotary drilled, and left with one inch iron pipe to full depth, with the pipe surrounded by mud or cuttings (or cement if necessary) to restrict water flow. Cuttings will be collected at frequent intervals. We are interested in arranging for the holes to be geophysically logged (E-log, etc.), but do not have funds in the budget to cover this type of logging. Any suggestions for how this might be done will be appreciated. We anticipate spending about $102,000 on drilling and drilling-related activities during FY 79.

Gravity studies will be subcontracted to University of Puget Sound. The regional (1 station per 5 square miles) coverage will be well coordinated with Dick Couch's proposed work to the south in Oregon. The regional study area extends from 121^{o} to 122^{o} 30' W. and from the Columbia River north to 46^{o} 30' N. In addition detailed gravity will probably be run on Mount Saint Helens. Some consideration is being given to running detailed gravity in the Camas area. We expect gravity studies to cost about $25,000 during FY 79.

In addition about $10,000 will be expended by petrologic studies and age dating of volcanic rocks and gradient measurements in existing wells in the Camas area. A $5,000 expenditure is anticipated for gradient measurements in existing wells in the Cowlitz River Valley, area, Lewis County, in preparation for drilling the heat-flow holes between Ohanapecosh and Morton. About $5,000 is planned to support Dr. David Blackwell's conductivity measurement and heat-flow calculation activities in the event that he is not successful in obtaining other USDOE funds for this purpose.

Information on scheduling of these activities and on plans for reporting results of the investigations will be forthcoming following a March 14 meeting with Drs. Molloy and Mink, and after we know the date when the full grant or contract will be issued.

cc: Marshall Reed, USDOE-DGE
David Williams, U.S. Geological Survey
James Swanson/Charles Bacon, U.S. Geological Survey
✓Clay Nichols, USDOE-IDO
Martin Molloy, USDOE-DGE-SAN
Ed McGavock, USGS, Water Resources

STATE OF WASHINGTON
Department of
Natural Resources

COMMISSIONER
BERT L. COLE

R. A. BESWICK
SUPERVISOR

OLYMPIA, WASHINGTON
98504

RECEIVED
JUN . 0 1979
GEOTHERMAL ENERGY BRANCH

June 11, 1979

Dr. Roy Mink
USDOE/Idaho
550 Second St.
Idaho Falls, ID 83401

Dear Roy;

I am in Eastern Washington in the field, so Mike will sign off on this letter for me. As we discussed earlier, we would like to make some adjustments to our budget, most especially to allow us to pay for the D.C. resistivity work at Camas which was not foreseen when the original budget was finalized. The total funding level is the same as before.

The current and proposed budgets are presented on the attached sheet, and some explanation follows here.

1. We propose to cut the time of employment for this contract period to two months for the geophysicist and the secretary. The project is running well so far without them, and we don't feel we will really require either until about September 1, 1979. At that time, however, we will certainly need to have both on board.

2. The decrease in the "Benefits" figure is directly the result of not hiring the geophysicist and secretary as early as we originally intended.

3. The $2,032 addition to "Equipment" will allow Mike to purchase a used "top of the line" Mettler top-loading balance with a 1,200 gram capacity, and a used flow-through sampler for the colorimeter. We feel both are needed in the lab, and we can get both at good prices.

4. We are purchasing more small lab items in getting the lab set up than we earlier anticipated, thus this figure is $3,000 higher, to see us through until October 31, 1979.

5. The "drilling contract" figure has been reduced slightly to provide funds for some of the items we wish to increase. I have done this because our low base bid is a little over $67,000 to drill the ten holes planned, and even with Murphy's law operating at 100 percent we should have adequate drilling funds to drill the ten holes and probably a couple of additional holes.

6. Bob McEuen's bid for Camas D.C. resistivity is the only one I have received so far. It is $18,530, if we supply three field assistants and a four-wheel-drive vehicle. Therefore, I have figured $20,000 as a reasonable provisional figure.

In addition, we hope to hire a field-assistant-type person to digitize some or all of the USGS Water Resources Division's water well gradients. These are at their Tacoma office. I don't know the magnitude of the job yet, but would like approval to spend up to $2,000 on it. These funds might come out of "Travel" or "Contracts, drilling". If you need this nailed down better, let me know.

I would appreciate your early reply on these items, Roy, for we must "strike while the iron is hot" on some of them. I hope you will be able to come over for a day or two about a month from now, so we can show you all of the field projects when they are (hopefully) in full swing.

Sincerely,

Mike Korosec for

J. Eric Schuster, Assistant Supervisor
Division of Geology and Earth Resources

Dear Roy;

In addition to Eric's information and requests report above, I thought I would tag on a progress report. The most important event to report is the low bid received for drilling the heat flow holes. We are in the process of signing off the contract and clearing up the paperwork on site permits. Four or five additional sites have been chosen for possible drilling, but are quite tentative at this stage. They include one at White Pass (an eastern extension of the Cascade heat flow traverse); a site near Alta Vista, southeast of Mossey Rock (a western extension of the traverse); a third hole on Mt. St. Helens (south side); and possible locations on Rock Creek or the Wind River, east of Camas, up from the Columbia River. I will discuss these possibilities with Eric when he returns, and we will approach the drillers with the proposals.

Frank Danes reports that gravity work at Camas was completed last month and preliminary reductions and results should be available by the first week in July. This past week, Frank has been skiing around Mt. St. Helens completing that portion of the gravity survey, and will spend the next few weeks on areas which may later be closed due to fire hazards.

Marshall Huntting reports only fair success at scrounging temperature gradients from Cowlitz River Valley wells. Most wells are either actively being pumped, are old and collapsed, or have been capped shut. Marshall soon will be scrounging wells in the Camas Area.

Item	Current Budget	Proposed Budget	Proposed is:
Salaries:			
Geol. II (Mike)	$ 23,831	$ 23,831	same
Geol. IV (Geophys.)	11,955	3,188	$ 8,767 smaller
Clerk-Typist III	4,393	1,352	3,041 smaller
Benefits:	8,697	5,957	2,740 smaller
Travel:	8,500	8,500	same
Equipment:	50,589	52,621	2,032 bigger
Rent, Goods and Services:	4,000	7,000	3,000 bigger
Contracts:			
Drilling	110,000	104,516	5,484 smaller
Tumac Mtn. geol.	5,000	5,000	same
Gradients and drilling supervision	10,000	10,000	same
Heat flow Calc., D. Blackwell	5,000	5,000	same
So. Cascade Gravity	30,500	30,500	same
Camas resistivity	5,000	20,000	15,000 bigger
Overhead:	19,429	19,429	same
Totals	$296,894	$296,894	same

Dave Blackwell's field assistant has made initial contact with us. His name is Michael Jackson, and, according to Dave, will be available for geophysical well log reductions (USGS files), heat flow scrounging (assistant to Marshall Huntting), and well drilling supervision. We will know more after his visit late this week.

I have contacted the USGS in Tacoma and have learned that there are four boxes of well logs available to us for interpretation.

Marty Molloy called on Monday, June 11th, needing to know (± $25,000) how much of the contract will not be spent by September 30th. I told him that the only left-overs would be moneys needed by us in October for salaries and outstanding unpaid bills. I will make a rough calculation and send it on to him. I am not sure of what value the figures will be, due to the nature of this sort of project.

In summary, we are both ahead and behind schedule, but delays have worked out for the best, so far.

Sincerely,

BERT L. COLE
Commissioner of Public Lands

Mike Korosec

Mike Korosec, Geologist
Division of Geology and Earth Resources

MK:pa

attachment

ID F-134 (Rev. 10-79) Ref. ID 1325.1

Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401	Subject: TRANSMITTAL OF WASHINGTON STATE PROGRESS REPORT

To: Distribution

From: L. L. Mink, OGE
DOE-ID

Margaret A. Widmayer for

Date: NOV 19 1979

Enclosed for your information and retention is a copy of the Washington State Geothermal Resource Assessment Program Progress Report for October. If you have any questions or comments regarding this report, please contact this office.

1 Enclosure

Distribution
G. P. Brophy, DOE-HQ
D. Foley, UURI

M.2.15

Progress Report,
Washington State Geothermal Resource
Assessment Program

Oct. 29, 1979

Temperature Gradients and Heat Flow

A. Early in the summer Michael Jackson, an employee of Dr. D. D. Blackwell, digitized temperature logs from some 215 water wells. These wells were logged by the USGS Water Resources office in Tacoma. Most of the measured wells are located in the Columbia Basin. A preliminary examination of these temperature logs indicates that about 70 of the logs are usable. Of these there are a few with gradients above 100°C/km. Most gradients are in the 30 to 50°C/km range. Dr. Blackwell has these data and will further analyze them.

B. We have examined the temperature gradient data in GEOTHERM and find that the gradients were calculated on the basis of bottom-hole temperatures and mean annual surface temperatures. In our opinion the GEOTHERM data are worthless. We will soon be prepared to replace the GEOTHERM data with measured gradients, thereby eliminating most of the uncertainty that diminishes the usefulness and accuracy of the present GEOTHERM gradients.

C. We have examined a portion of the USGS WATSTORE data as well, and find that water temperatures and well depths are often reported. However, gradients calculated from such data are subject to the same problems as the current GEOTHERM data, or worse, so we will not attempt to report gradients from the WATSTORE data.
We will, however, use the water temperature and chemical data from WATSTORE in an attempt to identify anomalous areas in which we could do gradient measurements and water sampling.

D. Dr. J. W. Crosby, Washington State University, has been measuring temperature gradients in the Columbia Basin for several years. We are making arrangements with Dr. Crosby to have his 400-500 gradients reproduced and sent to us.

E. During the summer, Marshall Huntting and Michael Jackson measured gradients in 89 existing wells in the southwestern Cascades and adjoining Puget Lowland. About 52 of these gradients appear to be useful.

F. We are sending all of the above temperature data to Dr. Blackwell as we accumulate them. We anticipate that he will be conducting further analyses on the gradients with the aim of producing a set of gradient, heat-flow, and mean surface temperature maps that are much more detailed than any done previously. A preliminary set of such maps, based on data now in hand, is being prepared by Dr. Blackwell for use in compiling a "public" geothermal resources map for NOAA.

DRILLING

Seven heat-flow holes have now been completed by our contractor, Soil Sampling Service. Holes that reached the 500-foot target depth are White Pass (sec. 2, T. 13 N., R. 11 E.), Packwood (sec. 16, T. 13 N., R. 9 E.), and Davis Mountain (sec. 3, T. 12 N., R. 8 E.). Completed holes that failed to reach 500 feet are Longmire (325 ft., sec. 6, T. 14 N., R. 8 E.), Ohanapecosh (375 ft., sec. 8, T. 14 N., R. 10 E.), Randle (421 ft., sec. 16, T. 12 N., R. 7 E.), and Mount St. Helens No. 1 (404 ft., sec. 18, T. 9 N., R. 5 E.).

Gradients are as follows:

Longmire - 64°C/km, 265' to 325', disturbed.

Ohanapecosh - 45°C/km, 200' to 365', not entirely equilibrated

White Pass - 51°C/km, 70' to 480', two linear segments with similar gradients; 51°C/km is an average.

Packwood - 48°C/km, 110' to 335', nearly the same gradient from 350' 495'. Reasonably linear.

Davis Mountain - Isothermal; we appear to have drilled the hole in a "thermally decoupled" block.

Randle - 42°C/km, 35' to 415', not entirely equilibrated.

St. Helens No. 1 - 19°C/km, 90' to 404', gradient still disturbed from cementing and drilling but is undoubtedly "real".

Drilling is still in progress at St. Helens Nos. 2 & 3, and the two holes at Camas are yet to be drilled. A hole between Morton and Randle is still needed to complete the Cowlitz Valley profile and more closely define the nature of the transition between the low gradients to the west and the "High Cascades gradients" (±50°C/km) to the east. However, because of extensive time overruns in the drilling, we don't plan to drill this hole until next year.

WATER GEOCHEMISTRY

Our geochemistry lab is almost fully functional now, and Mike Korosec has sampled and analyzed 37 waters from 20 different spring systems. No previous analyses have been published for 8 of these spring systems. Elements, chemical species, and properties being measured include conductivity, pH, temperature, chloride, alkalinity, sulfate, silica, sodium, potassium, calcium, magnesium, lithium, flouride, bromide, and iodide.

Since the lab. has become fully operational only recently we expect to be able to turn out a considerably larger number of analyses next year.

GEOLOGIC MAPPING

Geoff. Clayton, U of WA graduate student, is on a subcontract to map the geology in the Tumac Mountain-White Pass area to the south and east of Rainier National Park. He has completed all of the field mapping except for a few "fringe areas" and is now engaged in lab. studies including petrography, age dating, and rock geochemistry.

CAMAS

A D.C. resistivity survey was completed by Dr. Bob McEuen and SAI, Inc. Results show a low resistivity area (10-15 ohm-meters) at the northwest end of Lacamas Lake and another fairly low resistivity area (ca. 50 ohm-meters) at the southeast end of the lake. Other resistivities are ±150 ohm-meters.

A moderately detailed gravity map for the Camas area has been completed by Dr. Z. F. Danes. An interpretation of the regional aeromagnetics has been made by Dave Williams and a couple of low-temperature non-mineral springs have been sampled by SAI, Inc., and analyzed by Crown Zellerbach.

Two drill sites have been selected to test the two resistivity anomalies.

REGIONAL GRAVITY

Dr. Z. F. Danes has measured gravity at 743 stations in the south Cascades and has tied into previous gravity surveys. The study area is now adequately covered except for a few inaccessible areas. These will be covered next year with the aid of a USGS helicopter (courtesy of Dave Williams). Computations will continue through the winter with the expectation that a south Cascades gravity map and report will be ready by June 1, 1980. Dr. Danes has also produced relatively detailed gravity maps for the Camas and North Bonneville areas, the former under his subcontract from the Department of Natural Resources and the latter through an arrangement with the City of North Bonneville.

"PUBLIC" GEOTHERMAL RESOURCES MAP

Planning and data acquisition for a public geothermal resources map of Washington has been progressing in cooperation with Duncan Foley of UURI (University of Utah Research Institute), Rod Smith of NOAA (National Oceanic and Atmospheric Administration), and Gordon Bloomquist and Stuart Simpson of OIT (Oregon Institute of Technology). We intend to have "Camera ready" materials ready for printing by NOAA by the end of calendar 1979.

SOL DUC HOT SPRINGS

We have kept in contact with the National Park Service through Gordon Bloomquist and have collected water samples, and run preliminary magnetic and shallow resistivity soundings at Sol Duc Hot Springs. The magnetic and resistivity surveys have yet to be interpreted.

GEOTHERMAL BIBLIOGRAPHY

The bibliography contains approximately 100 citations of publications pertinent to the State of Washington. It will soon be open-filed and will continue to be updated.

COORDINATION WITH OTHER GROUPS

We are keeping abreast of the geothermal-related activities of the USGS, State Energy Office, Oregon Institute of Technology, Seattle City Light, Crown Zellerbach, Burlington Northern, and City of North Bonneville. We will continue to cooperate with such organizations and provide basic data to them whenever possible.

J. Eric Schuster

IMPORTANT MESSAGE

TO Duncan

DATE 2-22 TIME 9[15] A.M. P.M.

WHILE YOU WERE OUT

M Stuart Simpson

OF

Area Code & Exchange 206-754-1219

TELEPHONED		PLEASE CALL	X
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	X
RETURNED YOUR CALL			

Message S11 may have some slides

Try PMW

Operator

Gates No. 152

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

25 Feb., 1980

MEMORANDUM

TO: Stuart Simpson

FROM: Duncan Foley

RE: Exploration outlines, etc.

I have searched our files, and am afraid that the best I can do is provide artwork for the enclosed xerox sheets. If you would like to use one of these, or have them slightly adapted for your needs, we could easily provide you with such.

Another source that you might check is the new book, about to be printed, from GRC and OIT on geothermal utilization. I have not yet seen the final copy of the exploration chapter, but it may be helpful.

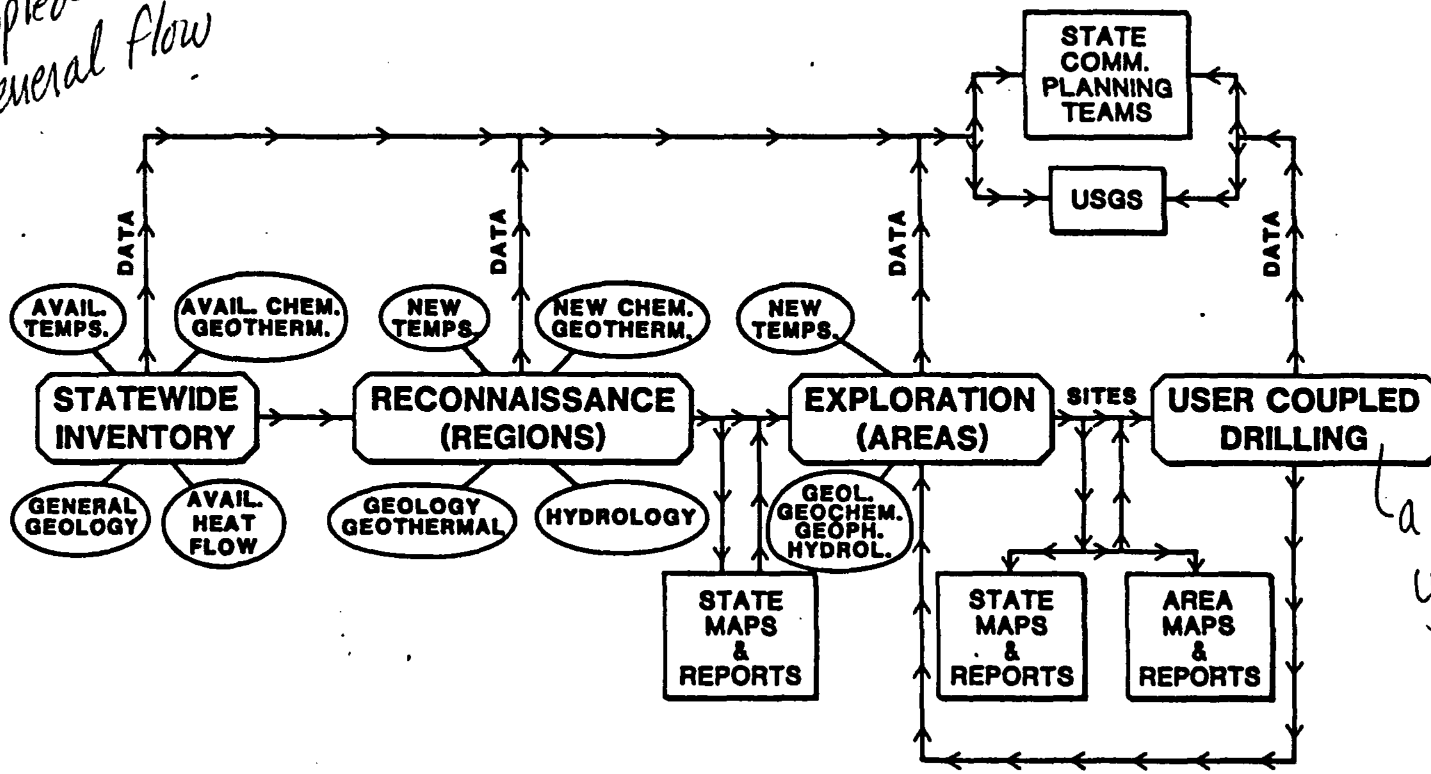
There is apparently one professor here who has a particularly complete slide collection; I will have him give you a call.

Keep me posted on what you need.

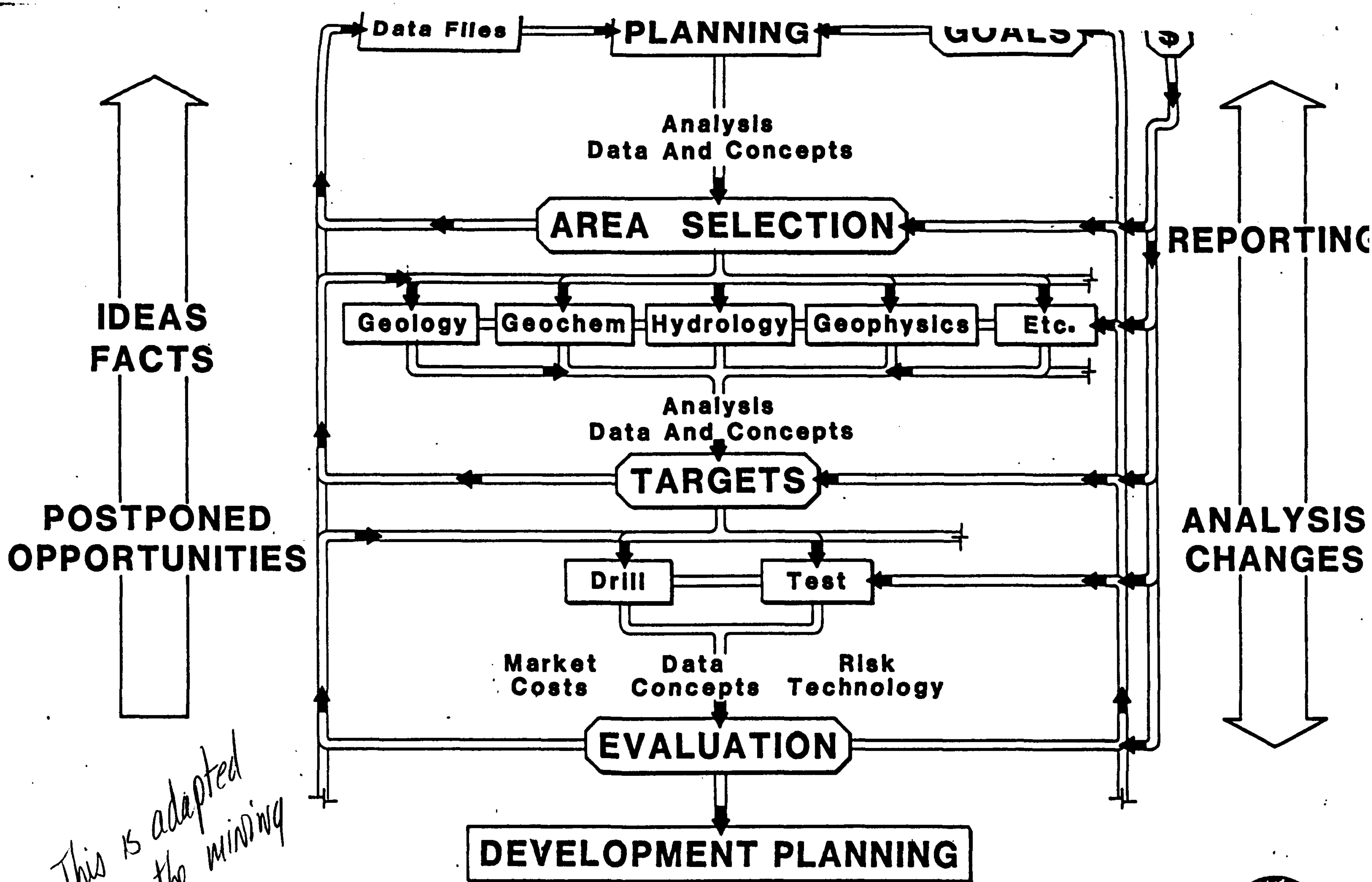
Duncan

STATE COUPLED PROGRAM

This shows the State Coupled Program general flow.

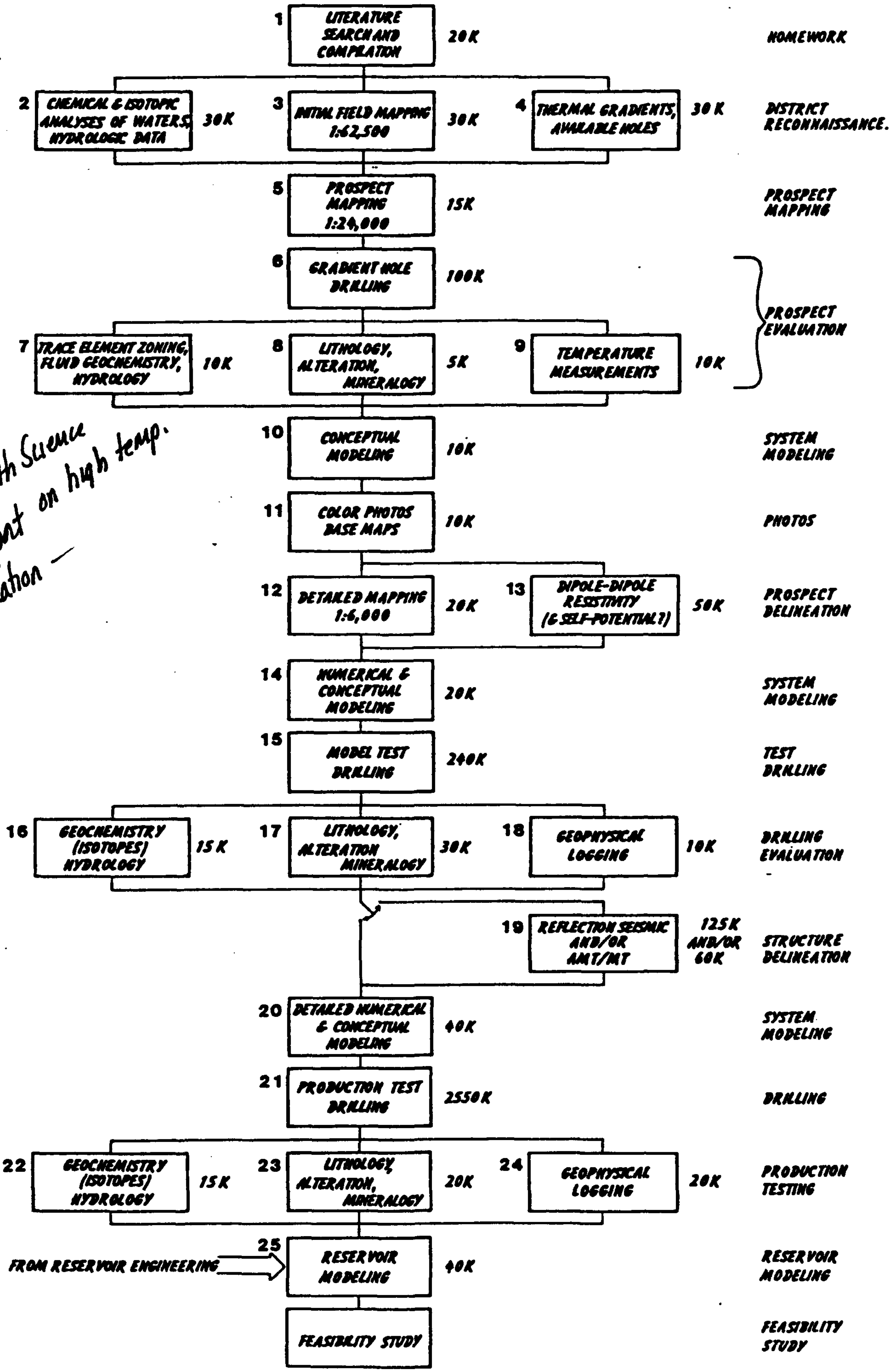


a program yet to come on line



This is adapted from the mining industry.

SUGGESTED HIGH TEMPERATURE HYDROTHERMAL EXPLORATION STRATEGY



From an Earth Science Lab report on high temp. exploration —

FIGURE 5

28 Oct. 80

CASCADES MTG.

Charley Bacon
Dave Williams
MAW
John Beaulieu
Eric Schuster
Norm Goldstein
Chuck Bufe
DF.

CB - $ cutting this FY
extramural phase out
projects ongoing get decent support

Dick Couch - had extramural $, CA casc. aeromag
DOE ", So Or " + gravity
will work up data w/ GS $, owes Beaulieu a map
good work, but late

DW - on Mt. Hood deep drilling - unsucces. in finding hydrothermal syst
series of papers (10) on Mt. Hood work
Volc. Haz. Roy Bailey coord.
HI -
YSTN -
CASC. - $ to day-to-day @ Mt. St. Helens
Don Peterson (?) @ Vancouver
also Gas monitoring

Beaulieu - Couch aeromag
N'n casc. gravity
lineament study - radar + hi alt. aerials
- S'n part of cascades
holes - 500' sitings
paleomag anom. - doesn't match W'n Cascades hydroth., heat flow, etc. anoms.
S'n - scrounge work
detailed mapping @ hi heat flow areas
expand Sammel → interp. w/ geophys.
geochron. needed
Crater Lk sits in end of Klam. F. graben
CB - no Pleisto. - recent volcs.
- interaction betw ~~magm~~ volc + B+R
faulting + dike injection may account for extension
- Crater Lake - 7K erupt, also holocene volc confined to caldera

CW - geoth. energy @ Hood N-S "~~crustal~~" thinning anom. grav., heat flo, etc.
below disturbance, Therm. grad. 55-70°C
sometimes > 1000-1300'

Bowen - mixing models applied dubiously

JB - drilling this winter along Hood River zone

DW - alt. zones

Norm - work on flanks of Mt. Hood
MT, Cont. Source EM
see near surf resistive zone, partially sat. normal groundH2O
conductors @ greater depth

Eric - says Wa. - needs more heat - plateau to E, as go N,

Cascadia Conf. - @ Salishan in last May
on Juan de Fuca

Segments: S'n Chain - more diffuse volcanism   soft margin
N'n " - points, ~~to~~ JdF plate

fissure → aligned cones → single cones

need - overall investig. of Arch., Geol, etc fr explo. strat.
indust. coop
frontiers

Col. Rvr. - 12-14 my course @ least
lg struct - syncline

hier volume volc. & heat flo go together
partial melt

Eric - 2 contracts - Hammond - S. Casc. - regional synthesis, map has been put out
Clayton - Bumping Lk, E of Mt Ran
Rk geoch. & age dating

Model fr volcanism - Hammond
push fr detailed geol. mapping
- work may not be appropriate fr DOE programs, (ES)

50°C/km as far N as Wht Pass

more heat flow needed

Snoq. & Stevens pass holes
bsmt to N is ~~[illegible]~~ older xtalline rx.

JB - Sun oil @ Breitenbush - fault controlled
Limited by, says DW, wilderness designations

NG. - LBL in Cascades since 78
specific problems
geohyd. of Mt. Hood
electric surveys
paper to JGR submitted, & recalled for problems

2 long MT lines - Mt. Hood "a bummer" } not yet released
K. Falls

support program for industry (K. Falls)
data languishing
DOE $
LBL in K. F., supporting PONs
YMCA
district heating
reservoir engineering - interf. tests, detail, etc
geol., detailed petrology, age dating

MAW - emphasis on more detailed studies
hydrology
alt. levels - σ thinks

δ - 2 levels of progs. dir. ht / elec

ident. anoms.
temp
H_2O

also - regional
- local

levels of emphasis, tasks, w/ levels of funding
analysis

recog. of WA/OR diffs.

Paisley - 220°F statewide scrounge
ongoing serendipity

MAW - "the regional poke-and-pray" method

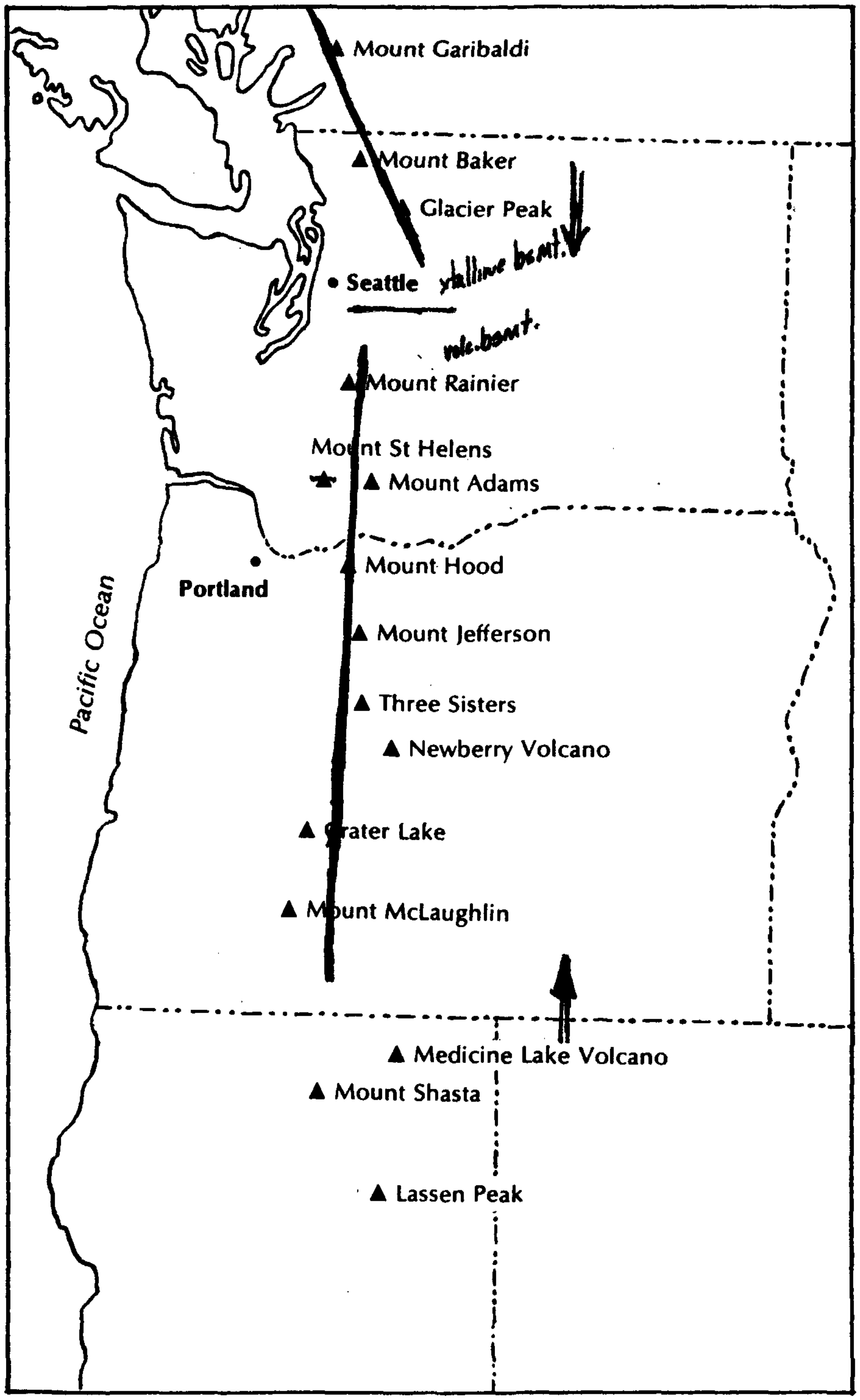
ES - emphasis on data base, not interp.

volcanoes, geophysical exploration methods for geothermal systems, and specific examples of drilling for geothermal resources in the Cascades. The multidisciplinary scope of the conference and the representation of research groups from government, academia, and the private sector created an extremely productive atmosphere of coöperation and enthusiasm for continued multidisciplinary coördinated studies in the Cascades.

The final afternoon of the conference was devoted to 5 workshops on the status, coördination, and future direction of different aspects of Cascade geoscience with stress on improving the understanding of geologic processes and the geothermal resource potential of the range. The results of the workshops reflected the major points of the earlier presentations, as well as considerable exchange of ideas and data that took place during breaks and in workshops themselves.

Knowledge of the regional stress field and of tectonic processes operating in the Cascade region through time is critical to an understanding of Cascade volcanic and hydrothermal systems. Installation of additional seismic stations, especially in Oregon, will lead to improved location of earthquake hypocenters and regional compilation of epicenters and focal mechanisms. Delineation of faults, mapping of dikes and volcanic vent locations, and paleomagnetic studies are improving models of the relations of volcanism to plate interactions, rotations and translations of crustal blocks, and the locations of preëxisting structures. The tectonic environments of neighboring regions (e.g., the Juan de Fuca Plate, the Columbia Plateau) can be used to shed light on the tectonics of the Cascade Range—information that is directly applicable to prediction of fracture patterns that may control the movement of geothermal fluids.

Much is being learned of the nature of the crust beneath the Cascades from seismic-refraction, teleseismic, aeromagnetic, gravity, magnetotelluric, and geomagnetic-induction surveys. Deep seismic-reflection lines, such as those being undertaken by COCORP, and additional seismic-refraction profiling using blasts at quarries and construction sites could further improve the picture of deep crustal structure beneath the range. The nature of the High Cascade—Western Cascade boundary in Oregon and of the transition in composition of the exposed crust along the axis of the range in southern Washington are among pressing problems that might be attacked with those techniques.



Mount St Helens is merely the most active volcano of the Cascade Range.

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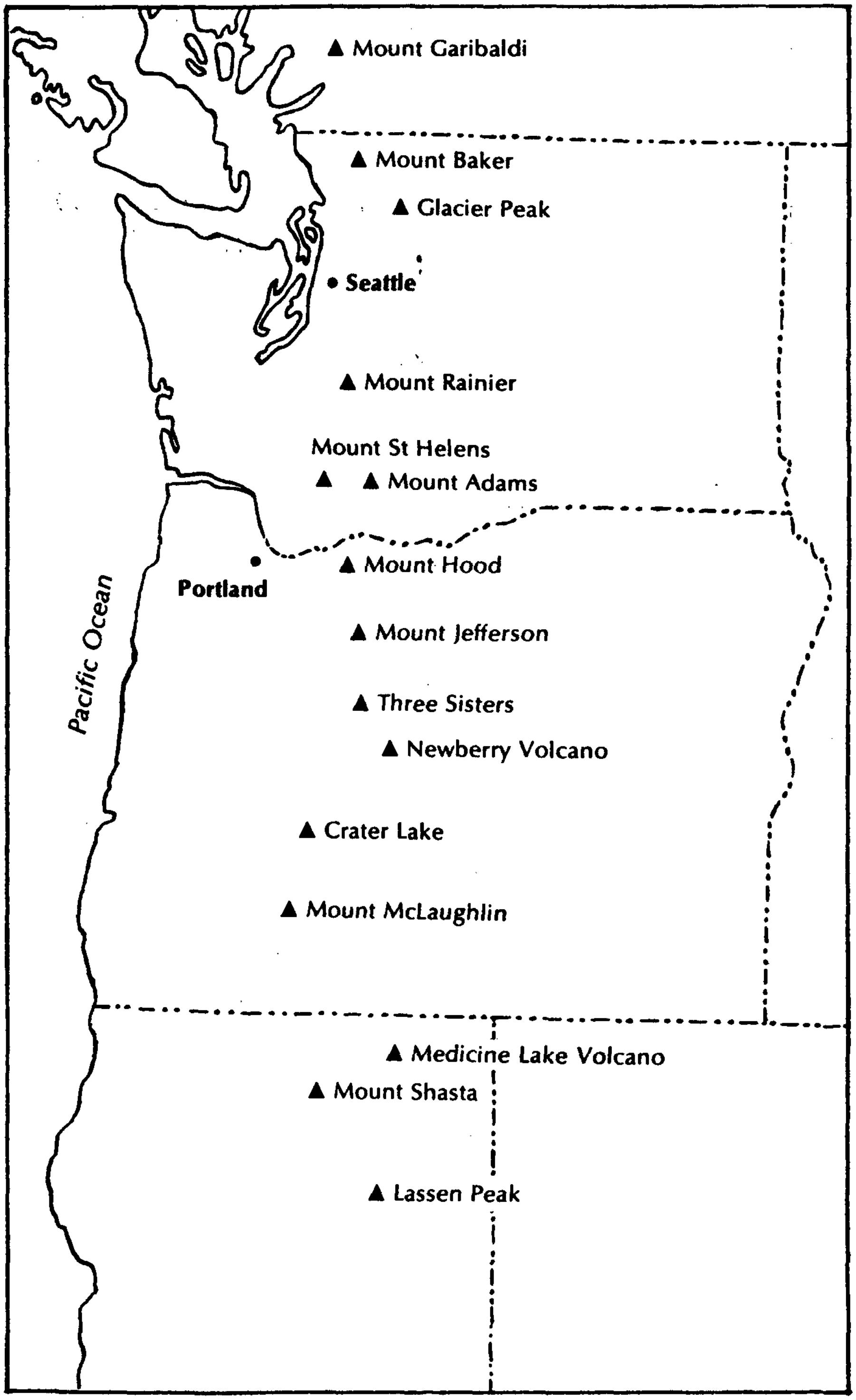

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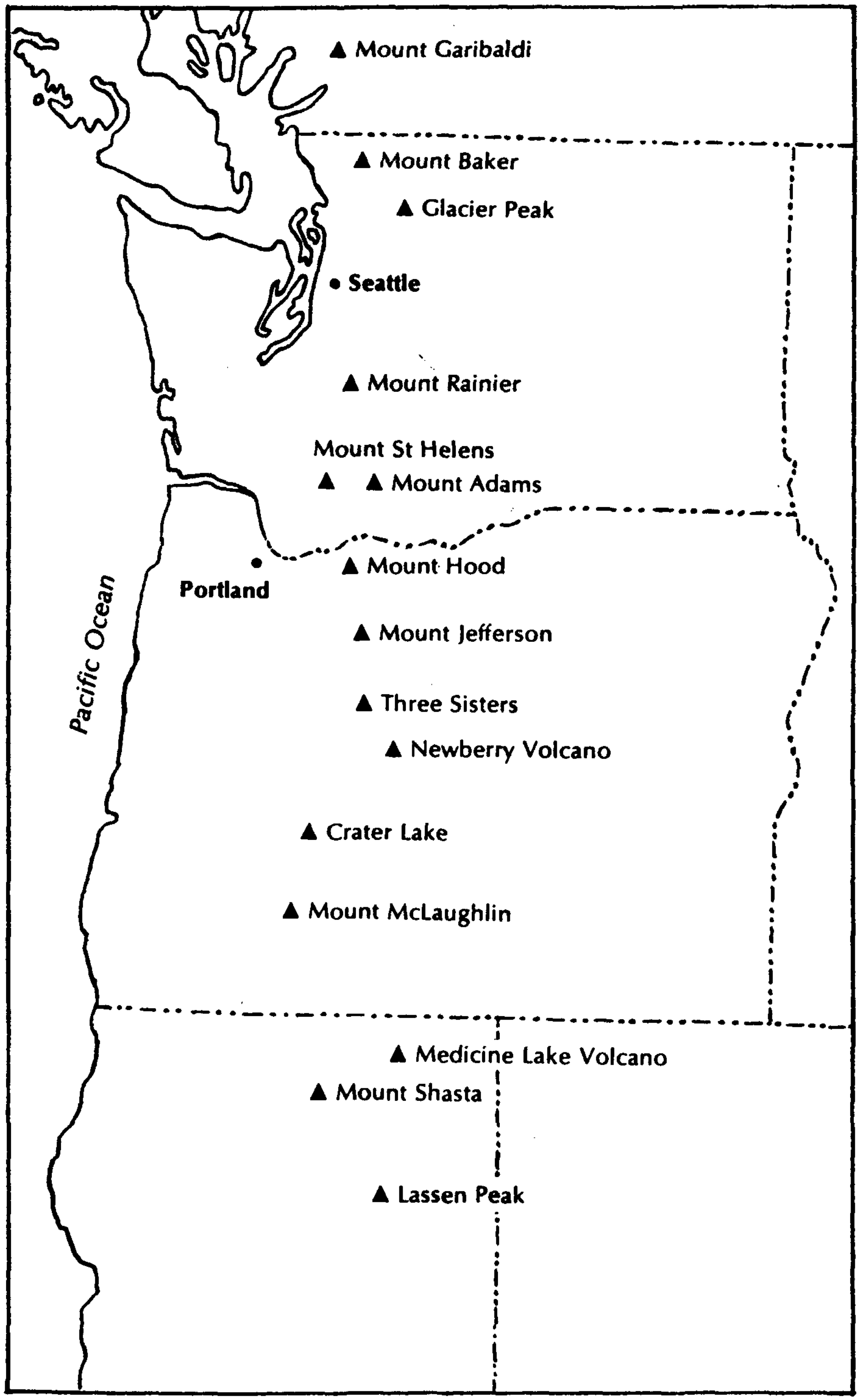

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28 Oct. 80

Foley

in Menlo Park

goals are set for research in Cascades

Even as Mount St Helens began to awaken last February, a 3-day conference on the tectonics, volcanology, and geothermal potential of the Cascade Range was held at the U.S. Geological Survey in Menlo Park, Calif. The conference, sponsored by the Survey's Geothermal Research Program, drew about 150 participants from government agencies, universities, industry, consulting firms, the Geological Survey of Canada, and the Pacific Geoscience Centre; they presented results of a wide range of research projects ranging from the Garibaldi belt of southern British Columbia to the Lassen region of northern California.

Topics included regional geologic, tectonic, geophysical, and geochemical studies, crustal structure, volcanic petrology, volcanic hazards, hydrothermal systems and attendant alteration, hydrologic setting of Cascade

volcanoes, geophysical exploration methods for geothermal systems, and specific examples of drilling for geothermal resources in the Cascades. The multidisciplinary scope of the conference and the representation of research groups from government, academia, and the private sector created an extremely productive atmosphere of coöperation and enthusiasm for continued multidisciplinary coördinated studies in the Cascades.

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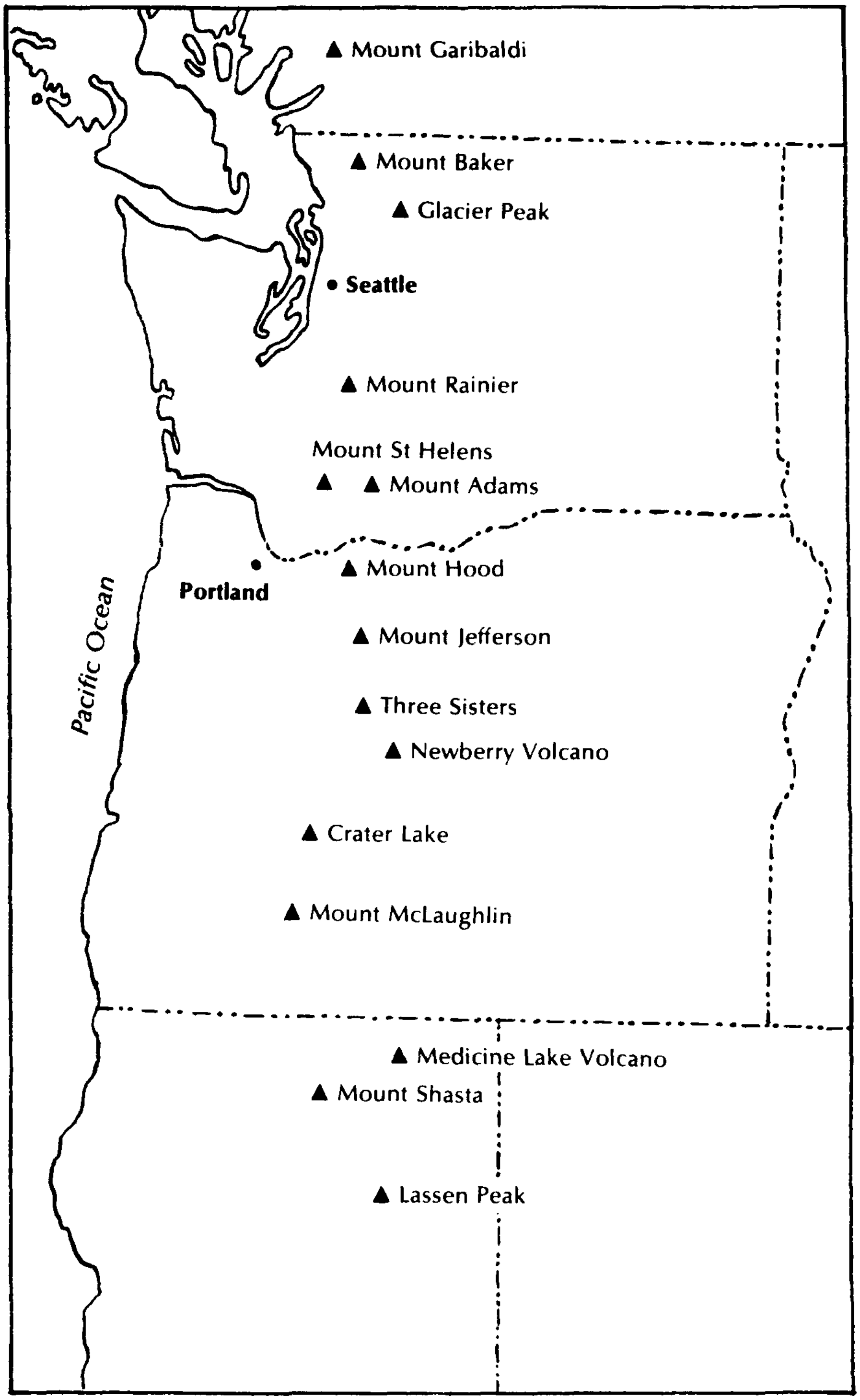

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about volcanism away from the major andesitic stratocones. The goal should be to determine time/volume/composition relations of the different regions of volcanism in the Cascade province.

The current eruption of Mount St Helens underscores the urgency of establishing a coördinated program to assess volcanic hazards, monitor Cascade volcanoes that may be dangerous, acquire baseline data, and learn to predict eruptions. Is is also recommended that the research community coöperate to improve its preparedness to maximize the scientific benefit from studies of any future volcanic eruption.

Geologic mapping is fundamental to evaluating the geothermal potential of the Cascade region. Compilation of existing maps has been undertaken; new mapping, both regional and detailed, is urgently needed. The U.S. Geological Survey is compiling a geological map of the range at a scale of 1:500,000 that can be used to target areas for further study and to serve as a base for data from regional gravity, aeromagnetic, and other geophysical surveys. We also need compilation of existing geochemical data and periodic release of new data. It was suggested that a digitized data bank be set up to include sites of dated and chemically analyzed samples and measurements of geophysical properties such as heat flow, gravity, and magnetotellurics.

The hydrologic setting of hydrothermal systems in the Cascades is just beginning to be evaluated. There may be 2 broad classes of hydrothermal systems: those directly associated with volcanic edifices, and those associated with fracture systems and faults, particularly in the Western Cascades. The configuration, circulation patterns, and sources of heat for Cascade hydrothermal systems are virtually unknown, partly due to the near-surface hydrologic regime characterized by flow of cool meteoric water in fractures or zones of high permeability enclosed in relatively impermeable rocks. Analyses of spring and surface waters for chloride content and stable-isotope ratios may detect an imprint of a hidden hydrothermal system within a given drainage basin. A knowledge of the structural geologic setting is necessary to understand the hydrothermal 'plumbing systems'. Examining fossil hydrothermal systems exposed in the Western Cascades and in some eroded High Cascade stratovolcanoes will help model modern hydrodynamics. Refining and testing models will require confirmatory drilling of a few deep (greater than 2 km) holes into and perhaps through Cascade hydrothermal systems.

Before any drilling is undertaken in a particular area, detailed geological and geophysical studies should be made in order to site holes appropriately. Geophysical-exploration tools that have been effective include resistivity, magnetotelluric, and aeromagnetic surveys. Shallow drilling for thermal-gradient studies is hampered by near-surface hydrology, as mentioned earlier. Many holes result in 'stair-step' or even reversed thermal gradients. Shallow heat-flow holes are best sited in impermeable rocks in valley floors. Considerably more carefully sited drilling will be needed in order to document regional variations in heat flow and to define anomalous areas. Preliminary data suggest a steep positive gradient in regional heat flow from west to east in the vicinity of the Western Cascade—High Cascade transition in Oregon and a region of high heat flow over a probable graben structure within the High Cascades. Regions of low near-surface heat flow, which may be areally extensive (e.g., the Medicine Lake highland), generally seem to correspond to topographically high recharge areas.

The consensus was that a few deep drill holes are needed soon, at an early stage of research and exploration, so that the relative merits of the various geochemical- and geophysical-exploration tools can be evaluated and calibrated at specific sites in the Cascade environment where thermal anomalies are well documented. Such drilling could possibly be done under the auspices of the Continental Scientific Drilling Program, now being formulated by the National Research Council, or by coöperative industry/government projects such as those presently conducted by the Department of Energy. Existing data from exploration geophysical surveys, geochemistry of waters, and logging of shallow drill holes suggest that viable geothermal resources exist within the Cascade Range. It appears that these resources can be defined and, where appropriate, developed with minimal impact on the environment.

The response from the research and exploration communities to the conference and the results of the workshops underscore the benefits of such meetings in providing a continuing forum for discussion and coördination of efforts during the active phases of multidisciplinary research.

Charles R. Bacon
U.S. Geological Survey, 345 Middlefield Road, Menlo Park, Calif., 94025

U.S. Geological Survey geothermal research program in the Cascade Range

INTRODUCTION

This list summarizes U.S. Geological Survey (USGS) activities that are already in progress or are about to begin in the Cascade Range of Oregon, Washington, and California. The list is divided into two parts: (1) projects associated with the geothermal research program, and (2) activities outside the geothermal research program. Work in progress by non-USGS groups under contracts, extramural grants, or Department of Energy funding is not included.

The Cascade Range comprises one of the major belts of active volcanoes of the world. Being located near several population centers, the Cascade volcanic chain would seem to be an attractive prospect for the development of geothermal energy. However, the geothermal potential of the Cascades cannot be accurately assessed until the geological history of the region, its structure, hydrology, and volcanic and hydrothermal processes are more thoroughly understood.

In combination with other research groups, the U.S. Geological Survey Geothermal Research Program has undertaken a number of long-term geologic, geophysical, geochemical, and hydrologic studies of the Cascade Range on both regional and local bases. A geologic map of the Cascade Range will be compiled and supplemented with detailed mapping in specific areas. Aeromagnetic, gravity, and heat flow maps are being prepared to complement the geologic maps. Additional geophysical investigations include both active and passive seismic, electrical, and remote sensing techniques. Petrologic and geochronological data are being acquired in conjunction with geologic mapping. Studies of the geochemistry of hydrothermal alteration and geothermal fluids have also been initiated. Reports and maps will be published by the USGS and in scientific journals as individual projects are completed.

A significant portion of the work included in the USGS program is being done by universities, state agencies, and private institutions under contracts and extramural grants. Throughout these investigations, a conscientious effort is being made to coordinate activities with others working in the Cascade Range under funding from different sources (for example, the Department of Energy). The Geothermal Research Program Coordinator has designated Charles R. Bacon, Menlo Park, California, as geologist responsible for coordination of USGS geothermal investigations in the Cascades.

Letters after researchers' names indicate USGS offices in the following cities: D = Denver, Colorado; MP = Menlo Park, California; R = Reston, Virginia; S = Seattle (LIA), Washington; and SLC = Salt Lake City, Utah.

USGS PROJECTS IN THE CASCADE RANGE ASSOCIATED WITH THE GEOTHERMAL RESEARCH PROGRAM

Geophysical studies

Geothermal geophysics—D. R. Mabey (SLC): Evaluation of KGRA's in Cascades using geophysical data including aeromagnetic, gravity, SP, MT, AMT, EM, and active seismic techniques.

nil in Cascades
Nat. aeromag map

Teleseismic and microearthquake geothermal studies—H. M. Iyer (MP): Delineation of magma systems and the deep structure under the Cascades, particularly in Oregon, through microearthquake surveys and teleseismic P-wave studies.

big involv.
Lassen
Or seis net
smaller eq. cap.

Geothermal/Tectonic seismic studies—C. S. Weaver (MP): Detailed seismicity studies to understand the tectonic environment of the Cascades in relation to possible geothermal systems, particularly in central and southern Washington.

St. Helens

Active seismic exploration of geothermal sources—D. P. Hill (MP): Detailed determination of the velocity structure of the crust and upper mantle beneath the Cascades. Use of this information in interpreting the pressure-temperature conditions in the crust in conjunction with laboratory measures of physical properties.

CB has
rumn, but
no facts, of
activity

Geothermal processes, heat flow—A. H. Lachenbruch (MP): Measurement and theoretical studies of heat flow in the Cascades of northern California and southern Oregon.

$500K drilling
$, unk in Casc.
Sn ½ in OR
+ Calif.
Crater Lk. S.

Geoelectric studies—W. D. Stanley (D): Use of deep electrical sounding techniques to investigate crustal structure beneath the Cascades.

open file shortly

Geophysical characterization of young silicic volcanic fields—D. W. Williams (D): Characterization

L

Umbrella Proj.
3 sisters
Grav. Mag. studies
coring the Lk bottom
Crater

gravity map of cascades
½ mi a better aeromg.
3 Sist. to S

of volcanic geothermal areas using gravity, aeromagnetic, and other geophysical data.

Only Mt Hood nil now

Engineering geophysics—H. D. Ackermann (D): Determination of the relationships between the rock properties in areas of geothermal interest and their seismic-wave transmission properties from seismic measurements in the field.

nil now

Geothermal regional studies—R. Simpson (D): The use of deep-sounding magnetotelluric measurements to provide information on broad crustal-mantle structure and on areas of geothermal interest.

airborne em on St. Helens/Hood

Electrical techniques applied to shallow- to medium-depth exploration for geothermal resources—D. B. Hoover (D): Development and application of AMT, SP, and telluric techniques for exploration and characterization of geothermal systems to a depth of about 1 km.

OR, St. H. regional data small operation

Transient geomagnetic and telluric investigations—J. N. Towle (D): Use of a geomagnetic-telluric array to study the conductivity of the crust and upper mantle under the Cascades.

Heat flow, Crater Lake—D. L. Williams (D): Measurement of heat flow in bottom sediments and photographic coverage of selected sites on the bottom of Crater Lake, Oregon.

Seismic stratigraphy and geologic history of the floor of Crater Lake—C. H. Nelson (MP): Detailed seismic reflection profiling of the floor of Crater Lake to study sedimentation processes and relations between submerged volcanic features.

Plodding along - working 1 set of pages CA-CA, mainly Ranier to the S.

Lineament analysis—D. Knepper (D): Preparation of maps of lineaments in the Cascade Range from LANDSAT imagery.

Geologic studies

Expanded Newb., 3 Sis, part Wild & geol. mapping

Geology of Newberry and Three Sisters Volcanoes—N. S. MacLeod (MP): Geologic mapping and related studies of Newberry and Three Sisters volcanoes. Geologic map of the west half of the Crescent 2° Quadrangle, Oregon.

Old Maid Flat, Breitenbush

Hydrothermal alteration in the Cascades—M. H. Beeson (MP): Detailed field mapping and laboratory petrological and mineralogical studies of selected areas of hydrothermal alteration associated with active and fossil geothermal systems of Western and High Cascades.

Geology of young volcanic rocks and thermal areas in and around Lassen Volcanic National Park—L. J. P. Muffler (MP): A geologic study of the volcanic rocks and hydrothermally altered areas in the region of Lassen Peak to provide the geologic framework for understanding the geothermal resources of the southernmost Cascades.

Regional volcanology—R. L. Smith (R): Classification, characterization, and geothermal evaluation of volcanic systems in the Cascades.

Umbrella

Expanding toward Medicine Lake

Volcanology and petrology of Mt. Shasta—R. L. Christiansen (MP): A study of the volcanic evolution of Mt. Shasta and the Cascade Range in its vicinity.

Medicine Lake Volcano—J. M. Donnelly (MP): Geology of Medicine Lake Highland with emphasis on its volcanic evolution in time, space, and composition.

Volcanic evolution of the Crater Lake region—C. R. Bacon (MP): Geology and petrology of Mt. Mazama and vicinity, with emphasis on processes leading to the development of shallow silicic magma reservoirs.

changed to Mt. Adams

Mt. St. Helens—W. Hildreth (MP): Geochemistry and petrology of Mt. St. Helens, in collaboration with the USGS volcano hazards studies and other non-Survey researchers.

not an official project

Regional petrologic reconnaissance of the Cascades—W. Hildreth (MP): Geochemical and isotopic reconnaissance of the many lesser vents between the major stratocones to develop a better understanding of the characteristic scales and longevities of the Cascade volcanic foci.

5 yrs away

Geologic map of the Cascades—R. G. Luedke (R): Compilation of a geologic map of the Cascade Range in California, Oregon, and Washington to be used in conjunction with regional geophysical maps for evaluation of the geothermal resource potential and tectonic regime of the modern Cascade Range.

Fluid geochemistry and hydrology

Geol., some coord w/ States

Rock-water interactions—R. O. Fournier (MP): Development of geochemical techniques for estimating conditions deep in hydrothermal systems from chemistry of geothermal fluids.

Geochemical indicators—A. H. Truesdell (MP): Application of chemical and isotopic methods to the study of geothermal systems to determine subsurface temperatures, flow directions, origins, and ages of geothermal waters.

Chemistry of thermal waters—R. H. Mariner (MP): Collection and analysis of liquid and gas samples from thermal springs and wells of the Western and High Cascades for chemical and isotopic data used to estimate reservoir temperatures, outline areas for further geothermal exploration, identify potential pollution problems, and estimate recharge-discharge relations.

Geothermal hydrologic reconnaissance of the southern Cascades—E. A. Sammel (MP): Description and evaluation of the hydrology of several geothermal areas in the southern Cascades, including the Klamath Falls, Newberry, Medicine Lake, Shasta, and Lassen areas.

Hydrologic studies at Mt. Hood—J. H. Robison (MP): Hydrologic reconnaissance of Mt. Hood with emphasis on the warm springs and drill holes on the

North and Middle Sister, part of the Three Sisters Wilderness Area now being studied by the USGS as part of its geothermal research program. (Oregon State Highway Division photo)

south flank.

Geochronology

U series, etc., capabilities exist

Potassium-argon dating—M. A. Lanphere (MP): Determination of age and evolution rate of volcanic centers in the Cascades using K-Ar radiometric dating.

Thermoluminescence dating—R. J. May (MP): Development of the thermoluminescence (TL) dating technique for volcanic rocks in the age range of 10^3 to 10^5 years.

Carbon-14 dating—S. W. Robinson (MP): Use of radiocarbon dating to provide chronology of episodes of late Pleistocene volcanism and lacustrine episodes in areas of geothermal potential.

Paleomagnetic studies—C. S. Grommé (MP): Dating young volcanic rocks using the paleomagnetic record of Holocene secular variation and the application of other paleomagnetic and rock-magnetic techniques to the study of volcanic geothermal systems.

USGS ACTIVITIES OUTSIDE THE GEOTHERMAL RESEARCH PROGRAM

Geophysical studies

Pacific states geophysical studies—A. Griscom (MP): Synthesis and interpretation of gravity and aeromagnetic data over northern California to gain a better understanding of the regional tectonism and structure.

California gravity—H. W. Oliver (MP): Preparation of interpretive text to go with preliminary Bouguer gravity map of California (1:750,000).

Geomagnetic polarity time-scale and paleosecular variation—E. A. Mankinen (MP): Paleomagnetic data from volcanic areas in California, Nevada, Arizona, and New Mexico will be used to determine paleosecular variation in the western United States during the last five to six million years.

Geophysical studies in Medford 2° Quadrangle (CUSMAP)—R. J. Blakely (MP): Gravity and aeromagnetic studies in the Medford 2° Quadrangle.

Thermal infrared studies of Cascade volcanoes—J. D. Friedman (D): Repetitive thermal infrared surveys of Cascade volcanoes for the purpose of delineating and monitoring areas of anomalously high surface temperature.

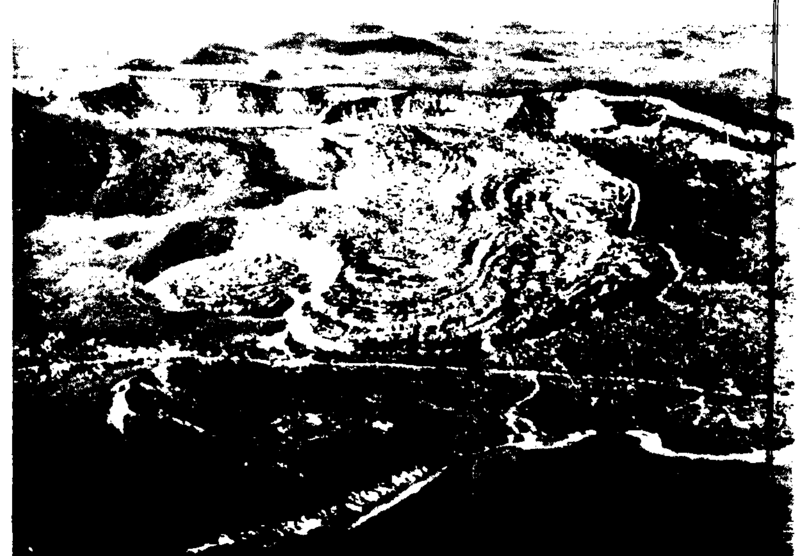
Remote sensing geothermal—K. Watson (D): Preparations of master image set for Mt. Hood and Newberry Crater areas from repetitive thermal infrared and multispectral data and ground meteorological measurements.

Geologic studies

Volcanic hazards overview—D. R. Mullineaux (D): Preparation of overview maps of volcanic hazards for Oregon (1:1,000,000) and western U.S. (1:2,500,000).

Volcanic hazards—D. R. Crandell (D): Rocks and unconsolidated deposits of volcanic origin and of late Quaternary age are being studied at volcanoes in

Newberry Volcano, near Bend, Oregon. Note Big Obsidian Flow in center of photo. The USGS is studying Newberry Volcano and surrounding volcanic features with its geothermal research program. (Oregon State Highway Division photo)



Washington, Oregon, and California for the purpose of evaluating potential hazards from future eruptions. Includes recent eruptive histories of Glacier Peak (J. E. Beget, Univ. Washington), Mt. St. Helens (R. P. Hoblitt [D]), Mt. Hood (Crandell), Mt. Shasta (C. D. Miller [D]), and studies of Holocene pyroclastic flows (Crandell).

Tephra hazards, Cascade Range volcanoes—D. R. Mullineaux (D): Study of large single shower beds of tephra, mainly from Mt. St. Helens and Mt. Mazama, to evaluate potential tephra hazards downwind from Cascade Range volcanoes.

Tephrochronology of the western region—A. M. Sarna-Wojcicki (MP): Isotopic age determination, and correlation of late Cenozoic ashes and tuffs by means of instrumental neutron activation, X-ray fluorescence, and electron probe analyses of volcanic glass, and by petrography and paleomagnetism. Includes studies of tephra units and source areas in the south, central, and north Cascade Ranges.

Sacramento Valley—Northern Sierran Foothills—E. J. Helley (MP): Preparation of geologic maps of Quaternary alluvial deposits and late Cenozoic volcanic rocks of the Sacramento Valley and Northern Sierran Foothills, with special emphasis on the age of associated faulting.

Medford-Coos Bay Quadrangles (CUSMAP)—J. G. Smith (MP): Preparation of a multidisciplinary land-resource analysis folio of Medford 2° Quadrangle, with primary emphasis on the evaluation of potential mineral resources and their relation to regional structure, tectonostratigraphic units, and plate tectonic models.

Geochemical exploration of Medford 2° Quadrangle (CUSMAP)—D. J. Grimes (D): Collection and analysis of stream sediment samples for 32 elements; preparation of preliminary maps and identification of target areas for detailed studies.

Mineral resources of Spirit Lake Quadrangle—R. P. Ashley (MP): Preparation of a geologic map and reports on geology and mineral resources of Spirit Lake 15' Quadrangle, Washington.

Wenatchee 2° Quadrangle—R. W. Tabor (MP): Preparation of geologic maps of four 1:100,000 quads making up Wenatchee 2° Quadrangle, Washington, with emphasis on tectonics.

Port Townsend 1:100,000 Quadrangle, Washington—J. T. Whetten (S) and H. D. Gower (MP): Preparation of geologic map with emphasis on tectonics.

Geologic map of Columbia Plateau; Columbia River Basalt—D. A. Swanson (MP); **Genesis of basalt**—T. L. Wright (R): Continuing studies of Columbia River Basalt in southeastern Washington and northeastern Oregon.

Seismo-tectonic analysis of Puget Sound province—H. D. Gower (MP): Investigation of suspected Quaternary and bedrock faults by marine seismic profiling; aeromagnetic, gravity, and geologic investigation; geologic reconnaissance of arcuate topographic feature east of Seattle in Western Cascade Range.

Tectonic analysis—K. F. Fox, Jr. (MP): Compilation of tectonic map of Washington (1:500,000).

Mt. Baker monitoring—D. Frank (S): Photographic surveys of fumarolic emission and associated snowmelt patterns, and chemical analysis of stream draining Sherman Crater for the purpose of monitoring activity of Mt. Baker.

Wilderness studies

Caribou-Thousand Lakes—A. Till (University of Washington)

Baker Cypress-Lava Rock—J. A. Peterson (MP)

Sky Lakes—J. G. Smith (MP)

Salmo Priest—F. K. Miller (MP)

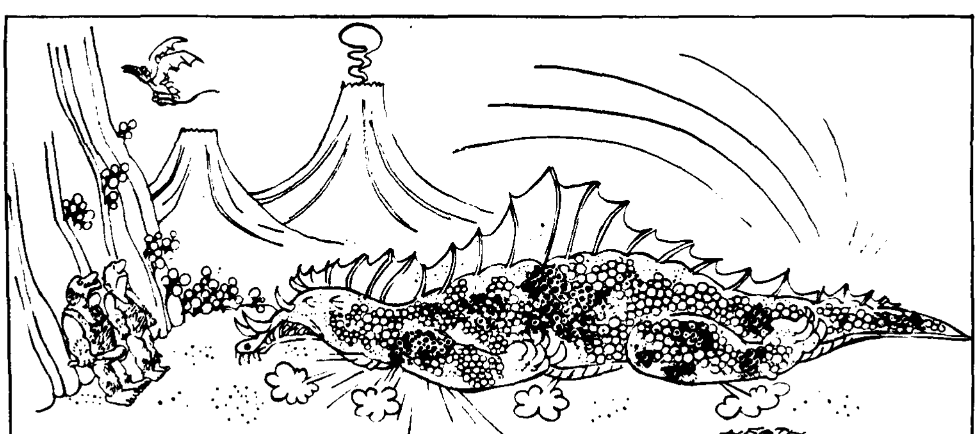
Three Sisters—N. S. MacLeod and G. W. Walker (MP)

Mt. Washington—N. S. MacLeod (MP)

Mt. Hood-Zigzag—T. E. C. Keith (MP)

Goat Rocks—D. A. Swanson (MP)

Glacier Peak—J. G. Evans and R. W. Tabor (MP) ☐



"Thank goodness! Extinct just in the nick of time!" (C) Punch-ROTHCO

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

April 22, 1980

MEMORANDUM

TO: State Coupled Program Core Group

FROM: Duncan Foley

SUBJECT: Meeting with Washington Resource Assessment Team

DATE OF TRIP: 7 April, 1980

PLACE: Offices of Washington Geology and Earth Resources Division; Department of Natural Resources, Olympia, WA

PURPOSE: Discussion of State Coupled and User Coupled Program Interfaces

ATTENDEES: Ted Livingston, Eric Schuster, Mike Korosec, Glennda McLucas, Washington DNR
Gordon Bloomquist, WA Planning and Commercialization team
Duncan Foley, ESL/UURI

General and Business

1. The Washington team has been keeping track of volcanic activity at Mt. St. Helens. They plan on resampling springs when the snow melts, and will also remeasure thermal gradient holes.

2. Foley presented the discussion of the interface between the State Coupled Program and the User Coupled Confirmation Drilling Program.

Technical

1. The Washington team is aware of plans by Shell Oil to drill to 15,000-20,000 ft. depths west of Yakima this summer, and they are interested in obtaining thermal data from this hole. Shell seems willing to share the hole, especially if it turns up dry. The Washington team predicts a regional gradient in excess of 50°C/km at the site.

2. Data sent to NOAA for inclusion of the public map include:
   a. Thermal springs and fumaroles, with supporting chemical data,
   b. Wells, separated into two categories: the first is anomalous sites, where the water temperature is above 22°C, the depth is greater than 140m, and the gradient is above 50°C/km, and the second is wells with an anomalous temperature that do not meet the other criteria.
   c. Cultural corrections to the base map.
   d. Areas of Quaternary volcanic vents and flows.
   e. Faults
   f. Lease Status
   g. Squibs

Action Items

1. ESL will report to Washington on loggers capable of 20,000 ft. depth.

2. ESL will provide analytic procedure data for rock analyses.

3. WDNR is interested in an evaluation of Band 8 Landsat images.

Duncan Foley/hb
Duncan Foley

DF/hb

THE UNIVERSITY OF UTAH

DEPARTMENT OF GEOLOGY AND GEOPHYSICS
COLLEGE OF MINES AND MINERAL INDUSTRIES
717 MINERAL SCIENCE BLDG.
SALT LAKE CITY, UTAH 84112

MEMO

August 21, 1980

TO: Duncan Foley

FROM: Stan Evans

Enclosed are all the dates for Geoff Clayton on his samples from Washington. I called him and gave the numbers to him over the phone but I am routing the enclosed info through you for your records.

Stan

Stan

Return to Duncan.

Sample No.	Unit	Material Dated	Weight (gms).	%K	Moles/gm Ar^{40}_{Rad} $(X10^{11})$	$\%Ar^{40}_{atm}$	Age (M.Y.)
PL-2,3		Whole Rock	5 ~~1~~.00113	0.57	0.174	93.1	1.75 ± 0.35
*PL-4,5		Whole Rock	2.52630	1.52	0.280	92.0	1.06 ± 0.18
*McN-q		Biotite	0.81368	6.71	3.989	73.7	3.42 ± 0.19
HN-Sp-1		Whole Rock	5.01978	0.78	0.208	88.0	1.53 ± 0.18
*RM-5		Whole Rock	2.51230	1.31	0.179	91.8	0.79 ± 0.13
SFCCF		Whole Rock	4.82114	0.93	0.105	88.9	0.65 ± 0.08
DH-2		Whole Rock	5.13920	0.57	0.378	82.7	3.80 ± 0.31

*Provisionary dates. Extractions done on newly calibrated line.

Constants Used:

$\lambda_\beta = 4.962 \times 10^{-10}/yr.$

$\lambda_\varepsilon = 0.581 \times 10^{-10}/yr.$

$K^{40}/K_{Tot.} = 1.167 \times 10^{-4}$ Mole/Mole

Bob

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

August 28, 1980

Mr. Geoff Clayton
1719 N.E. 50th Street
Seattle, Washington 98105

Dear Geoff,

Enclosed is a copy of a memo from Stan Evans at the University of Utah concerning age dates of certain rock samples that were submitted from you.

If you have any questions, please call.

Sincerely,

Bob

Robert E. Blackett
Geologist

REB:ls

Enclosure

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TECHNICAL PROGRESS REPORT FOR AUGUST 1980

Contract DE-AC07-79ET27014, Modification A003

?s for MAW - contract on p2

by

J. Eric Schuster
and
Michael A. Korosec

September 15, 1980

HEAT FLOW DRILLING

Drilling sites are as specified in the Technical Progress Report for July 1980. Preliminary drilling specifications have been written and submitted to the Department of Natural Resources' Engineering Services Section for preparation of the bid advertisement document. The preliminary drilling specifications have been sent to USDOE/ID for review. The bid advertisement document will be sent for review as soon as it has been prepared.

Negotiations have been concluded with Richard C. Kent, Consulting Geologist, 19443 Wilderness Drive, West Linn, Oregon 97068, to serve as a drilling supervisor. A contract for Mr. Kent will be prepared shortly and sent to USDOE/ID for review and approval.

TEMPERATURE MEASUREMENTS

John Biggane, Washington State University, has continued to work with available temperature-depth data from Yakima County. Using data out of about 200 wells, he has culled out the obviously poor quality data and performed a regression analysis on the remaining data. Results so far are quite preliminary, but do show an apparent variability in gradient versus geographic location. Biggane's report for August is attached.

Arrangements have been made to hire a geologist to measure temperature gradients in existing wells in eastern Washington. The contract is awaiting review and approval by USDOE/ID.

GEOLOGIC MAPPING

Subcontracts have been finalized with Geoff Clayton, University of Washington, and Paul Hammond, Portland State University, for geologic mapping, rock geochemistry, age dating, and formulation of preliminary space-time-

NOT GEOTHERMAL! this was NOT according to ESL, supposed to be let composition models for volcanism in the central and southern Cascades, respectively. These subcontracts are awaiting USDOE/ID approval.

GRAVITY SURVEY

The Cascades gravity survey has made further progress during August, with the measurement of 294 gravity stations in the central Cascades and in the Mount Baker area. Dr. Danes' report for the month is attached.

GEOPHYSICAL INTERPRETATIONS

how many $

There have, as yet, been no activities under this task.

GEOCHEMISTRY

During the month of August, waters were collected from Sol Duc, Scenic, and Goldmeyer Hot Springs and from a cold mineralized well near Goldmeyer Hot Springs.

Where was Mike

At Sol Duc Hot Springs, waters were collected during a pump test of a hot water well drilled last year near the hot springs. Four sets of samples were taken for the Division by R. Gordon Bloomquist at different stages of the pump test. In all cases, the temperatures were a few degrees less than the main hot springs, which flow at 48^{o} to 52^{o} C.

Bob Mariner, of the U.S. Geological Survey (Water Division out of Menlo Park), joined Mike Korosec of the Division during a sampling trip to Goldmeyer Hot Springs. This enabled the two to compare sampling technique and discuss analytical procedures used back in the lab. While the USGS was most interested in only the hottest of the springs (about 51° C), Korosec collected from all four main springs in the area and noted a few minor springs in the vicinity.

About 2 miles west of the Goldmeyer Hot Springs, along a logging road, cold mineralized waters flow artesian from an old exploration drill hole. A sample was collected from this "well" for comparative purposes.

MOUNT ST. HELENS

During the month of August, we kept in contact with other investigators who are studying thermal features around the volcano. Thus far, no "thermal leaks" have been detected beyond the flanks of the volcano, as detected by thermal IR surveys (Charles Rosenfeld, Oregon State University). Fumaroles generated by buried hot debris in the North Fork of the Toutle River valley continue to steam away, especially in the areas covered by the most recent pyroclastic flows. Plans are in the making for working more closely with other investigators, such as C. Rosenfeld and USGS geologists to develop thermal and hydrologic models for Mount St. Helens which will serve to better understand thermal-hydrologic systems on other Cascade Stratovolcanoes.

FAULT-LINEAMENT MAP

During August progress was made in detailed fault compilation (was 80% complete, now about 90%), ERTS lineament compilation from black and white images (was 20%, now about 50%), and U-2 infrared lineament compilation (was 30%, now 40%). As during July, no field checks have been possible (see July report for explanation).

USGS GEOTHERMAL FILE

To be done during winter months.

WASHINGTON STATE UNIVERSITY
PULLMAN, WASHINGTON 99164

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
Geological Engineering
(509) 335-8546

September 9, 1980

Dr. J. Eric Schuster
Assistant Manager
Division of Geology and Earth Resources
Department of Natural Resources
Public Lands Building
Olympia, WA 98504

Dear Dr. Schuster:

Enclosed is the Geothermal Thesis Project Monthly Report for August, 1980.

Fiscal status of the project is as follows:

Actual and Estimated Expenditures	$ 1,898
Balance Remaining	13,102

Sincerely,

John Biggane

John Biggane
Research Assistant

JB:dw
Enc.

Geothermal Thesis Project in the Yakima Area

Monthly Letter Report - August, 1980

Temperature data have been compiled for 200 wells that are located in or near Yakima County, Washington. Of these wells, 132 are less than 1000 feet (305 m) deep, 61 are between 1000 feet (305 m) to 2000 feet (610 m) deep, and the remaining 7 wells have depths greater than 2000 feet (610 m). Unfortunately, all of the wells greater than 2000 feet (610 m) deep are located outside of Yakima County.

Thermal gradients (based on bottom hole and static level temperatures), land surface temperature (determined by projecting the thermal gradient to the surface), and the depth of the 20^{o}C isotherm (found through examination of the temperature-depth logs) have been determined for these wells. Thermal gradients and projected land surface temperatures, determined in such a manner, often have no significance due to flow within the well.

More meaningful results have been obtained through a linear regression analysis (least squares method) of bottom hole temperatures. Preliminary results of this work are provided in Table 1. Thermal gradients range from 27.2^{o}C/km to 69.1^{o}C/km. Land surface temperatures range from 5.85^{o}C to 14.6^{o}C. Depth of the 20^{o}C isotherm ranges from 480 feet (146 m) to 902 feet (275 m). Analysis of the wells greater than 2000 feet (610 m) deep results in a thermal gradient of 29.2^{o}C/km with the 100^{o}C isotherm at a depth of 8337 feet (2541 m).

The linear regression results will be updated as additional data are collected. The incorporation of elevation, topography, and aquifer characteristics into the regression analysis should increase the reliability of these correlations.

Table 1. Results of Regression Analysis

Township	Range	Number of Wells	Thermal Gradient (°C/km)	Land Surface Temp. (°C)	Depth to 20°C Isotherm (meters)	r^2*
7	19-26	10	30.5	11.6	274	.62
9,10	23,25	5	39.0	11.7	213	.98
10	16-18	8	27.2	14.6	200	.91
10,11	20	5	30.5	13.5	213	.79
11	19,20	6	39.1	12.3	197	.72
11	21	11	43.1	12.5	175	.94
11,12	22	5	46.6	10.9	196	.85
12	16	4	50.0	12.6	149	.88
12	17	4	35.7	12.8	201	.93
12	18	7	44.6	11.9	180	.81
12	19	3	39.4	14.0	152	.998
12	20	8	38.3	14.4	146	.88
12,13	21	6	34.8	13.6	183	.76
12	22-24	6	53.8	8.6	212	.87
13	18	3	40.6	13.95	149	.94
13	19	8	41.6	12.15	188	.82
13	20	7	39.9	14.1	147	.93
14	16	5	35.2	10.4	273	.91
14	17	9	27.2	12.5	275	.51
14	18,19	4	55.5	10.8	166	.92
15	17-19	6	52.9	9.15	205	.92
16,17	16-21	6	69.1	5.85	205	.93
Deep wells	-	6	29.2	25.7	-	.99

*r^2, the coefficient of determination, is a measure of the quality of fit achieved by the regression. Values of r^2 close to 1.0 indicate a better fit than values close to zero.

Work to be conducted during September will include the collection of additional temperature data, the collection of water samples, and the examination of the nuclear and lithologic logs for the purpose of stratigraphic correlation.

University of Puget Sound
TACOMA, WASHINGTON 98416

September 5, 1980

Mr. Eric Schuster
Division of Geology and
Earth Resources
Department of Natural Resources
Olympia, WA 98504

Dear Eric:

Progress Report for August 1980 - Gravity Survey of the Cascade Mtns.
Project #DE-AC07-79ET27014
Modification #A003

During the month of August 1980, 294 gravity readings were taken in the area of the present project. Of those, 104 readings were repeats, base ties and new subbases. The rest (190) are new stations.

About one-third of the work was done in the area between North Bend and Snoqualmie Pass; the remainder was spent in the area around Mt. Baker. That area has now been adequately covered, with the exception of two "holes", one around Mt. Baker proper, the other around Mt. Shuksan. If weather conditions and the surface of the glaciers permit, we may fill in those regions this year. Otherwise, we plan on doing it next spring.

The production was lower this month for two reasons: many of the stations could only be reached on foot, often after several hours or days of walking; also, one instrument only was used in the present project, while the other one was on a stand-by for a detailed work in the Mt. Margaret Wilderness Area. The latter job has not yet been initiated due to bad weather, low ceiling for the helicopter, and other commitments on the part of the pilot.

We also re-submitted some gravity stations to the USGS for reduction--trying to find the error in last month's reductions; however, to date, we have not received the answer.

At present we are in the process of obtaining the necessary terrain information from the USGS, and in the future, we hope to run the terrain corrections on the UPS Computer.

Attached is a Xerox copy of the Ledger. It is not quite up-to-date: approximately $600 will be processed in the next few weeks. At ~~that~~ time we shall send you an updated copy.

Sincerely yours,

Z. F. Daneš
Professor of Physics

ZFD:ha

Enclosure

Geothermal Test Drilling, Central and Southern
Cascade Mountains, Washington

DESCRIPTION OF WORK

This project consists of drilling 10 holes, each to a depth of 500 feet. Minimum hole diameter must be sufficient to allow installation of a 2" inside diameter black iron pipe in the hole.

The purposes of the test holes are:

1. To measure temperature gradients.
2. To obtain cuttings samples of the rock units penetrated for laboratory studies.
3. To run electrical and other logs in the holes.
4. To obtain samples for geochemical testing of any unusual waters encountered.

The drill holes must be left in a permanently sealed condition such that vertical flow of water in the well bore is presented.

DRILLING SCHEDULE

The contractor shall be expected to start work within a reasonable period of time following receipt of the owner's notice to proceed, and to continue with the work to completion with as few interruptions as possible.

In the event that winter weather conditions make drilling impractical, the owner and contractor will, 1) abandon the effort to drill at higher elevation sites in favor of continued drilling at lower elevation sites, or 2) discontinue all drilling until weather conditions improve in the spring of 1981. These decisions are to be arrived at by negotiation and mutual agreement, but the final decision is the owner's, with due regard to health and safety of the contractor's employees and the practicality of drilling under anticipated conditions.

Except for owner-approved suspensions of drilling activity, the contractor is expected to finish all work within 70 working days (figuring one shift per day and 5 days per week except for legal holidays).

PENALTY

The contractor will pay a $150 penalty for each working day beyond 70 that the job is not completed.

BONUS

The owner will pay a bonus of $150 per day for each working day under 70 if the job is finished in less than 70 working days.

PROCEDURES

Drilling

Drill to solid bedrock and install welded steel casing 5 feet into bedrock. Cement the 5 foot interval between the casing and bedrock. Holes will generally be sited where depth to bedrock is 50 feet or less, but the contractor will be prepared to install casing to a depth of 100 feet if necessary.

what if too low?

After installation of welded steel casing the contractor will continue drilling until a 500 foot depth is reached. Water production is to be expected. Holes drilled in the Cascades in the past were 4½ inches in diameter, and some of them produced up to 60 gpm of artesian flow when drilling had stopped, and up to 100-200 gpm while drilling with air. We prefer that the contractor continue to drill through water zones rather than stopping to cement them. This is because stopping to cement each of several aquifers in a drill hole takes too much time. In the event that water production from the hole causes the air hammer to "drown out" the contractor will be required to have the necessary equipment on hand to continue drilling T.D. using air and a tricone or other type of rotary bit.

Equipment Required

1. Farling 1500 or equivalent drill rig.
2. Minimum of 750 cfm @ 250 psi compressor.
3. Casing driving capability.
4. Up to 100 feet of casing per hole.
5. On site capability to drill to 500 feet using an air hammer and rotary

bit with air if the hole cannot be finished with the air hammer because of water problems.

6. Capability to cement the "joint" between casing and bedrock.

Finishing the Hole

Install 2 inch black iron pipe in the hole to T.D. The bottom of the 2 inch pipe will be equipped with a check value or a cap, depending on the mudding or cementing procedure to be used. Deburr inside joints of the 2" pipe to allow free passage of logging tools. Mud or grout the hole using one of the following procedures (this decision will be made by the owner's representative):

1) In a hole with insignificant water-producing zones the annulus may be filled, from the bottom up, with heavy drilling mud and a ten-foot cement plug installed at the surface.

2) In a hole with significant water zones but little or no artesian flow the hole will be sealed with grout using one or two methods: a) install a check valve at the bottom of the 2" pipe and pump cement through the 2" pipe until cement returns to the surface in the annulus, then wash the cement out of the 2" pipe using 1" flush-coupled steel tubing inserted into the 2" pipe, or b) perforate the bottom several feet of the 1: flush-coupled steel tubing (to prevent plugging), strap it loosely to the 2" pipe and install both to T.D. In this case, the 2" pipe would have a pipe cap on the bottom and it would be filled with water and capped as soon as installation is complete. Pump cement through the 1" pipe until cement returns to the surface in the annulus, and retrieve the 1" pipe.

3) In a hole with significant artesian flow use method 2a or 2b after packing off the artesian flow to prevent washing of the grout after it has been emplaced.

After cementing or mudding, the hole is to be finished by cutting off the welded steel casing slightly below ground level and cutting the 2" pipe at ground level and installing a threaded steel cap. The 2" pipe is to be left unobstructed to allow free passage of logging tools and filled with water.

Equipment Required for Each Hole

1) 500 feet of flush-coupled 1" steel tubing with a perforated bottom section several feet long.

2) 500 feet of 2" black iron pipe with caps and/or check valve as required.

3) Mud/cement pump capable of delivering 300 p.s.i. pressure.

4) High-pressure couplings to connect the mud/cement pump with either the 1" pipe or the 2" pipe.

5) Cement. If the hole size is 6" it may take 750 gallons or more of slurry to fill the annulus. Preferred mix is 1 sack plus 6½ gallons of water plus no more than 3 lbs. of calcium chloride to make 10.1 gallons of slurry.

6) Drilling mud.

7) Packing materials to seal the annulus at the surface, if necessary.

8) Cement mixer and holding tank.

9) Water truck.

LOCATION OF DRILL SITES

The ten drill sites will be located as follows, and they will be drilled in order listed if possible:

1. Near the town of Scenic on the Stevens Pass Highway.

2. Near Snoqualmie Pass.

3. On the west fork of the White River just north of the northern boundary of Mount Rainier National Park.

4-6. Three holes between White Pass and the town of Naches.

7-10. Four holes in the Wind River valley between the town of Carson and Government Mineral Springs.

SITE INFORMATION

All drill sites will be located on or near existing roads, such that access by a truck-mounted drilling rig and service vehicles should be practical.

GEOLOGY

Wherever possible drill sites will be located where overburden is 50 feet thick or thinner, but the contractor will be prepared to case through up to 100 feet of overburden if necessary.

Artesian flow and other water-production problems, as outlined under Procedures, can be expected in, on the average, about 50 percent of the holes.

Bedrock formations are expected to be relatively competent Tertiary basalts, andesites, volcano-sedimentary, and/or sedimentary rocks.

STANDBY

Stan - This should be the same as it was for Project No. - DNR-79-20, except we need to add inclement weather as a cause for delay that we will not pay for (prolonged inclement weather would lead to a move to lower elevation or cessation of drilling until spring). Lost time due to fire closures and bad weather would not count as worked days for purposes of charging penalties for not finishing the work in 70 days. Equipment maintenance, breakdowns, etc., would count as worked days for penalty purposes.

DRILLER'S LOG

(Stan - same as for DNR-79-20)

WATER

(Stan - same as for DNR-79-20)

CUTTINGS SAMPLES

hmmm

(Stan - same as for DNR-79-20, except 1) only one sample for each sampling interval is required, and it need only be about 2 cups in size, 2) we have no need of the date and time on the sample label.)

BIDDING

Base Bid should be Calculated on:

1. Mob. & Demob. - lump sum.
2. Drilling with air hammer - 5,000 lin. ft @ $________/lin. ft. and $________ total.
3. Surface casing - 300 lin. ft. @ $________/lin. ft. and $________ total.
4. 2" black iron pipe - 5,000 lin. ft. @ $________ lin. ft. and $________ total.
5. Standby - 20 hours @ $________/hour.

Additional Work

1. Air-rotary drilling @ $__________/foot.
2. Installation of surface casing @ $__________/hour.
3. Installation of 2" iron pipe @ $__________/hour.
4. 1/ Mudding or cementing @ $__________/hour.
5. Portland Cement @ $__________/scak

Driller Must Specify

1. Size of drilled hole.
2. Size of welded steel casing.
3. Make, model, and depth capability of rig.
4. Make and capacity of air compressor (cfm at what p.s.i.).
5. Make, type, and pressure capability of mud/cement pump.

1/ Includes cost of water truck.

11 Sept 80

MAW
DF } ESL
BB

ERIC / MIKE

ERIC - has contract to WSU, since May 1

Yakima

John Biggane as MSC under Jim Crosby (w/ Blackwells gear)

ES says MAW has subcontrack @ 15k

Map, Synthesis, Geol., T grad, heat flo

thermal & hydrol. model

starting w/ Yakima Co, then narrow in

Yak hosp using (a planning to) mid-80°F H_2O - heat pump

St. Eliz (83 @ surf.)

Aquifer transmissivity vy hi (96°F @ depth

hospital doesn't have $ to go right away

H_2O entering near bottom

Ellensburg Fm 1200-1400'

semi-confined aquifer w/ good artesian head

so far - grads from ~70 wells

H_2O chem. - no work by Eric yet

conductiv. ~200-400

Not much anom.

Mike - says could distinguish 25 from 26 ppm on SiO_2

Eric - chem lab use vy low

MAW - Yakima H_2O qual. (?)

Eric - Not much down hole

Mike - too much mixing

Moving - ∴ not doing anal til early next year

St. Helens

met w/ Mariner

Anal since July - 0

coll'n since " - 10

In year 45-50 spls

Accuracy - compared lab on spg.

Si - reduces Moly w/ Na nitrite

will be doing splits of same spl in Jan

11 Sept 80 ②

ES -
will be drilling 6 wks - 2 mos

MAW - now need EPA statement, all DOE drilling progs
- only 1 state had filed program papers (of 16)
each site is impacted - how ...

ES - environ. ✓ list - would be OK
MAW - will provide outline to ES

ES - has to meet EPA type things - Wa Dept. of Ecology

Mike - faced w/ split season on drilling
MAW - end of Mar(?)
end of May finishing - ∴ no trouble getting holes

drilling consultant   Rick Kent   Portland, OR
i.e. supervisor   a sm consulting firm

→ ∴ proposal by Dec. 1 to meet Mar. 1 contract date

ES - balancing Blackwell w/ program w/ gaps
· needing nos in Cascades
- regional heat-flo. pattern

siting - near thermal, where appropriate
gaps
some geol.
} of thermal grads.

Technical Progress Report for July, 1980

Contract DE-AC07-79ET27014, Modification A003

by

J. Eric Schuster
Principal Investigator

Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington

August 14, 1980

Technical Progress Report for July, 1980

Contract DE-AC07-79ET27014, Modification A003

Heat-Flow Drilling

Events of the past several months have caused some of the sites for heat-flow holes to be moved. The contract calls for the drilling of two holes east of Mount St. Helens, but the series of 1980 eruptions has made that impossible. Instead we plan to drill these two holes in the central Cascades near the Stevens and Snoqualmie Pass Highways, in areas where there are no existing wells. Instead of drilling one hole in the Cowlitz River valley as called for in the contract, we intend to drill at an alternate site on the West Fork of the White River about one mile north of the center of the northern boundary of Mount Rainier National Park.

Three holes will be drilled between White Pass and the town of Naches (near Yakima) in order to complete the cross-Cascades gradient and heat-flow profile that was begun in the Cowlitz Valley during 1979.

Of the eight holes planned, the last two will be located in the Wind River valley, one near St. Martin's Hot Spring, as earlier planned, and the second farther upstream near Government Mineral Spring. We do not plan to drill near the town of North Bonneville because the town has secured other USDOE/State Energy Office funding to carry out that work.

Because of the extra work load imposed by the continuing eruptions of Mount St. Helens and by the fact that contractual authority to proceed with subcontracts was not established until about July 1, 1980, the 1980 drilling contract is not yet in place. The drilling contract should be let within two months. We don't anticipate that the delay will cause serious difficulties because most of the drill sites that are subject to severe winter weather are located adjacent to all-weather highways.

Temperature Measurements

Temperative gradients in the Yakima area were measured by Sherry Kelly, an employee of D. D. Blackwell at Southern Methodist University during July 1980. She measured temperatures in approximately 50 water wells. These data are in the possession of Blackwell, we have a copy, and John Biggane, research assistant at Washington State University, has a copy. Biggane is working on a thesis designed to evaluate the low-temperature geothermal resources of the Yakima County area and is doing so under a subcontract as part of the USDOE-sponsored Washington State Resource Assessment program. Biggane has a set of D. D. Blackwell's temperature-logging gear and he will be logging as many wells as possible in Yakima County.

We plan to hire at least one person to log temperatures in existing wells in the southeastern Cascades and southwestern Columbia Basin, but this subcontract is not yet in place. We anticipate having someone working at this task by mid-September, 1980, and we may stop the work during the most severe winter months and resume logging again next spring.

Geologic Mapping

The contract calls for geologic mapping and related studies in the area of one of the stratovolcanoes (ie. Mount Adams or Mount Baker). We have attempted, without success, to set up such a study through the Department of Geological Sciences at the University of Washington. We have, however, received requests for support from Geoff Clayton at the University of Washington and Dr. Paul E. Hammond at Portland State University. Geoff Clayton worked for us during 1979 in the White Pass-Tumac Mountain area, turning out a high-quality geologic map and geochemical analyses of the rocks. Age dates will follow, pending completion of laboratory analyses by University of Utah Research Institute. Dr. Hammond has worked in cooperation with the Division of Geology and Earth Resources for several years on his geologic mapping projects in the south Cascades. Both investigators have our fullest conficence.

Geoff Clayton proposes to extend his geologic mapping and rock sampling northward into the Bumping Lake area, with emphasis on Pliocene and Quaternary volcanic rocks. Paul Hammond needs minor financial assistance for the analysis of rock samples collected in the south Cascades during earlier field work.

If we support their work the results will be 1) a quality geologic map of the Bumping Lake area in northwestern Yakima County; 2) a computer file containing rock-geochemical data from the south Cascades (including data from Hammond, Hopson, and others); 3) and the development of a good time-space model for Quaternary magma generation. We will be sending proposed subcontracts to USDOE for review as soon as they can be prepared.

Gravity Survey

A subcontract for gravity investigations by Drs. Z. F. Danes and A. A. Eggers was signed during July, 1980. During July two field teams were operating in the Bumping Lake, Enumclaw, Greenwater, Lester, Easton, Bandera, and Snoqualmie 15' USGS Qaudrangles, and in the Orting, Wilkeson, Buckley, Black Diamond, Cumberland, and Eagle Gorge 7½' USGS Quadrangles, all in the central Cascades. 403 gravity readings were taken; of those, about 50 are base readings, ties, and calibrations; the rest are new data.

The Black Diamond and Cumberland Quadrangles are finished and Report Sheets have been sent to the Denver office of the U.S. Geological Survey for reductions. Work on the other map districts continued with the expectation that operations would move into the Mount Baker area during August.

Geophysical Interpretations

It has not yet been necessary to engage in any activities under this task.

Geochemistry

Several trips were made into the area around Mount St. Helens in an effort to examine temperature and/or flow changes at known cold springs, and to check for new thermal and mineral springs which might have been created by the eruptions. Most of the springs which we had examined during 1979 were destroyed by the May 18 eruption. Kalama Spring, on the southwest flank of the volcano, had not changed; it was still flowing at its normal high rate and very cold temperature. No new thermal springs were found, but numerous fumeroles were examined in the area of pyroclastic and debris flows in the valley of the North Fork of the Toutle River to the north of the volcano.

A search was made for Green River Soda Spring (within the devastated zone to the northwest of the volcano), but it could not be found because of difficult access due to fallen timber and ash cover.

Fault-Lineament Map

The area of study extends from 121°30'W (the crest of the Cascades) west to 123°W., and from the Columbia River north to 47° N. (about the latitude of Olympia). To the east of this area it has been determined that a considerable amount of lineament mapping has already been done by Batelle Northwest. For the above study area, lineaments are being compiled from a variety of sources, and faults are being compiled from the literature. The various subtasks and percentages of compilation (in parentheses) are as follows: detailed fault compilation (80%), SLAR lineament compilation (100%), ERTS lineament compilation from enhanced color images (100%), ERTS lineament compilation from black and white images (20%), U-2 infrared lineament compilation (30%), and topographic map lineament compilation (70%). All 1:100,000 base maps have been obtained from the USGS, all bibliographic material has been compiled, and all lineament studies done previously are on hand for comparison purposes.

The eruptions of Mount St. Helens have resulted in the closure of most of the Gifford Pinchot National Forest and large areas of private land which have been included in the "red zone" around the mountain. Furthermore, field trips with geologists familiar with the geology of the study area have had to be cancelled due both to land access restrictions and to those investigators beginning new investigations connected with the eruptions. These circumstances have made it impossible to field check the lineament-fault map as planned. Field checks will be made when it once again becomes possible.

USGS Geothermal File

This task will be started during the winter months. At this time, we anticipate the need to hire a temporary geologic aide this winter to help carry out this task.

Technical Progress Report Distribution List

No. of Copies	To
2	M. A. Widmayer, Program Manager U.S.D.O.E./ IDAHO 550 Second Street Idaho Falls, ID 83401
2	Bob Gray USDOE, Division of Geothermal Energy M.S. 3344, Federal Bldg. 12th and Penn., N.W. Washington, D. C. 20461
1	Duncan Foley UURI 420 Chipeta Way, Suite 120 Salt Lake City, UT 84108

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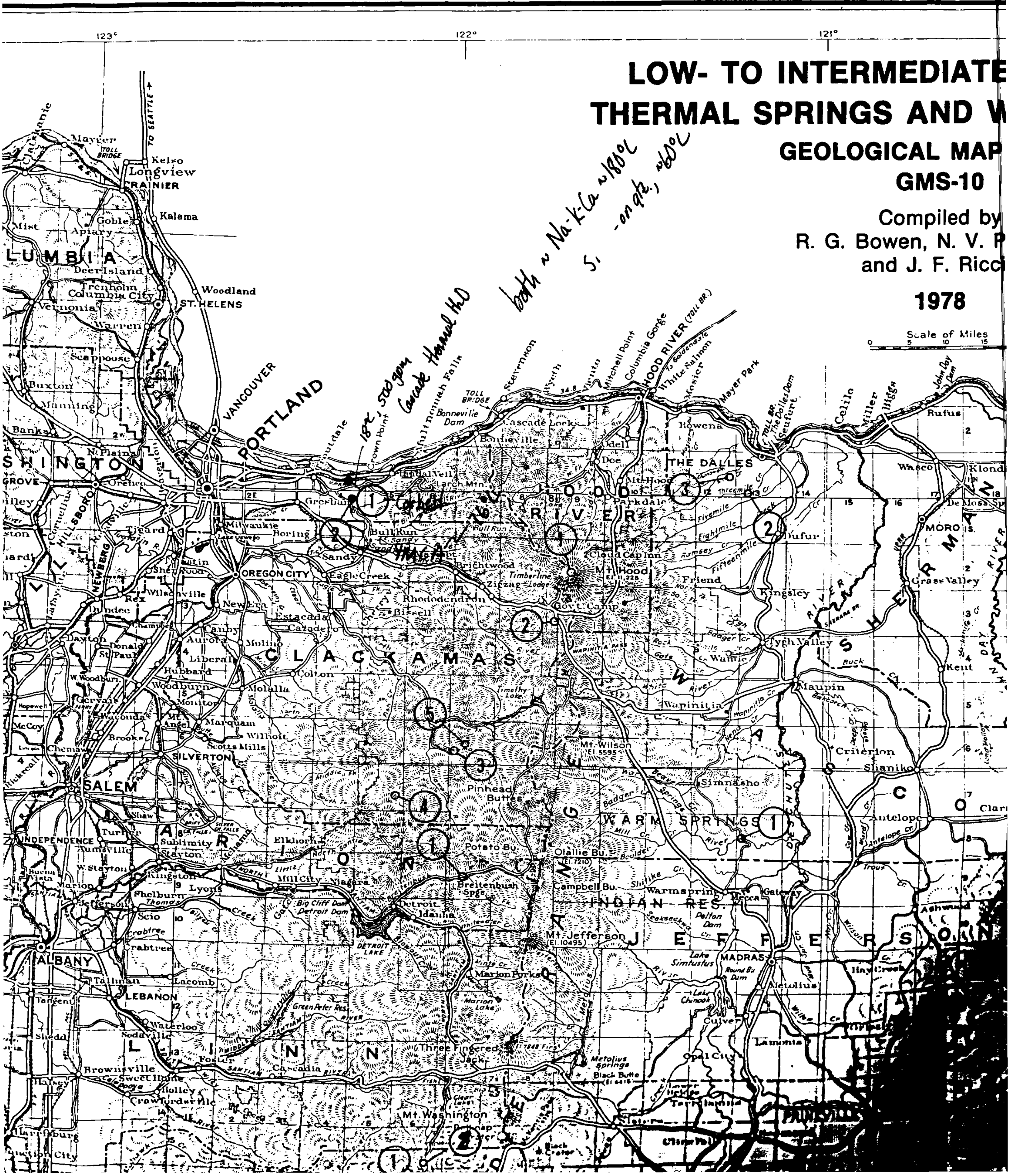
LOW- TO INTERMEDIATE
THERMAL SPRINGS AND W

GEOLOGICAL MAP
GMS-10

Compiled by
R. G. Bowen, N. V. P
and J. F. Ricc

1978



Mike K- refs on Hg
He Dennis } coso, etc.
resist } on Coso

~~any infmn on~~ splng
~~units~~

get back on water splng

23 April 79 1

Frank Danes, Univ. Pug. Sound - will be doing gravity
Mike Korasec, Eric Schuster - Wash. DNR
Joe Upton, J.J. Jacobson
Marshall Reed
GP Bophy
Dick Bowen
Larry Gratt SAI
f-
Roy Mink
Ed Toms
Dave
Bob McCuen
Dave Williams
Gordon Bloomquist

Eric on Camus Plans
Gravity
Geol. (rk geochem. & K-Ar dates)
H_2O Geochem
Gradient Scrounging
Heat Flow drilling

work won't be staged, as might be desirable
overall use sum of this year

gravity work - regional survey - 46°30min S to Col. Rvr; 122°30W to Dalles
spacing ~ 1/5 □mi
reduction using Couches programs so Ore Wash data won't conflict

23 April 79

gravity-detail - on basis of 1954 topo map
122° 20' on E, 122° 30' on W, 45° 40' on N, on S, Col River
stas @ 2/□ mi. as final detail, but may do 1/□ mi. to see if lg signatures

Lackamus fault, may extend into Ore or
gravity - will tell if fault exists, & ~ how much
D Bowen - how will s-s faults, which Dick understands most NW faults are

gravity may not give dip on fault, Frank feels not
ground magnetometer - too much culture
D. Will. - had been proposal on aeromag - regional on Sn cascades, over to covering Camus

note phasing, this year bkgrnd for 80 studies

Geology - will use Mundorff, as surf. work
want to do whole rk & trace elem 50 spls
UU/66 → 6-8 spls for K-Ar - bslts may be very young
put into genetic context, pin age of volcanism
would style of volcanism @ camus display any residual heat

Dick - Boring Lava - trad. consid 100k - 1my, but Mundorff felt Tumtum Mtn overlies ~ 40k alluv.
John Allen, Port. St. studying Boring

ES - dating may not be pertanant; but may help

Ted Livingston joins

H2O Geochem
to serve as bkgrnd
much asking of locals to find wells & spgs
will ✓ Dept. of Ecology & USGS

Thermal Gradients
Marshall Hutting
DB - says localize work on Camus, near Lackamas fault zone
do ~ 100² mi area

Heat Flow Drilling
10 holes, 500', in entire [illegible]
1st & 10th holes will be @ Camus

Camus - on bench 200' above river
Dick suggests 1000' holes (ES worried about [illegible] cost)
wants daily bht

on hole, try w/o casing

6" hole to 500' is ~~[illegible]~~ cost @ $11k

DB - will need to get below Troutdale
LM - strongly pushed for getting rig specs
DB - doesn't know dip of fault -
✓ by seismic work - using vy active quarry nearby

DB- Pat State a Wash may have equip. 23 April 79 ④

ESch - could walk from Wash be timely? - Prob not

DB- now think in terms of drilling both sides w/in 1/2 mi of fault
fault based on linear pattern, Mond found slicks
bslts vary across a canyon, & Ansel John. has been keeping track of e.q. swarm,
& Johnson feels

SAI: map VLF technique on fault - get trace, but not dip
have had success in X'line rx @ S. Dieg.
contractor in Pat has (D.B.)
estim cost $1000

Rvr Gravels ~ 500' thick along Ore side
Col. Rvr. Bslt on line in Ore doesn't have surf. expression of Lackamus flt
Gravity suggests that there is offset, of unk. dimens.
SAI- brings up alocogen along Col Rvr from Zietz's aeromag.

th.grad.
holes will be logged by Erics crew, & then
Blackwell will do heat flow calcs.

Dick Bowen - could put estab. of dip of fault off'l next year
& not put absolute
Gravity may be done from boat along river

ES would like to start drilling in June
ES has capability to do shallow (100-200') resis. - bison

if there is a clear target, Dave Will. could arrange deep resis.

23 April 79 (5)

Goal this year - not "source of heat", but get suggest. on if geoth res exists

ES this year - enuf data to design program
DB - min. temp ~300°F @ econ. depth, @300-400 gpm
econ depth could be 8k'
x river, [redacted] have 35-45°C, to 60°C @ Old Maid Flat

SAI guy is McEwen

Ed - CZ's phases 1) outline prog.
2) drill 1k-2k' holes wi DOE $
3) prod. wells & reinjection
4) interface wi plant

fuel bill = $20 mil /year (& will be going up) @ this plant

CZ's goal - give DOE enuf. confidence to fund further work

Dave Will. - fault @ depth is only reg. target, wants higher powered expl. strat conc. on fault

SAI - suggests MT
promotes EM 60
mentions Hg mineralization

DB - troutdale aquifer may

ES - bottom line is $30k to spend on Camus

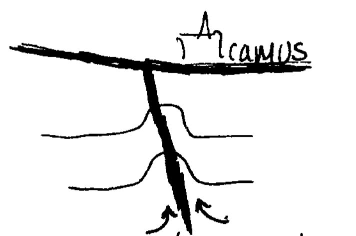
SAI - wants dipole-dipole, wi inversion by UURI

Williams will talk wi people in Den on MT & AMT, to be seen if free

Williams uses model of convection cycles in plane of fault, w/ dn & up circ. along fault

not circ. to fault from somewhere else

Dick B says –



Dick B doesn't like, being pushed by Marshall, doing bkgrnd geol & rkgeochem

Eric agrees to geophys. & age dating –

Prob. is masking anything nearsurf.

McEu - 3 profiles ⊥ to strike of fault, maybe $5k
if Dal Stanley can't do for USGS study might be $10

Williams may be able to get MT done as part of USGS

Ed - for Crown Z, offers to share cost

23 April 79 (7)

may be able to have CZ. contract out resist.
& UURI do inversion
field time ~ 1½ wks
Williams will find out on MT Avail thru Geotronics working thru Dal. Sullivan of GS

Ph. 1 prog. – Gravity
Resistivity
H_2O Geochem
Grad. Scrounging
Heat-Flow drilling

Age dating & rock chem

23 April 79

AIs- Evans
Modeling costs - inverting data
get back to Eric

feedback to Eric, in vy short term, on specs. for contracts

DFoley

Name	Affiliation	Phone
Duncan Foley	Earth Sci. Lab, Univ. Ut	801-581-5283
Gerry Brophy	DOE/HQ	202-376-4898
Joe Upton	Battelle (Pacific Northwest Laboratory)	509-946-26[illegible]
Eric Schuster	WASH. DNR, Geology & Earth Resources	206-753-6183
Marshall Reed	DOE	202-376-4897
Jim Jacobson	BATTELLE - PNL	509-946-3653
David L. Williams	USGS	303 234 5160 or 2623
Z.F. DANEŠ	U. of Puget Sound	(206) 756-3127
Robert B. McEwen	Consultant	(714) 582-7344
LARRY GRATT	SCIENCE APPLICATIONS, INC.	(714) 454-3811 x 247
Dick Bowen	Consultant for SAI	503/223-0040
Mike KOROSEC	DGER, DNR	206-754-1217
Leland Roy Mink		208-526-0638
R. Gordon Bloomquist	OIT	(206) 754-1220
Ted Livingstone	DGER, DNR	
Ed Tonns	Crown Z.	

23 April, 1979

D. Foley

DOE Form AD-10A
(12-77)

U.S. DEPARTMENT OF ENERGY

memorandum

DATE: April 10, 1979

REPLY TO
ATTN OF:

SUBJECT: Meeting - April 23, 1979

TO: Roy Mink, IDO
Mike Wright, UURI/ESL
Marshall Reed, DOE/HQ
Ed Tonns, Crown Zellerbach
Eric Schuster, WGS
Duncan Foley, UURI/ESL

A reminder that we have agreed to assemble to review the plans of the Washington Geological Survey for a geological study of the Camas area under the State Coupled Program of DOE. The meeting is scheduled for April 23, at 1:00 p.m. in Room 2F22 in the Highway Building, Department of Highways, located about one block from 14th and Jefferson, which is the location of Eric's office.

Gerald P. Brophy
Program Manager
Division of Geothermal Energy

May 14, 1979

MEMORANDUM

TO: P. M. Wright and H. P. Ross

FROM: D. Foley

SUBJECT: Crown Zellerbach Paper Co., Camus, WA, User assistance request

On 23 April, 1979, a meeting was held in the offices of the Washington Division of Geology and Earth Resources, in Olympia, WA, to discuss the Crown Z. project. Sixteen people attended (see attached list).

Crown Z. is presently spending $20 million a year on fossil fuels at their facility in Camus; they are interested in replacing as much of this as possible with alternative resources. They already use wood chips to provide about half of their energy.

Camus, WA, is across the Columbia River from Portland, OR. No thermal waters are known on the site, although in Oregon there are one hot spring and one hot well in the vicinity.

The target concept is to intercept the Lacamus fault at depth. This fault is a northwest striking fault, with unknown displacement. The vertical component of movement may be small; Dick Bowen suggested that most of the northwest trending faults in this area are strike-slip faults.

The major problem in encountering deep circulation along the fault is to identify the direction of dip. Although regional gradient would be the source of heat, it is not known whether the water will be coming from circulation down along the fault itself, or if a significant component of lateral movement in deeply buried basalts might be occurring.

Crown Z. owns property on both sides of the fault, so drilling sites exist for whichever direction the fault is found to dip.

After much discussion, the exploration program that has been settled on for the first year's efforts is:

gravity - regional studies are being done by Danes; he will also look in detail at the area along the fault, to see if any displacements are detectable

Water geochemistry - the Washington state team will be analyzing wells in the area and doing thermometry calculations

gradient scrounging - The Washington team will also look in the area for any wells in which they can get gradients

resistivity - three short traverses will be made across the trace of the fault. ESL aid will be needed in design of the survey and in the interpretation of the results. About six line miles are probably involved

heat flow drilling - two 2000 foot holes are planned in the area; it is hoped that preliminary studies will establish the warm side of the fault, and that these holes can be used to help identify especially warm areas

geology - the area is predominantly basalts, and geologic conditions are poorly known. Although not part of the formal program in confirming dip of the fault or selecting drill sites, trace element and age dating studies of the rocks will help establish local stratigraphy. The Boring basalt has classically been considered to be about 1 my old; new data suggests that less than 40k years is more likely. ESL will support these studies.

Crown Z. will probably support part or all of the resistivity program, as this will avoid bidding delays in the Washington state government.

ESL support is especially needed in design of the resistivity program, and interpretation of the data. If there are any costs to Washington involved, these should be identified. If this can be covered by the user assistance program, we should let them know.

Duncan

Duncan Foley

DF/smk

Name	Affiliation
Duncan Foley	ESL/UURI
Gerry Brophy	DOE/HQ
Joe Upton	Battelle (PNL)
Eric Schuster	Wash. DNR, Geology & Earth Resources
Marshall Reed	DOE
Jim Jacobson	Battelle-PNL
David L. Williams	USGS
Z. F. Danes	Univ. of Puget Sound
Robert B. McEuen	Consultant to SAI
Larry Gratt	Science Applications, Inc.
Dick Bowen	Consultant for SAI
Mike Korosec	Washington Assessment Team
Roy Mink	DOE/ID
R. Gordon Bloomquist	OIT (Washington O.R.)
Ted Livingstone	Director of Washington Division of Geology and Earth Resources
Ed Tonns	Crown Zellerbach

April 23, 1979

User Assistance Requests

5/18/79 DS

Site or Person	Person / Corporation	Potential Use
Camas, Wa.	Crown Zellerbach	Industrial Processing
Beryl, Ut.	Sylvia Goeltz	Industrial Processing
Thermo. Hot Sprgs, Ut.	Nick Coffee, EMMA	Direct Uses
Crescent Valley, Nv.	Half Circle Ranch Corp.	Cascading uses: Industrial Processing, Agriculture, Space Heating
Lowman, Idaho	Two Ravens Corp.	Space Heating (Condominium & Resort Dev.)
Salmon, Id.	Salmon School Board	Space Heating
Lava Hot Sprgs, Id.	City of Lava H.S.	Municipal Space Heating
Ketchum, Id.	Barbara Volker (Realtor)	Space Heating
Ephraim, Ut.	Snow College	Space Heating
Salt Lake City, Ut	Jeff Platt	Space Heating
Fairfield, Id.	Fairfield School Board	Space Heating
La Verkin, Ut.	Alan Ragozzine	Space Heating / Industrial Processing

4/2/79

TO: Duncan
From: Deb
Re: Lowman, Idaho

- There is very little information on the Lowman Area. Most of what I could find focused upon the gold deposits in the Boise Basin, SW of Lowman. From this reading a few generalizations can be made:

  - rx in the area = Idaho batholith

  - Local Porphyry Belt (Miocene)
    - extends from Lowman to the NW part of the Boise Basin
      strike length ≈ 35 mi., width ≈ 1-2 mi.
    - general trend = N60E (i.e. about ∥ to Eastern SRP trend)
      (may be part of regional structure which projects to the NE along the Middle Fork of the Salmon)

  - Idaho Batholith structures
    - dominant fracture N60° W, 80° S

  - Pertinent geologic map is missing from Library

  - References (and transcripts) furnished upon request!

4 May, 1979

MEMORANDUM

To: P.M. Wright
H.P. Ross

From: D. Foley

Re: Crown Zellerbach Paper Co., Camus, WA., User assistance request

On 23 April, 1979, a meeting was held in the offices of the Washington Division of Geology and Earth Resources, in Olymipa, Wa., to discuss the Crown Z. project. 16 people attended (see attached list).

Crown Z. is presently spending $20 million a year on fossil fuels at their facility in Camus; they are interested in replacing as much of this as possible with alternative resources. They already use wood chips to provide about half of their energy.

Camus, Wa., is across the Columbia river from Portland, Or. ~~area~~ No thermal waters are known on the site, although in Oregon there ~~is~~ are one hot spring and one hot well in the visinity.

The target concept is to intercept the Lacamus fault at depth. This fault is a northwest striking fault, with unknown displacement. The vertical component of movement may be small; Dick Bowen suggested that most of the northwest trending faults in this area are strike-slip faults. Crown Z. owns property on both sides of the fault, so drilling sites exist for whichever direction the fault is found to dip.

The major problem in encountering deep circulation along the fault is to identify the direction of dip. ~~along the fault.~~ Although regional gradient would be the source of heat, it is not known whether the water will be coming from circulation down along the fault itself, or if a significant component of lateral movement in deeply buried basalts might be occuring.

→ make a new ¶

After much discussion, the exploration program that has been settled on for the first years' efforts is:

gravity - regional studies are being done by Danes; he will also look in detail at the area along the fault, to see if any displacements are detectable

water geochemistry- the Washington State team will be analyzing wells in the area, and doing thermometry calculations

gradient scrounging - The Washington team will also look in the area for any wells ~~that~~ in which they can get gradients

resistivity - three short traverses will be made across the trace of the fault. ESL aid will be needed in design of the survey, and ~~ESL will do~~ in the interpretation of the results. About six line miles are probably involved

heat flow drilling - two 2000 foot holes are planned in the area; it is hoped that preliminary studies will establish the warm side of the fault, and that these holes can be used to help peg especially warm areas

geology - the area is predominantly basalts, and geologic conditions are poorly known. Although not part of the formal program in confirming dip of the fault or selecting drill sites, trace element and age dating studies of the rocks will help establish local stratigraphy. The Boring basalt has classically been considered to be about 1 my old; new data suggests that less than 40k years is more likely. ESL will support these studies.

Crown Z. will probably support part or all of the resistivity program, as this will avoid bidding delays in the Washington State government.

ESL support is especially needed in design of the resistivity progam, and is handling of the resistivity data. If there are any costs to Washington involved, these should be identified. ~~soon.~~ If this can be covered by the user assistance program, we should let them know soon.

Duncan

DFoley

Name	Affiliation	~~Phone~~
Duncan Foley	Earth Sci. Lab, Univ. Ut	~~801-581-5283~~
Gerry Brophy	DOE / HQ	~~202-376-4898~~
Joe Upton	Battelle (Pacific Northwest Laboratory)	509-946-
Eric Schuster	WASH. DNR, Geology & Earth Resources	~~206-753-6183~~
Marshall Reed	DOE	202-376-4897
Jim Jacobson	BATTELLE - PNL	~~509-946-3053~~
David L. Williams	USGS	~~303 234 5160 or 2623~~
Z. F. DANEŠ	U. of Puget Sound	~~(206) 756-3127~~
Robert B. McEuen	Consultant	(714) 582-7344
LARRY GRATT	SCIENCE APPLICATIONS, INC.	~~(714) 454-3811~~ x 24
Dick Bowen	Consultant for SAI	~~503/223-0040~~
Mike Korosec	DGER, DNR	~~206-754-1241~~
Leland Roy Mink		208-526-0638
R. Gordon Bloomquist	OIT	~~(206) 754-1220~~
Ted Livingstone	DGER, DNR	
Ed Tonns	Crown Z.	

on this list, just type name and affiliation no need to alphabetize

23 April, 1979

Abstracts of papers to be presented at the 1970 meeting of the Northwest Scientific Association

(Following are abstracts of papers received by presstime to be presented at the 43rd Annual Meeting of the Northwest Scientific Association to be held at Oregon State University, Corvallis, Oregon, on March 27 and 28.

Clastic Dikes of the Touchet Beds, Southeastern Washington

John A. Alwin
and
W. Frank Scott
Washington State University
Pullman, Washington

The Touchet Beds are cyclic lacustrine sands and silts of Pleistocene age in southeastern Washington.

Numerous clastic dikes characteristically cross-cut these beds. They penetrate downward from a few inches to more than a hundred feet. The strike of the dikes seems to be random; dip is nearly vertical. Dikelets vary in width from less than an inch to several inches, but are usually compounded to form vertically stratified dikes up to 60 inches wide. Common features include clay wall-linings with chevron marks, cross-stratification, graded beds, and oriented grains.

Primary structures indicate a downward infilling of the dikes by sand and silt. Analogy with modern frozen ground suggests that the dikes represent fillings of permafrost-related crevices.

Seasonal Variation in Physical and Chemical Properties of Two Central Washington Soils

T. D. Anderson
Pacific Northwest Forest and Range Experiment Station
Wenatchee, Washington

Soils derived from two widely distributed parent materials in central Washington were examined periodically during 1968-69 for physical and chemical properties. Basalt soils showed significant seasonal variation in Na content, cation exchange capacity, and pH. In sandstone soils, Ca, Mn, Na, N, K, and organic content varied significantly among sampling dates. Although certain physical properties showed definite trends, none were statistically significant.

These results indicate that, where sampling dates vary, seasonal variation in certain chemical properties of these soils may be a confounding factor in evaluating research findings or management prescriptions.

Paleogeography of the Prune Hill Area, Camas, Washington, and Its Relation to the Geologic History of the Portland Area

Gennara Aviolo
and
Don W. Baggs
Portland State University
Portland, Oregon

The area west of Camas near Prune Hill is underlain by a sequence of rocks ranging in age from Eocene to Holocene. The Eocene Skamania volcanics are the oldest known rocks in the Portland area and are well represented near Camas. Apparently the Camas area was a highland during Eocene time. Eruptions of the Skamania volcanics lasted through the Oligocene, and the area remained a highland until the Pliocene. In Pliocene time, the area underwent a slight downwarping. Later in Pliocene time, fluvial deposits of the Troutdale Formation were deposited in the Camas area. During the later stages of Troutdale deposition, an andesitic volcano erupted to the west of Camas. In the Camas area, the typical gravels of the Troutdale Formation grade upward into a silty phase, which may be contemporaneous with the Portland Hills Silt of the Portland area. Following slight uplift during Pleistocene time, the Camas area was scoured by floods of the Columbia River, which undercut the south side of Prune Hill creating a large landslide. [illegible]

Fuel Accretion and Distribution in the Larch-Fir Forest Type

William R. Beaufait
Forest Service, Region 5
U.S. Department of Agriculture
Missoula, Montana

Plant wastes create most of the fuel which sustains forest fires. Therefore, organic

Duncan

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
420 CHIPETA WAY, SUITE 120
SALT LAKE CITY, UTAH 84108
TELEPHONE 801-581-5283

November 14, 1979

Mr. Fred Rigby
Science Applications, Inc.
P.O. Box 2351
La Jolla, CA 92038

Dear Mr. Rigby:

Enclosed is a rough draft memorandum by C. E. Mackelprang which presents the modeled resistivity distribution and corresponding computed resistivity values for lines A-A' and B-B' from Camas, Washington. Dr. William Sill of the University of Utah Department of Geology and Geophysics also contributed to these model solutions.

Please note the very different models for Line B-B'. Our field and modeling experience suggests that either the high (94.2, 76.6, 104.3 ohm-m) or low (5.5, 37.1 ohm-m) data values at n=4,5 on this line are in error. This problem and the many missing data values on the profile make any inversion of the data quite ambiguous so we have not attempted a closer match to the observed data.

I regret that travel commitments and other factors have delayed our response to your interpretation request. In Duncan Foley's absence I am forwarding this memorandum in a draft form to avoid further delay.

Sincerely,

Howard P. Ross

Howard P. Ross
Senior Geophysicist

HPR/hb

cc: D. Foley

Enclosure

November 14, 1979

MEMORANDUM

TO: Duncan Foley and Howard Ross

FROM: C. E. Mackelprang

SUBJECT: Camas area, Washington - Two-dimensional Resistivity Modeling of Dipole-Dipole Lines A-A' & B-B'

Two-dimensional models for Camas, Washington lines A-A' and B-B' are attached.

Line A-A'

Line A-A' was partitioned into three segments for modeling purposes. A good fit between observed and computed data values was obtained with models having reasonable continuity between segments. Because geologic information is sparse, the model results should only be considered as one resistivity distribution which would give rise to the actual field data, and as a first approximation to the geologic structure.

In general, the model of line A-A' shows a moderately resistive surface layer having a resistivity of about 50 ohm-meters and a thickness of approximately 250 meters extending from stations 0.0 to 3.5. Isolated pods of slightly more resistive (75 ohm-meters) material were necessary to enhance the model/field data comparison. At depth beneath this same station interval lies a thick conductive media which is represented on the model by 10-15 ohm-meters apparent resistivities.

The surface material appears much less uniform between stations 3.5 and 8.0 with apparent resistivities varying between 30 and 150 ohm-meters. It was necessary to significantly thicken this material between stations 3.5 and 7.0. A more conductive media (15 ohm-meters) lies at greater depth.

Finally, from station 8.0 to the end of the line the observed data can be modeled satisfactorily by assuming 50 to 75 ohm-meters material at the surface increasing to about 200 ohm-meters with depth. No conductive media are present over this station interval.

Line B-B'

It appears that several errors may be present in the observed field data for n=4,5 between station 0.0 and 1.0. It is not possible to obtain a single model showning good comparison with all the field data. Adjustments in one area tended to distort values in another.

As a result, two models are shown having equal plausibility which partially match the field data. Major differences in these models are: a very conductive media (1 ohm-meter) extending to great depth beneath and adjacent to very resistive (1000 ohm-meters) material vs. a conductive media (10 ohm-meter) of finite thickness sandwiched between 200 ohm-meter material.

Discussion

Results of the modeling for line A-A' suggest a surface layer of fairly moderate apparent resistivity extending over the entire line. This layer increases in thickness in the central portion of the line. A conductive media is present at a fairly shallow depth on the northwest end of the line but deepens to the southeast and is absent at the southeast end of the line.

Model results of line B-B' are questionable but tend to suggest a layering of resistive - conductive - resistive medias of unknown configuration and thicknesses on the southwest half of the line. To the northeast the models are less complex showing a trend into fairly conductive ground.

The attached models are two-dimensional (i.e. infinite strike length). If the survey lines have been run at some angle other than normal to the geologic structure then the model interpretation will not approximate the true resistivity distribution. The presence of three dimensional resistivity distributions would also detract from the applicability of the model solutions. We understand that line A-A' runs subparallel to a major geologic structure and topographic features. This may reduce the applicability of the resistivity model submitted here.

C. E. Mackelprang
Geophysicist

CEM/hb

X 9/1/82

Department of Natural Resources

OLYMPIA, WASHINGTON
98504

BRIAN J. BOYLE
Commissioner of Public Lands

July 8, 1982

Ms. Susan Prestwich
Geothermal Energy Branch
USDOE/ID
550 Second Street
Idaho Falls, ID 83401

RE: Contract DE-AC07-79ET27014, Modification A006

Dear Susan:

This letter contains proposed contract modifications in line with our discussions in Salt Lake City and subsequent telephone conversations. Enclosed for your reference you will find a copy of my earlier letter modification proposal dated Feb. 19, 1982, a ledger sheet which shows expenditures to April 30, 1982 and details the dollar changes we are proposing, and a copy of the "deliverables" section of contract modification A006.

Proposed program changes are described below, in terms of the "deliverables" section of contract modification A006:

C.1. — Cascade Range Regional Gravity Subcontract.

Dr. Danes is currently working toward completing the regional gravity map for the Cascade Range and it appears that the completion date of April 1, 1983, will be met without much difficulty. Bill Phillips of our staff is closely monitoring the gravity work. However, we have not entered into any contract for detailed gravity work with Danes because we need the regional gravity map before the sites for detailed gravity investigations can be intelligently chosen. April 1, 1983, is not a realistic date for completion of detailed gravity and we have some doubt that a finished map or maps could be finished by September 30, 1983. We propose that $10,000 continue to be allotted for detailed gravity investigations in prospectively important geothermal areas, that we contract for such detailed gravity investigations as can be performed during the Summer of 1983, and that the results be presented as supplemental detailed gravity maps with lists of principal facts by Sept. 30, 1983. The work that can be performed may or may not cost $10,000, but will certainly not exceed that amount.

3

investigator on this project has dropped out of his graduate program. Professor Crosby will replace him with Scott Widness. He expects no net loss of productivity and asks for no change in schedule, budget, or deliverables. See attached letter from Prof. Crosby dated June 1, 1982.

C.5. — Geologic assessment of low-temperature geothermal resources in the Walla Walla area, Columbia Basin. All information in February 9, 1982 letter still applies.

C.6. — Heat flow and temperature gradient investigations in the Columbia Basin.

Information in February 9, 1982 letter still applies, with the following changes: Keith Stoffel will still be assigned to the project for five months, but his salary will be paid from state geothermal funds rather than federal, and he will work to interpret suites of well logs regarding the depth, structure, stratigraphy, temperature, and other characteristics of low-temperature geothermal aquifers exclusively. Consequently, he will not be able to spend time at Washington State University processing suites of logs. Instead, we propose to allot $9,350 of state and federal funds (see line 19 on enclosed ledger sheet) for staff and computer time at WSU for well log processing and preparation of reproducible copies of well log suites.

C.7. — Heat flow and temperature gradient investigations at Mount Baker.

Proposed action as described in Feb. 9, 1982 letter still applies, with the following change: We propose to add $5,956 to the drilling budget (proposed total for drilling becomes $32,956, see lines 23 and 29 of enclosed ledger sheet) and drill a third 500-foot gradient hole at either Carson on the Wind River, Skamania County, or near Green River Soda Spring on the trend of the seismically-identified fracture zone that extends to the NNW from Mount St. Helens. This third gradient hole will only be drilled if bids come in low enough to drill all three holes for $32,956 or less. If this is not the case, then only the two Mount Baker holes will be drilled on a proposed budget of $27,000, and the excess $5,956 will be allocated toward funding publications.

C.8. — K-Ar dating, etc., by Paul Hammond.
No change from February 9, 1982 letter.

Finally, we propose to allocate $10,000 toward publication costs. We will be preparing for publication virtually all of the information and interpretations generated by the state-coupled geothermal program in Washington. These reports will be published as part of our regular series of geologic maps, reports of investigations, information circulars, and bulletins. Thus far, the information has been presented only as open file reports, which receive very little editing, drafting, and limited distribution.

I hope this adequately explains our proposed activities for the final year of the geothermal contract. I will look forward to your reply.

Sincerely,

J. Eric Schuster

J. Eric Schuster
Assistant State Geologist
Division of Geology
& Earth Resources

JES:la

cc: Kent Hastings, Contracts Mgmt. Div.
USDOE/ID, 550 Second St.
Idaho Falls, Idaho 83401

Duncan Foley, UURI/ESL
420 Chipeta Way
Salt Lake City, UT 84108

Enclosures

9/1/82
Issuance of a Mod 001 under advisement by Prestwich. Foley has provided inputs, Mod will probably be approved as requested on attached letter. T.E. to 9/30/83 requested.

Department of Natural Resources
OLYMPIA, WASHINGTON
98504

BRIAN J. BOYLE
Commissioner of Public Lands

February 9, 1982

Ms. Susan Prestwich
Geothermal Energy Branch
USDOE/ID
550 Second Street
Idaho Falls, ID 83401

RE: Contract Modification

Dear Ms. Prestwich:

We propose several changes to Contract No. DE-AC07-79ET27014, Modification A006. These changes should enable us to carry out the remaining work called for more efficiently, and deal with some problems which have arisen. They also recognize economic reality — our state is in poor financial condition and budget cuts have affected our ability to meet the original proposed state matching contribution.

Enclosed please find a ledger sheet which details the dollar changes we are proposing. The footnotes explain the program changes. Below I will detail the program changes proposed for the federally-funded portion of our program, this time in terms of the description of deliverables in section "C" of the contract (copy enclosed).

C.1. - No change in Cascade regional gravity subcontract.

C.2. - Yakima area investigations by John Biggane, WSU. We had earlier extended John's contract to February 28, 1982, with no cost increase. We propose to increase his funding by $1,421 and extend the time to March 31, 1982. This is to allow John to include reproducible copies of 49 suites of logs from Yakima area wells in his final report. We feel that this is important so that future investigators and explorationists will have access to the original logs.

C.3. - Wind River geology; Dulcy Berri, PSU. Decrease funding by $735. We were able to contract for the work at less than the estimated $20,000.

C.4. - Low-temperature geothermal resources of the Moses Lake-Ritzville-Connell area, Columbia Basin. Increase funding by $4,008 and extend time period to September 30, 1983. The original budget was not adequate to fund computer time, travel, or other miscellaneous expenses.

C.5. - Geologic assessment of low-temperature geothermal resources in the Walla Walla area, Columbia Basin. We propose to eliminate this project for the following reasons:

1. A detailed study of the Walla Walla area would have left us at the end of the contract period with three areas in the Columbia Basin (Yakima, Moses Lake-Ritzville-Connell, and Walla Walla areas) that were reasonably well understood, but large areas in the rest of the Columbia Basin without any significant interpretation of low-temperature geothermal aquifers and their structure, stratigraphy, and characteristics. We believe such a situation would leave us in a weaker overall position with respect to offering assistance to explorationists and developers than we would be in if we work with the best subsurface data from the entire Columbia Basin and try to form an overall assessment for the larger geographic area, even though the coverage would necessarily be less detailed.

2. The best wells from the Walla Walla area will be included in proposed well-log interpretation work (see C.6. below).

3. The Walla Walla study was proposed at a time when we believed or at least hoped that USDOE funding would continue and enable us to obtain interpretive coverage of the entire Columbia Basin through a series of detailed reports on smaller areas within the Basin. That approach is no longer possible.

C.6. - Heat-flow and temperature gradient investigation in the Columbia Basin. We propose to eliminate this project. It was proposed at a time when we believed that the log suites for 400 wells had been reduced to well-organized computer storage at WSU and we would have to pay only for the cost of having them computer plotted in reproducible form. We later learned that the logs actually exist in the form of field-generated punched paper tapes and a considerable amount of human labor and computer time is necessary in order to reduce them to a "plotter ready" status.

Nevertheless, the WSU log suites are the only set of data in existence which will allow interpretive work regarding the depth, structure, stratigraphy, temperature, and other characteristics of Columbia Basin low-temperature geothermal aquifers. We would, therefore, like to work with the data set to the greatest extent possible with the time and funds remaining.

To accomplish this, we propose to assign a geologist, Keith Stoffel, from our Cheney office, who is familiar with Columbia Basin stratigraphy to the project. He will "work up" about 60 of the best suites of logs from areas in the Columbia Basin outside of the Yakima and Moses Lake-Ritzville-Connell areas. To the extent possible, he will work toward the same objectives as the Yakima and Moses Lake-Ritzville-Connell investigators (John Biggane and Al Amos, respectively), and he will work cooperatively with Biggane and Amos using the existing facilities at WSU.

The reasons for using one of our own staff for this work are as follows:

1. Keith's experience with Columbia Basin stratigraphy should allow him to progress more rapidly than an inexperienced graduate student could;

2. working with log suites from the whole Columbia Basin does not lend itself to a readily definable masters level thesis project;

3. Professor Crosby at WSU has expressed his agreement with this course of action, and

4. the travel expenses associated with working in Pullman (Cheney is about 80 miles away) are probably more than offset by not having to pay the 45 percent WSU administrative overhead.

The changes indicated by footnote 1/ on the attached ledger sheet are those associated with this proposed change.

C.7. - Heat-flow and temperature gradient investigation at Mount Baker. We propose to add $5,000 to the budget for this project. The originally proposed budget of $22,000 would not have been adequate to fund the proposed two drill holes.

C.8. - K-Ar dating of Quaternary rock previously collected from the Cascade area. These data were originally to have been supplied by the laboratory at University of Utah Research Institute, but were included as a budget item in the second year of contract modification A006 when we found that most of the rocks that Dr. Hammond wished to have dated were too young to be dated in the UURI lab.

We now propose to move the budget for age dating forward into the current contract year, and to add $1,000 to it to allow Dr. Hammond to pay for student workers who will assist him in reducing data on the area and volume of Quaternary volcanic units, and the geochemistr and age of these units.

I hope that the above explanations are clear; if not please call me at (206) 459-6

The subcontract modifications and new subcontracts necessary to effect the changes proposed above will be submitted to your office for approval as soon as possible.

May I look forward to your early response, so that I can put the modifications int action quickly?

Sincerely,

J. Eric Schuster

J. Eric Schuster
Assistant State Geologist
Division of Geology and Earth Resources
Enclosures

c. Provide subcontract administration and field monitoring for the subcontracts described in Washington State Department of Natural Resources Proposal dated April 24, 1981, revised June 20, 1981, and July 9, 1981, as follows:

1. Cascade Range Regional Gravity Subcontract with Danes Research Associates; $35,700; last year of four-year program; finalize, compile, and complete report for public dissemination by April 1, 1983.

2. Yakima Area Geothermal Investigations Subcontract with Washington State University; $11,481; two-year program, second year; a final report for the second-year effort containing appropriate geology, temperature gradient, heat-flow, hydrologic maps and cross sections and all other pertinent data and information is due January 31, 1982.

3. Wind River Geology Subcontract with Portland State University; $20,000; eleven month effort; a final report containing data reduction and analytical work, geologic maps, cross sections and interpretive text is due July 31, 1982.

4. Low temperature Geothermal Resources of the Moses Lake-Ritzville-Connel Area, Columbia Basin, Washington; $30,000; procure a subcontract for twelve month effort; final report containing stratigraphic correlation, structural interpretation, thermal aquifers and their characteristics, temperature gradients, and heat flow and identification, and characterization of potential low-temperature geothermal resources is due July 31, 1982.

5. Geologic-hydrologic assessment of low temperature geothermal resources in the Walla Walla area, Columbia River, Washington; $25,000; procure a subcontract for twelve month effort, final report containing stratigraphic correlation, structural interpretation thermal aquifers and their characteristics, thermal gradients, and heat flow and indentification, and characterization of potential low-temperature geothermal resources is due April 1, 1983.

6. Heat-flow and temperature gradient investigation at Columbia Basin; $6,000; procure a subcontract to acquire computer-plotted copies of suites of well logs (400 + wells). Include results in data set report due August 1, 1983.

7. Heat-flow and temperature gradient investigation at Mount Baker; $22,000; procure a subcontract to drill two 500 foot heat flow holes in the area of Mount Baker. Include results in data set report due August 1, 1983.

8. K-Ar Dating of Quarternary rock previously collected from the Cascade area; $5,000; data gathered shall be used for space-time-composition model for South Cascade Range. Report to include age data and analysis due August 1, 1983.

d. Incorporate available data from the DOE-ID funded temperature gradient-heat flow subcontract with Southern Methodist University, Dr. David Blackwell, Principal Investigator, into appropriate final reports.

CONTRACT NO.
DE-AC07-79ET27014

Prepared by	Initials	Date
Prepared by	JLL	7-8-82
Approved by		

ITEM:	ORIGINAL BUDGET IN MOD. A006, 8-1-81 to 9-30-83			ACTUAL EXPENDITURES, 8-1-81 to 4-30-82			U.S.D.O.E.		STATE		PROPOSED BUDGET FOR 5-1-82 to 9-30-83		
	1	2	3	4	5	6	7	8	9	10	11	12	13
	USDOE	STATE	TOTAL	USDOE	STATE	TOTAL	Balance on 5-1-82	Proposed Changes	Balance on 5-1-82	Proposed Changes	USDOE	STATE	TOTAL
Salaries;													
Geol. II, Stoffel	—		—	—	386 —	386 —	—	—	<386>	11046 —	—	10660 —	10660 —
Geol. III, Korosec	—	54826 —	54826 —	—	19335 —	19335 —	—	—	35491 —	1147 —	—	36638 —	36638 —
Geol. II, Phillips	—	47191 —	47191 —	—	4688 —	4688 —	—	—	42503 —	<26513>	—	15990 —	15990 —
Clerk-Typist II, Preston	—	21684 —	21684 —	—	7221 —	7221 —	—	—	14463 —	<79>	—	14384 —	14384 —
Asst. State Geol., et. al.	—	21833 —	21833 —	—	9637 —	9637 —	—	—	12196 —	3638 —	—	12196 —	12196 —
Benefits; 20% of salaries	—	29107 —	29107 —	—	8253 —	8253 —	—	—	20854 —	<2880>	—	17974 —	17974 —
Travel;	10150 —	6000 —	16150 —	3706 —	851 —	4557 —	6444 —	—	5149 —	<5149>	6444 —	-0-	6444 —
Equipment, supplies, services;	10734 —	6000 —	16734 —	3902 —	6047 —	9949 —	6832 —	—	<47>	2024 —	6832 —	1977 —	8809 —
Subcontracts;													
Cascades Regional Gravity (Danes)	25700 —	—	25700 —	14110 —	—	14110 —	11590 —	—			11590 —		11590 —
Detailed Gravity (Danes)	10000 —	—	10000 —	-0-	—	—	10000 —	—			10000 —		10000 —
Yakima Area (Biggane, WSU)	11481 —	—	11481 —	10039 —	—	10039 —	1442 —	1421 —			2863 —		2863 —
Walla Walla Area (WSU)	25000 —	—	25000 —	-0-	—	—	25000 —	<25000>			—		—
Well Log Processing (WSU)	—	—	—	-0-	—	—	—	4350 —	-0-	5000 —	4350 —	5000 —	9350 —
Mt.-Ritz.-Conn. Area (Widness, WSU)	30000 —	—	30000 —	-0-	—	—	30000 —	4008 —			34008 —		34008 —
Wind River Geology (Berri, PSU)	20000 —	—	20000 —	9135 —	—	9135 —	10865 —	<735>			10130 —		10130 —
Col. Basin Heat Flow Invest.	6000 —	—	6000 —	-0-	—	—	6000 —	<6000>			—		—
Mt. Baker Heat Flow Drilling	22000 —	—	22000 —	-0-	—	—	22000 —	5000 —			27000 —		27000 —
Age Dates (Hammond, PSU)	5000 —	—	5000 —	-0-	—	—	5000 —	1000 —			6000 —		6000 —
Overhead; 15.66%	27572 —	—	27572 —	6404 —	—	6404 —	21168 —	<240>			21168 —		21168 —
Reports Publication								10000 —			10000 —		10000 —
Heat-Flow Drilling								5956 —			5956 —		5956 —
TOTAL	203637 —	186641 —	390278 —	47296 —	56418 —	103714 —	156341 —	<18450>	130223 —	<15404>	156341 —	114819 —	271160 —

12/7/81

WASHINGTON - STATE OF

DE-AC07-79ET27014 / 6

~~Need Contract copy and~~

~~All Mods (1 thru 6)~~

$ ~~396,070~~
203,673

HAVE MOD 3, 1, 2, 4, 5, 6 &

CONTRACT.

COMPLETION
07-31-83

AWARD/CONTRACT

GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41CFR) 1-16.101

1. CONTRACT (Proc. Inst. Ident.) NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST/PROJECT NO.	4. CERTIFIED FOR NATIONAL DEFENSE UNDER BDS REG. 2 AND/OR DMS REG. 1 RATING
DE-AC03-79ET27014	11/01/78	03-79ET27014	

5. ISSUED BY CODE

DEPARTMENT OF ENERGY
SAN FRANCISCO OPERATIONS OFFICE
1333 BROADWAY
OAKLAND, CA 94612

6. ADMINISTERED BY (If other than block 5) CODE ACN

MAR 79ET27014

EXECUTED COPY

7. DELIVERY
[X] FOB DESTINATION
[ ] OTHER (See below)

8. CONTRACTOR CODE FACILITY CODE
NAME AND ADDRESS (Street, city, county, State, ZIP code)

Washington State
Department of Natural Resources
Olympia, WA 98504
ATTN: Eric Schuster

9. DISCOUNT FOR PROMPT PAYMENT

10. SUBMIT INVOICES (4 copies unless otherwise specified) TO ADDRESS SHOWN IN BLOCK 12

11. SHIP TO/MARK FOR CODE

12. PAYMENT WILL BE MADE BY CODE

FINANCE DIVISION
DOE/SAN
1333 BROADWAY
OAKLAND, CA 94612

13. THIS PROCUREMENT WAS [ ] ADVERTISED, [X] NEGOTIATED, PURSUANT TO: [ ] 10 U.S.C. 2304 (a)( ) [X] 41 U.S.C. 252 (c)(10)

14. ACCOUNTING AND APPROPRIATION DATA

B&R NO. AE-1001020 & 35-AE-10
ALLOTMENT NO. SF-90-91 and SF-91-40

15. ITEM NO.	16. SUPPLIES/SERVICES	17. QUANTITY	18. UNIT	19. UNIT PRICE	20. AMOUNT
	SEE ATTACHED SCHEDULE				
	DUNS Contractor Establishment No.: 079-248-936	DOE Share -			$296,894
	Principal Place of Performance: Olympia, Washington	Contractor Share -			$ 12,984
	THIS CONTRACT SUPERSEDES IN ITS ENTIRETY LETTER CONTRACT DE-AC03-79ET27014 DATED FEBRUARY 9, 1979				

21. TOTAL AMOUNT OF CONTRACT $ 309,878

CONTRACTING OFFICER WILL COMPLETE BLOCK 22 OR 26 AS APPLICABLE

22. [X] CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return 2 copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)

23. NAME OF CONTRACTOR DEPT. OF NATURAL RESOURCES

BY (Signature of person authorized to sign)

24. NAME AND TITLE OF SIGNER (Type or print)
PAUL E. KRAUSS
DEPUTY SUPERVISOR

25. DATE SIGNED
APR. 23, 1979

26. [ ] AWARD (Contractor is not required to sign this document.) Your offer on Solicitation Number .... including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the items listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your offer, and (b) this award/contract. No further contractual document is necessary.

27. UNITED STATES OF AMERICA

BY Robert H. Ragan (Signature of Contracting Officer)

28. NAME OF CONTRACTING OFFICER (Type or print)
Robert H. Ragan

29. DATE SIGNED
5/8/79

SCHEDULE

ARTICLE I SCOPE OF WORK

(a) The Contractor shall conduct a program titled, "Geothermal Assessment and Reservoir Definition in Washington," to accomplish the work set forth in:

Exhibit I - Statement of Work
Exhibit II - Reporting Requirements

Work completed, including the submittal of the reports required by Exhibit II in an acceptable manner, are used to measure progress under the contract and as a basis for the approval of payments. Failure to comply with the reporting requirements of Exhibit II may result in a delay in the payment of invoices until corrective action is taken.

(b) All work under this contract shall be performed under the general guidance and direction of the Technical Manager whose responsibilities are defined in ARTICLE IV. Such guidance and direction shall not, however, effect any change in the specification requirements or cost structure of this contract, increase its estimated cost, or extend the period of performance. Such changes shall be only by action of the Contracting Officer.

ARTICLE II PERIOD OF PERFORMANCE

The period of performance under this contract shall commence on November 1, 1978 and expire on October 31, 1979. The period of performance may be extended for additional periods by the written agreement of the parties.

ARTICLE III ESTIMATED COST AND COST SHARING

(a) The total estimated cost of the work under this contract is $309,878. Of this estimated cost, the Government will fund a maximum amount of $296,894.

(b) The Contractor and the Government have agreed to share the cost of all work performed in accordance with the provisions of this Contract in a ratio of 95.810 percent by the Government and 4.190 percent by the Contractor of all operating-funded costs determined to be allowable in accordance with the Clause of the General Provisions entitled "Allowable Cost and Payment." The Contractor will not share in the cost of the capital equipment. The Contractor shall be paid no fee for the work performed under this contract.

SCHEDULE

(c) The Contractor shall fund out of its own resources an estimated amount of $12,984 for its share of costs identified in paragraph (b) above. In the event that the actual cost of the work exceeds the amount of $309,878, it is agreed that the Contractor shall be under no further obligation to thereafter share costs of contract performance hereunder for its own account, and in no event shall Contractor be obligated to contribute an amount hereunder for its own account in excess of a total of $12,984.

(d) The total amount presently obligated by the Government under this contract is $296,894. Of these funds $248,235 are available for operating expenses and $48,659 for the purchase of capital equipment. 57,621

ARTICLE IV TECHNICAL DIRECTION AND SURVEILLANCE

(a) The work to be performed by the contractor under this contract is subject to the surveillance and written technical direction of a "Technical Manager" who shall be specifically appointed by the Contracting Officer in writing. Technical direction is defined as a directive to the contractor within the requirements of the Article hereof entitled "Scope of Work," which approves approaches, solutions, designs, or refinements; defines or otherwise completes the general description of work; and otherwise furnishes technical guidance to the contractor. The Technical Manager shall monitor the contractor's performance with respect to compliance with the requirements of the Scope of Work, schedule and cost. Technical direction includes the process of conducting inquiries or transmitting information or advice by the Technical Manager, regarding matters within the requirements of the Scope of Work. Technical direction and management surveillance shall not impose tasks or requirements upon the contractor additional to or different from the general tasks and requirements stated in the Article of this contract entitled "Scope of Work." The technical direction to be valid:

(1) Must be issued in writing consistent with the general scope of the work set forth in this contract;

(2) Shall not commit the Government to any adjustment of the estimated cost and fees or other contract provisions.

(b) In the event any Government technical direction is interpreted by the contractor to fall within the Clause of the General Provisions hereof, entitled "Changes" the contractor shall not implement such direction, but shall notify the Contracting Officer in writing of such interpretation within ten (10) days after the contractor's receipt of such direction. Such notice shall (i) include the reasons upon which the contractor bases its belief that the technical direction falls within the purview of the "Changes" clause; and (ii) include the contractor's best estimate as to revision in estimated cost, fee, performance time, delivery schedules and any other contractual provisions that would result from implementing the technical direction.

(1) If, after reviewing the information presented pursuant to paragraph (b) above, the Contracting Officer is of the opinion that such direction is within the purview of the "Changes" clause and he considers such change desirable, he will issue unilateral direction to proceed pursuant to the authority granted him under the clause. If he determines that such direction is technical direction authorized by this article, he will direct the contractor to proceed with the implementation of such technical direction.

(2) In the event the Contracting Officer determines that it is necessary to avoid a delay in performance of the contract he may, in writing, direct the contractor to proceed with the implementation of the technical direction pending receipt of the information to be submitted under paragraph (b) above. Should the Contracting Officer later determine that a direction under the "Changes" clause is appropriate, the written decision issued hereunder shall constitute the required direction.

(c) Failure of the Contractor and the Contracting Officer to agree on whether Government Direction is technical direction or a change within the purview of the "Changes" clause shall be a dispute concerning a question of fact within the meaning of the Clause of the General Provisions entitled "Disputes."

(d) The only persons authorized to give technical direction to the Contractor under this contract are the Contracting Officer and any "Technical Manager" who may be appointed by him as contemplated by paragraph (a) above. Any action taken by the Contractor in response to any direction given by any person other than the Contracting Officer or Technical Manager whom he may appoint shall be at the contractor's own risk.

ARTICLE V ORDER OF PRECEDENCE

In the event of inconsistency in this contract, the inconsistency shall be resolved by giving precedence in the following order: (A) Schedule, (B) Statement of Work, (C) General Provisions, (D) any other provisions of this contract, whether incorporated by reference or otherwise; and (E) the Contractor's technical proposal if incorporated in this contract by reference or otherwise.

ARTICLE VI GENERAL PROVISIONS

The Contractor shall comply with clauses which are set forth in General Provisions "DOE/SAN Cost-Type Contracts with Commercial Organizations dated March 1978" consisting of 45 pages which are a part of this contract. In accordance with the clause entitled "Subcontracts", any consent by the Contracting Officer to the placement of subcontracts shall not be construed to constitute approval of the subcontractor or any subcontract terms or conditions, determination of the allowability of any cost, revision of this contract or any of the respective obligations of the parties thereunder, or creation of any subcontractor privity of contract with the Government.

ARTICLE VII ALTERATIONS AND ADDITIONS

(a) Clause 2 "Limitation of Cost" is deleted in its entirety and the following new clause entitled, "Limitation of Cost (Cost-Sharing)" is added as follows:

"CLAUSE 2 LIMITATION OF COST (COST-SHARING)

(a) It is estimated that the cost of the Government for the performance of this contract will not exceed the estimated cost to the Government set forth in the Schedule, and the Contractor agrees to use his best efforts to perform the work specified in the Schedule and all obligations under this contract within such estimated cost to the Government plus the share of the cost of performance agreed to be borne by the Contractor, as set forth in the Schedule. If, at any time, the Contractor has reason to believe that the costs which he expects to be incurred in the performance of this contract in the next succeeding 60 days, when added to all costs previously incurred, will exceed 75 percent of the estimated total cost to the Government and to the

Contractor then set forth in the Schedule, or if, at any time, the Contractor has reason to believe that the total cost for the performance of the contract (exclusive of any fee) will be greater or substantially less than the then estimated total cost thereof, the Contractor shall notify the Contracting Officer in writing to that effect, giving his revised estimate of such total cost for the performance of this contract.

(b) Except as required by other provisions of this contract, specifically citing and stated to be an exception from this clause, the Government shall not be obligated to reimburse the Contractor for costs incurred in excess of the estimated cost to the Government set forth in the Schedule, and the Contractor shall not be obligated to continue performance under the contract (including actions under the Termination clause) or otherwise to incur costs in excess of the estimated total cost set forth in the Schedule, unless and until the Contracting Officer shall have notified the Contractor in writing that such estimated total cost has been increased and shall have specified in such notice a revised estimated total cost which shall thereupon constitute the estimated total cost of performance of this contract. The increase in such estimated total cost shall be allocated in accordance with the formula set forth in the Schedule governing such increases. No notice, communication, or representation in any other form or from any person other than the Contracting Officer shall affect the estimated cost to the Government of this contract. In the absence of the specified notice, the Government shall not be obligated to reimburse the Contractor for any costs in excess of the estimated cost to the Government set forth in the Schedule, whether those excess costs were incurred during the course of the contract or as a result of termination. When and to the extent that the estimated total cost set forth in the Schedule has been increased, any costs incurred by the Contractor in excess of the estimated total cost prior to such increase shall be allowable to the same extent and in the same percentage as if such costs had been incurred after the increase; unless the Contracting Officer issues a termination or other notice and directs that the increase is solely for the purpose of covering termination or other specified expenses.

(c) Change orders issued pursuant to the Changes clause of this Contract shall not be considered an authorization to the Contractor to exceed the estimated cost to the Government set forth in the Schedule in the absence of a statement in the change order, or other contract modification, increasing the estimated cost.

(d) In the event this contract is terminated or the estimated cost not increased, the Government and the Contractor shall negotiate an equitable distribution of all property produced or purchased under the contract based upon the share of costs incurred by each."

(b) Clause 3, "Allowable Cost, Fixed-Fee and Payment" is retitled "Allowable Cost and Payment" and the following changes thereto are made:

(1) Insert the following sentence in lieu of the second sentence of paragraph (c) of the clause:

"After payment of an amount equal to 80 percent of (the Government's share of) the total estimated cost of performance of this contract set forth in the Schedule, the Contracting Officer may withhold further payment on account of allowable cost until a reserve shall have been set aside in an amount which he considers necessary to protect the interests of the Government, but such reserve shall not exceed 5 percent of the Government's share of such total estimated cost or $50,000 whichever is less."

(2) In paragraph (e) delete the words "and any part of the fixed fee."

(3) In paragraph (a)(1)(i), delete Subpart 1-15.2 of the Federal Procurement Regulations (41 CFR 1-15.2), as supplemented or modified by DOEPR 9-15.2 (41 CFR 9-15.2), and replace with "Subpart 1-15.7 (41 CFR 1-15.7), as in effect on the date of this contract; and

(c) Clause 22, "Utilization of Labor Surplus Area Concerns" and Clause 49, "Labor Surplus Area Subcontracting Program" are deleted in their entirety and replaced with the following:

"CLAUSE 22 UTILIZATION OF LABOR SURPLUS AREA CONCERNS

(The following clause is applicable if this contract exceeds $10,000.)

(a) It is the policy of the Government to award contracts to labor surplus area concerns that agree to perform substantially in labor surplus areas, where this can be done consistent with the efficient performance of the contract and at prices no higher than are obtainable elsewhere. The Contractor agrees to use his best efforts to place his subcontracts in accordance with this policy.

(b) In complying with paragraph (a) of this clause and with paragraph (b) of the clause of this contract entitled "Utilization of Small Business Concerns," the Contractor in placing his subcontracts shall observe the following order of preference: (1) Small business concerns that are labor surplus area concerns, (2) other small business concerns, and (3) other labor surplus area concerns.

(c) (1) The term "labor surplus area" means a geographical area identified by the Department of Labor as an area of concentrated unemployment or underemployment or an area of labor surplus.

(2) The term "labor surplus area concern" means a concern that together with its first-tier subcontractors will perform substantially in labor surplus areas.

(3) The term "perform substantially in a labor surplus area" means that the costs incurred on account of manufacturing, production, or appropriate services in labor surplus areas exceed 50 percent of the contract price.

CLAUSE 49 LABOR SURPLUS AREA SUBCONTRACTING PROGRAM
(applicable if this contract exceeds $500,000)

(a) The Contractor agrees to establish and conduct a program which will encourage labor surplus area concerns to compete for subcontracts within their capabilities. In this connection, the Contractor shall --

(1) Designate a liaison officer who will (i) maintain liaison with duly authorized representatives of the Government on labor surplus area matters, (ii) supervise compliance with the Utilization of Concerns in Labor Surplus Areas clause, and (iii) administer the Contractor's "Labor Surplus Area Subcontracting Program";

(2) Provide adequate and timely consideration of the potentialities of labor surplus area concerns in all "make-or-buy" decisions;

(3) Assure that labor surplus area concerns will have an equitable opportunity to compete for subcontracts, particularly by arranging solicitations, time for the preparation of bids, quantities, specifications, and delivery schedules so as to facilitate the participation of labor surplus area concerns;

(4) Maintain records showing the procedures which have been adopted to comply with the policies set forth in this clause and report subcontract awards (see 41 CFR 1-16.804-5 regarding use of Optional Form 61). Records maintained pursuant to this clause will be kept available for review by the Government until the expiration of 1 year after the award of this contract, or for such longer period as may be required by any other clause of this contracts or by applicable law or regulations; and

(5) Include the Utilization of Labor Surplus Area Concerns clause in subcontracts which offer substantial labor surplus area subcontracting opportunities.

(b) (1) The term "labor surplus area" means a geographical area identified by the Department of Labor as an area of concentrated unemployment or underemployment or an area of labor surplus.

(2) The term "concern located in a labor surplus area" means a labor surplus area concern.

(3) The term "labor surplus area concern" means a concern that, together with its first-tier subcontractors, will perform substantially in labor surplus areas.

(4) The term "perform substantially in labor surplus areas" means that the costs incurred on account of manufacturing, production, or appropriate services in labor surplus areas exceed 50 percent of the contract price.

(c) The Contractor further agrees to insert, in any subcontract hereunder which may exceed $500,000 and which contains the Utilization of Labor Surplus Area Concerns clause, provisions which shall conform substantially to the language of this clause, including this paragraph (c), and to notify the Contracting Officer of the names of such subcontractors."

(d) Clause 46 "Cost Accounting Standards" and Clause 47 "Administration of Cost Accounting Standards" are deleted in their entirety.

(e) Paragraphs (g) and (h) of Clause 37, "Rights In Technical Data," are not applicable unless the Contractor is withholding proprietary data under paragraph (e) of that clause.

(f) Clause 55, "Date of Incurrence of Costs" is hereby added:

"CLAUSE 55 DATE OF INCURRENCE OF COSTS

The Contractor shall be entitled to reimbursement for costs incurred in an amount not to exceed $100,000 on or after November 1, 1978 which, if incurred after this contract had been entered into, would have been reimbursable under the provisions of this contract."

STATEMENT OF WORK

1. General Scope (Objective)

The State of Washington will investigate geothermal reservoirs in the State, as a continuation of the Washington State Coop Project. The objective of this investigation is to characterize the geothermal reservoirs in the State of Washington. This information is necessary to develop specific geothermal reservoirs for direct use of the heat energy.

The Washington Division of Geology and Earth Resources has been involved in the assessment of the state's geothermal resources since 1971 when the First Northwest Conference on Geothermal Power was held in Olympia. From the beginning the goal has been to assess the geothermal potential of the State of Washington. Progress toward achieving this goal has been made by engaging in projects that: 1) provide baseline geologic, geophysical, and geochemical data that can be utilized by industry to cut exploration lead time and speed its assessment of Washington's geothermal resources; and 2) assess the geothermal potential of specific geographic areas where the possible occurrence of geothermal energy is recognized but where industry either shows no strong interest or is prevented from conducting exploration by legal and institutional barriers. The geothermal resource assessment results of the contract will supply information to the U.S Geological Survey for its continuing national assessment. The reservoir definition results will provide the State and DOE planning groups with the resource information necessary for future geothermal development in Washington.

2. Specific Contractor Tasks

A. Establish a Geothermal Data Bank.

Acquire, evaluate, and compile all geologic, hydrologic, geophysical, and geochemical information that pertains to the assessment of Washington's geothermal resources. The resulting data bank will be maintained as part of the Division library and, as such, it will be available for reference by anyone interested in Washington's geothermal resources. Evaluate the applicability of existing data to geothermal resource assessment, and transmit these evaluations on to users in the form of annotated bibliographies. Incorporate data compilations whenever possible in order to avoid unnecessary duplication of effort.

B. Provide Technical Advice to the State Interagency Geothermal Council.

An Interagency Geothermal Council has been formed for the purposes of encouraging the timely assessment and development of Washington's geothermal resources. Provide technical assistance to the Council regarding the assessment of geothermal resources.

C. Conduct Geothermal Resource Assessment Projects.

Conduct and manage assessment-oriented field operations as soon as projects are selected and subcontracted. The selection of projects to be subcontracted will be done with the advice and cooperation of USGS, USDOE, and university personnel. Projects to be subcontracted will include heat flow, temperature gradient, and possibly magnetotelluric and telluric, resistivity, and gravity studies. When analytical facilities or outside geochemical analyses are available, begin a comprehensive thermal and mineral spring inventory, sampling, and source-temperature estimating project. It is estimated that 3 to 4 years will be required to complete the initial inventory, with results reported each year to provide information to users in a timely manner. Following the initial inventory, a follow-up project will involve resampling important springs at different times of the year in an effort to evaluate mixing effects of spring waters with near-surface and ground waters to try and determine if there is a significant "masking effect" caused by high precipitation.

D. Planning

The full assessment of Washington's geothermal resources will be a multi-year project involving federal, state, corporate, university, and probably local agencies. The Division of Geology and Earth Resources will develop plans that will draw together and wisely apply the talents of all individuals and agencies that are involved in geothermal resource assessment in Washington. These planning and assessment activities will be carried out in full cooperation with the USGS, USDOE, and the university investigators and the State Interagency Geothermal Council.

3. Deliverable Items

By the end of FY 79, the Division of Geology and Earth Resources will prepare and open-file the following reports:

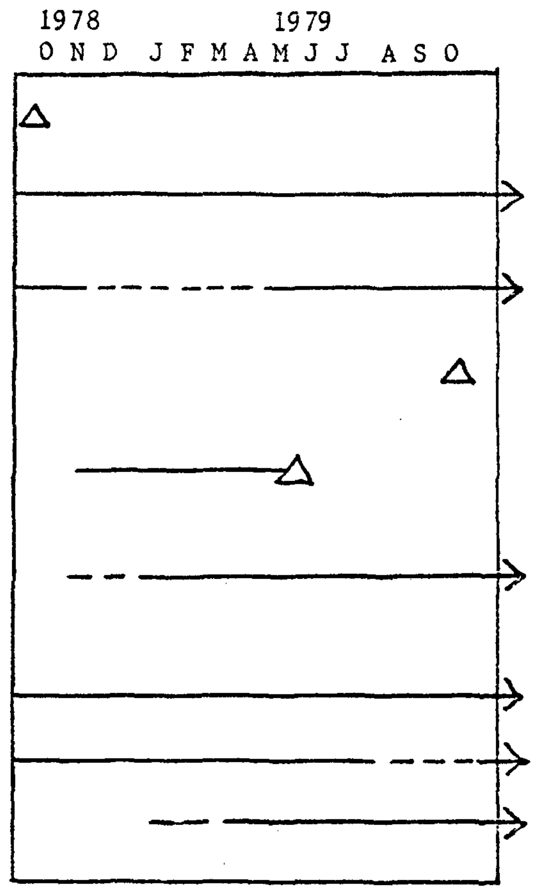
A. A progress report on the inventory of thermal and mineral springs in Washington. After the first year's investigations, 25 to 33 percent of the state's thermal and mineral springs is expected to have been sampled.

B. Selected annotated bibliography of geological, geophysical, hydrological, and geochemical reports that pertain to the assessment of geothermal resources in

Washington.

C. Five-year plan for the assessment of geothermal resources in Washington. This plan will include detailed reviews of future requirements for geologic mapping, lineament mapping, geochemistry, collection of hydrologic data, and geophysics including but not limited to heat-flow measurements, magnetotelluric and telluric measurements, and resistivity measurements.

4. Schedule



Implementation of proposal

Advise Interagency Geothermal Council

Thermal and mineral spring inventory

Open-file progress report on spring inventory

Compilation and publication of Bibliography

Formulation of mixing models and geothermometers for Cascade Springs

Compile data bank

Formulate assessment plans

Conduct or manage subcontracted investigations

DOE Form CR-537
(1-78)

U. S. DEPARTMENT OF ENERGY

REPORTING REQUIREMENTS CHECKLIST

(See Instructions on Reverse)

FORM APPROV
OMB NO. 38R-0

1. IDENTIFICATION 03-79-ET-27014.000
Geo. Assess. & Reservoir Def. in Washington.

2. OBLIGATION INSTRUMENT:
AE-1001020 35-AE-10 89X0201.91

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequenc
1. ☒ Management Plan	O	1. ☒ Notice of Energy RD&D Project (SSIE)	O
2. ☒ Milestone Schedule & Status Report	OQ	2. ☒ Technical Progress Report	Q
3. ☒ Cost Plan	OY	3. ☒ Topical Report	A
4. ☐ Manpower Plan		4. ☒ Final Technical Report	F
5. ☒ Contract Management Summary Report	M	C. PMS/MINI-PMS	
6. ☒ Project Status Report	M	1. Cost Performance Report	
7. ☒ Cost Management Report Short Form	M	☐ Format 1 WBS	
8. ☐ Manpower Management Report		☐ Format 2 Functional	
9. ☒ Conference Record	A	☐ Format 3 Baseline	
10. ☒ Hot Line Report	A	☐ Format 5 Problem Analysis	
		2. ☐ Cost/Schedule Status Report	
		3. ☐ Management Control System Description	
		4. ☐ Summary System Description	
		5. ☐ WBS Dictionary	

FREQUENCY CODES:
A – As Required
C – Contract Change
F – Final (End of Contract)
M – Monthly
O – One Time (Soon After Contract Award)
Q – Quarterly
S – Semi-Annually
X – Mandatory for Delivery with Proposals/Bid
Y – Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

5. ATTACHED HEREWITH:

☐ Report Distribution List ☐
☐ WBS/Reporting Category ☐

6. PREPARED BY (Signature and date):

7. REVIEWED BY (Signature and date):

CONTRACT NO. 03-79-ET-27014.000

Geothermal Assessment and Reservoir Definition in Washington.

Addressees	No. of Report Copies														Instru
Marshall Reed, Program Manager, DGE/ Mail Stop 3122-C, DOE/HQ 20 Massachusetts Ave, NW, Washington, D.C. 20545	1	1	1		1	1	1		1	1		1	1	5	
Dr. Martin W. Molloy, Program Manager, GED/SAN, 1333 Broadway, Oakland, CA 94612	1	1	1		1	1	1		1	1		1	1	10	
Finance Division/SAN							1								
Plans & Budget Division/SAN			1		1										
Procurement Division/SAN									1	1				1	
Office of Patent Counsel/SAN														1	
DOE Technical Information Center (TIC), P. O. Box 62, Oak Ridge, Tennessee 37830														1	Reproducible Master
Mr. S. M. Hansen, Chief, MIS & Control Branch, DOE/Div. of Program Res. Mgmt., 300 E Street, NW, Washington, DC 20545					1							1			
David Williams, USGS, Denver Federal Center, Denver, CO 80225	1	1	1		1	1			1	1		1	1	1	
James Swanson/C. Bacon, USGS 345 Middlefield Rd., Palo Alto, CA 94025	1	1	1		1	1			1	1		1	1	1	
Clay Nichols, IDO/DOE, 550 2nd St., Idaho Falls, ID 83401	1	1	1		1	1			1	1		1	1	1	

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF

1. AMENDMENT/MODIFICATION NO. M001
2. EFFECTIVE DATE
3. REQUISITION/PURCHASE REQUEST NO.
4. PROJECT NO. (If applicable)

5. ISSUED BY — CODE
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) — CODE

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) — CODE — FACILITY CODE
State of Washington
Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington 98504
Attn: Eric Schuster

8. ☐ AMENDMENT OF SOLICITATION NO. ______
DATED ______ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5-8-79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS
☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.
Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:
(a) By signing and returning ______ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS
(a) ☐ This Change Order is issued pursuant to ______
The Changes set forth in block 12 are made to the above numbered contract/order.
(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.
(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

As requested in your letter dated October 23, 1979, the completion date of the subject contract, as set forth in Article II - Period of Performance, is hereby extended from October 31, 1979, through June 1, 1980.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY [signature] (Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY [signature] (Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)
Paul E. Krauss
Deputy Supervisor, Governmental

16. DATE SIGNED
11-13-79

18. NAME OF CONTRACTING OFFICER (Type or print)
J. P. Anderson, Chief
Contract Administration Branch

19. DATE SIGNED
11/15/79

30-101-01

☆ U.S. GOVERNMENT PRINTING OFFICE: 1967—264-496

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 1

1. AMENDMENT/MODIFICATION NO. M002
2. EFFECTIVE DATE
3. REQUISITION/PURCHASE REQUEST NO.
4. PROJECT NO. (If applicable)

5. ISSUED BY CODE
U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS CODE FACILITY CODE
(Street, city, county, state, and ZIP code)
State of Washington
Department of Natural Resources
Olympia, Washington 98504
Attn: J. Eric Schuster

8.
☐ AMENDMENT OF SOLICITATION NO. ____
DATED ____ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5/8/79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The period of performance under Article II, Period of Performance, of the "SCHEDULE" is extended from June 1, 1980, to June 30, 1980.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR		17. UNITED STATES OF AMERICA	
(Signature of person authorized to sign)		BY (Signature of Contracting Officer)	
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
Manager, Dept. of Natural Resources, Division of Geology	June 9, 1980	J. P. Anderson, Chief Contract Operations Branch	6/17/80

30-101

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
A003	7/1/80	07-80ET27014.504	

5. ISSUED BY CODE

U.S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) CODE FACILITY CODE

State of Washington
Department of Natural Resources
Olympia, Washington 98504
Attn: J. Eric Schuster

8. ☐ AMENDMENT OF SOLICITATION NO. ______
DATED ______ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5/8/79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ______ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ______
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

1. Article I, Scope of Work, of the "SCHEDULE" is revised to include the following tasks which shall be performed under this Modification No. A003 in continuation of the Washington State Coop Program:

Task 1. Heat Flow Drilling - Eight heat flow holes to a maximum depth of 500 feet will be drilled in the Southern Cascades: Two holes will be drilled east of Mt. Saint Helens, one hole will be drilled in the Cowlitz Valley in the Puget Lowland, one hole will be drilled near St. Martins Hot Springs, and one hole will be located in the North Bonneville area. The locations for the other three holes will be determined later. Changes in drilling location and/or number of holes must be approved by DOE prior to change. Drilling will be accomplished by a subcontract, which will have DOE approval prior to issuance by the State of Washington.

--continued

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect. Extra

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR		17. UNITED STATES OF AMERICA	
BY Earl E. Krause (Signature of person authorized to sign)		BY (Signature of Contracting Officer)	
15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
Deputy Supervisor, Dept of Natural Resources	6/25/80	Nell W. Fraser, Director, Contracts Management Division	JUL 11 1980

☆U.S.GPO:1979-0-281-187/5001

Task 2. Temperature Measurements - Temperature measurements and thermal gradients will be obtained for all available existing wells in the Southeastern Cascades, Yakima Valley, and southwestern Columbia Basin. A preliminary map and interpretation of these data to include geo-hydrologic, and existing data on file with this program, will be produced.

Task 3. Geologic Mapping - Detailed geologic mapping, of lithology and structures, rock analysis, and age dating will be conducted on one of the strato-volcanoes (i.e., Mt. Adams or Mt. Baker). The study area to be studied will be approved by DOE prior to beginning work. Preliminary maps and interpretations of geothermal potential of the study area will be produced.

Task 4. Gravity Survey - A subcontract will be issued to perform gravity surveys (one station per five square miles density) in the central and Northern Cascades. Data reduction and preliminary interpretations will be produced. A gravity map of the Cascades of Washington will be prepared by 1982. This subcontract must be approved by DOE prior to issuance.

Task 5. Geophysical Interpretations - A task within this program is to assist in the evaluation of data as it relates to geothermal development in the State of Washington. It is understood that $5,000 will be available under this modification to purchase consultant time, as required, to aid in the interpretation of geothermal information associated with this program.

Task 6. Geochemistry - Water samples will be collected from thermal springs and wells along the Columbia and Wind Rivers, in the southeast Cascades, and in eastern Washington. Geochemical analyses will be performed on the samples as outlined in the participant's proposal, herein incorporated as part of this modification. Soil mercury and radon studies will be conducted in these areas to help delineate faults associated with geothermal fluids. Preliminary maps and results of these surveys will be presented in the yearend report.

Task 7. Fault - Lineament Map - Construct a well documented lineament map of south Cascades and southwest Columbia Basin areas. Field verification of lineaments and faults will be accomplished.

Task 8. USGS GEOTHERM file - All pertinent information on geothermal resources will be transmitted to the USGS GOETHERM File for encorporation.

Task 9. Reports - The Contractor shall furnish reports for work under this modification in accordance with attached DOE Form CF-537.

2. Article II - PERIOD OF PERFORMANCE of the "SCHEDULE" is revised to read as follows:

   The period of performance for work under this modification shall begin on July 1, 1980 and be completed on May 31, 1981. The period of performance may be extended for additional periods by written agreement of the parties.

3. Paragraphs (a), (c) and (d) of Article III - ESTIMATED COST AND COST SHARING of the "SCHEDULE" are revised to read as follows:

   (a) The total estimated cost of the work under this contract is increased from $309,878 to $616,962 for work under the original contract and this Modification No. A003. Of this estimated cost, the amount that DOE will fund is increased from $296,894 to $591,111 for work under this Modification No. A003.

   (c) The amount of costs that the Contractor shall fund out of its own resources is increased from $12,984 to $25,851 for work under the this Modification No. A003. In the event that the actual cost of the work under the original contract and this Modification No. A003 exceeds the amount of $616,962 it is understood and agreed that the Contractor shall be under no further obligation to thereafter share costs of contract performance hereunder, and in no event shall the Contractor be obligated to contribute an amount from its own resources in excess of $25,851 for work under the original contract and this Modification No. A003.

   (d) The total amount presently obligated under this contract is increased from $296,894 to $591,111. Of these funds $549,510 is available for operating expenses and $41,601 for the purchase of capitol equipment. Amounts obligated under the contract by both parties is summarized as follows:

	DOE Share	SOW Share
Original contract	$296,894	$12,984
Increase Mod A003	294,217	12,867
Totals	$591,111	$25,851

4. Paragraph (e) is added to Article IV - TECHNICAL DIRECTION AND SURVEILLANCE, of the "SCHEDULE" to read as follows:

   (e) The "Technical Manager" for DOE is as follows:

   M. A. Widmayer
   Resource Definition Branch
   USDOE - Idaho Operations Office
   550 Second Street
   Idaho Falls, ID 83401
   Telephone (208) 526-1466

The Principal Investigator for the Contractor under this contract is:

J. Eric Schuster
Assistant Manager
Division of Geology and Earth Resources
Department of Natural Resources
State of Washington
Olympia, WA 98504
Telephone (206) 754-1616

753 5327

206 - 457-6372

U. S. DEPARTMENT OF ENERGY

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-537
(1-78)

(See Instructions on Reverse)

FORM APPROVED
OMB NO. 38R-0190

1. IDENTIFICATION Geothermal Resource Assessment in Washington	2. OBLIGATION INSTRUMENT: Modification No. A003 to Contract No. DE-AC07-79ET27014

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. ☐ Management Plan		1. ☐ Notice of Energy RD&D Project (SSIE)	
2. ☐ Milestone Schedule & Status Report		2. ☒ Technical Progress Report	M
3. ☐ Cost Plan		3. ☒ Topical Report	Y
4. ☐ Manpower Plan		4. ☒ Final Technical Report	Y
5. ☒ Contract Management Summary Report	M	C. PMS/MINI-PMS	
6. ☒ Project Status Report	M	1. Cost Performance Report	
7. ☒ Cost Management Report	M	☐ Format 1 WBS	
8. ☐ Manpower Management Report		☐ Format 2 Functional	
9. ☐ Conference Record		☐ Format 3 Baseline	
10. ☐ Hot Line Report		☐ Format 5 Problem Analysis	
		2. ☐ Cost/Schedule Status Report	
		3. ☐ Management Control System Description	
		4. ☐ Summary System Description	
		5. ☐ WBS Dictionary	

FREQUENCY CODES:
A — As Required
C — Contract Change
F — Final (End of Contract)
M — Monthly
O — One Time (Soon After Contract Award)
Q — Quarterly
S — Semi-Annually
X — Mandatory for Delivery with Proposals/Bid
Y — Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

A.5., A.6., and A.7. - Copies are due within fifteen days after end of the calendar month.

B.2. - Copies are due within fifteen days after end of the calendar month.

B.3. - Submit 2 copies in draft forty-five days prior to completion of the yearly term. After DOE approval is received, submit copies as required on attached "Report Distribution List."

B.4. - Submit 2 copies in draft forty-five days prior to completion date of contract term. After DOE approval is received, submit eleven copies including one camera-ready copy.

5. ATTACHED HEREWITH

☐ Report Distribution List
☐ WBS/Reporting Category

6. PREPARED BY (Signature and date):	7. REVIEWED BY (Signature and date): J. O'Kee 5-28-80

ID F-129 (Rev. 08-79)
Ref. DOE 13302
(use with DOE CR-537)

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

REPORT DISTRIBUTION LIST

Contract No.
DE-AC07-79ET27014

Modification No. A003

Addressees	Management Plan	Milestone Schedule & Status Report	Cost Plan	Manpower Plan	Contract Management Summary Report	Project Status Report	Cost Management Report	Manpower Management Report	Conference Record	Hot Line Report	Notice of Energy RD&D Project (SSIE)	Technical Progress Report	Topical Report	Final Technical Report	Cost Performance Report	Cost/Schedule Status Report	Management Control System Description	Summary System Description	WBS Dictionary
M. A. Widmayer, Program Manager Resource Definition Branch U.S.D.O.E. Idaho Operations Office 550 Second Street Idaho Falls, ID 83401					2	2						2	2	12					
Bob Gray U.S.D.O.E. Division of Geothermal Energy MS 3344 Federal Building 12th and Penn., N.W. Washington, D.C. 20461					2	2						2	2						
Duncan Foley UURI 420 Chipeta Way Suite 120 Salt Lake City, UT 84108					1	1						1	1						
E. G. Jones, Director Financial Management Division U.S.D.O.E. Idaho Operations Office 550 Second Street Idaho Falls, ID 83401							1												

Special Instructions

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 1

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
M004			

5. ISSUED BY CODE
U. S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR CODE FACILITY CODE
NAME AND ADDRESS
(Street, city, county, state, and ZIP Code)
State of Washington
Department of Natural Resources
Olympia, Washington 98504
Attn: J. Eric Schuster

8.
☐ AMENDMENT OF SOLICITATION NO. ____
DATED ____ (See block 9)
☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5-8-79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of mutual agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The period of performance under Article II, Period of Performance, of the "SCHEDULE" is extended from May 31, 1981 to July 31, 1981.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 3 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY X Russell W Cahill
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY Preston B. Brimhall
(Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)
X Russell W Cahill

16. DATE SIGNED
X 6-11-81

18. NAME OF CONTRACTING OFFICER (Type or print)
Preston B. Brimhall

19. DATE SIGNED
6-22-81

30-101 Russell W. Cahill
Dept. Supervisor

☆U.S.GPO:1980-0-311-153/5520

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 1

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
A005	8-1-81		

5. ISSUED BY CODE
U. S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR CODE FACILITY CODE
NAME AND ADDRESS
(Street, city, county, state, and ZIP Code)

State of Washington
Department of Natural Resources
Olympia, Washington 98504
Attn: J. Eric Schuster

8.
☐ AMENDMENT OF SOLICITATION NO. ______
DATED ______ (See block 9)

☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5-8-79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ______ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☒ This Change Order is issued pursuant to Clause 52 "Changes" of the contract
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☐ This Supplemental Agreement is entered into pursuant to authority of ______
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

This Modification No. A005 is authorization and direction for you to perform work in the attached "Statement of Work" beginning August 1, 1981 and continuing through July 31, 1982. An amount of $75,000 is hereby obligated for performance of the work.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☒ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☐ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN ______ COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY ______
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY Preston B. Brimhall
(Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
		Preston B. Brimhall	7-30-81

Modification No. A005
Contract No. DE-AC07-79ET27014

STATEMENT OF WORK

The Contractor will perform following tasks to complete the work on the geothermal resource assessment of the State of Washington.

Task 1. Complete data compilation for publication by NOAA of a State Geothermal Resources Map and publish a State Geothermal Resource Map.

Task 2. Data Gathering

a. Sample and analyze additional thermal springs and wells; verify rumored thermal springs and wells; interpret and report for dissemination geology, geochemistry, and recommendations for further work and/or development of springs and thermal wells. Conduct temperature gradient logging of wells and springs. Submit a final report on thermal springs and wells incorporating geology and geochemistry.

b. Obtain and report for dissemination soil mercury determinations near selected thermal springs. Submit a final report on findings.

Task 3. Data Compilation and Dissemination

a. Augument, interpret and publish for dissemination data sets pertinent to geothermal assessment and exploration. Data sets will include but not be limited to the following: geology, geophysics (gravity, seismic and areomagnetics) faults, and linements, rock and water geochemistry, temperature gradients and heat flow, and geothermal leasing.

b. Prepare and publish for dissemination a Final Report on Geothermal Potential of Washington which will summarize all present and previous activities under this contract.

Task 4. Project Management

a. Provide overall project management and complete and report on tasks in a timely manner.

b. Provide all management reports, open file and published reports, and final reports as defined by the attached DOE Form CR-537 Reporting Requirements Checklist.

H2-0932H

c. Provide subcontract administration and field monitoring for the subcontracts described in Washington State Department of Natural Resources Proposal dated April 24, 1981, revised June 20, 1981, as follows:

   1. Cascade Range Regional Gravity Subcontract with Danes Research Associates; $25,700; last year of three-year program; finalize, compile, and complete report for public dissemination by May 31, 1982.

   2. Yakima Area Geothermal Investigations Subcontract with Washington State University; $11,481; two-year program, second year; a final report for the second-year effort containing appropriate geology, temperature gradient, heat-flow, hydrologic maps and cross sections and all other pertinent data and information is due January 31, 1982.

   3. Wind River Geology Subcontract with Portland State University; $20,000; eleven month effort; a final report containing data reduction and analytical work, geologic maps, cross sections and interpretive text is due July 31, 1982.

   4. Low temperature Geothermal Resources of the Moses Lake-Ritzville-Connel Area, Columbia Basin, Washington; $30,000; procure a subcontract for twelve month effort; final report containing stratigraphic correlation, structural interpretation, thermal aquifers and their characteristics, temperature gradients, and heat flow and identification, and characterization of potential low-temperature geothermal resources is due July 31, 1982.

d. Incorporate available data from the DOE-ID funded temperature gradient-heat flow subcontract with Southern Methodist University, Dr. David Blackwell, Principal Investigator, into appropriate final reports.

Modification No. A005 (Cont'd)
Contract No. DE-AC07-79ET27014

SUMMARY OF DELIVERABLES

		Due
1.	Final Report Yakima Area Geothermal Investigations	1/31/82
2.	Final Report Cascade Range Regional Gravity	5/31/82
3.	Data Sets	7/1/82
4.	Final Report Thermal Springs and Wells Sampling Based on Geology and Geochemistry	7/1/82
5.	Final Report Soil Mercury Determinations near Selected Thermal Springs	7/1/82
6.	Final Report Wind River Geology	7/1/82
7.	Final Report Low Temperature Geothermal Resources of Moses Lake-Ritzville-Connell Area, Columbia Basin, Washington	7/1/82
8.	Final Report on Geothermal Potential of Washington	6/15/82 (draft) 7/31/82 (final)

U. S. DEPARTMENT OF ENERGY

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-537
(1-78)

(See Instructions on Reverse)

FORM APPROVED
OMB NO. 38R-0190

1. IDENTIFICATION Geothermal Resource Assessment in Washington	2. OBLIGATION INSTRUMENT: Modification No. A005 to Contract No. DE-AC07-79ET27014

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. ☐ Management Plan		1. ☐ Notice of Energy RD&D Project (SSIE)	
2. ☐ Milestone Schedule & Status Report		2. ☐ Technical Progress Report	
3. ☐ Cost Plan		3. ☒ Topical Report	A
4. ☐ Manpower Plan		4. ☒ Final Technical Report	Y
5. ☒ Contract Management Summary Report	M	C. PMS/MINI-PMS	
6. ☒ Project Status Report	M	1. Cost Performance Report	
7. ☐ Cost Management Report		☐ Format 1 WBS	
8. ☐ Manpower Management Report		☐ Format 2 Functional	
9. ☐ Conference Record		☐ Format 3 Baseline	
10. ☐ Hot Line Report		☐ Format 5 Problem Analysis	
		2. ☐ Cost/Schedule Status Report	
		3. ☐ Management Control System Description	
		4. ☐ Summary System Description	
		5. ☐ WBS Dictionary	

FREQUENCY CODES:
A — As Required
C — Contract Change
F — Final (End of Contract)
M — Monthly
O — One Time (Soon After Contract Award)
Q — Quarterly
S — Semi-Annually
X — Mandatory for Delivery with Proposals/Bid
Y — Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

A.5., A.6. - Copies are due within fifteen days after end of the calendar month.

B.3. - Submit in draft after completion of work as indicated in Statement of Work. After DOE approval is received, submit copies as required on attached "Report Distribution List."

b.4. - Submit 2 copies in draft forty-five days prior to completion date of contract term. After DOE approval is received, submit in final including one camera-ready copy.

5. ATTACHED HEREWITH:

☒ Report Distribution List ☐
☐ WBS/Reporting Category ☐

6. PREPARED BY (Signature and date):	7. REVIEWED BY (Signature and date):

REPORTING REQUIREMENTS CHECKLIST

PURPOSE

A checklist to identify and communicate additional reporting requirements which are not otherwise set forth in the General Purpose clauses of DOE contracts and agreements. It will be included as part of the contract or agreement. This form will be completed for each proposed contract or agreement and can be modified as required in Special Instructions to adapt it to a specific situation.

INSTRUCTIONS

Item 1 — Enter the title as indicated in the Procurement Request, Interagency Agreement, or initiating memorandum.

Item 2 — Enter the identification number of the Procurement Request or Interagency Agreement, the date of the memorandum, and contract number after award.

Item 3 — Check spaces to indicate plans and reports required. For each reporting requirement checked, indicate frequency of delivery in column provided using one of the frequency codes shown.

3.A.1 *Management Plan* — The contractor's plan to manage the effort described in the statement of work or similar document. It will contain management methodologies, control systems, and procedures he will use. Includes milestones and other planning schedules, organizational identification and descriptions, and special and critical plans, such as test plans, plans for handling of Government owned property. Work breakdown structures, key personnel identification, and methods for monitoring progress toward objectives may be required.

3.A.2 *Milestone Schedule and Status Report* — The contractor's milestone schedule for all work breakdown structure items, line items, or deliverables specified in the contract. Updated periodically (usually monthly) with status, progress toward completion, and percent completion of each line item and of the total contract.

3.A.3 *Cost Plan* — A baseline plan for incurring costs on a contract or agreement to measure progress in terms of cost; update and forecast contract fund requirements; plan funding changes; and develop fund requirements and budget estimates.

3.A.4 *Manpower Plan* — A baseline plan to allocate manpower to each reporting category identified in the contract or agreement.

3.A.5 *Contract Management Summary Report* — A single-page graphic presentation of integrated cost, major milestones, and manpower for rapid visual analysis and trend forecasting.

3.A.6 *Project Status Report* — A periodic report to communicate to DOE management an assessment of contract status, to explain variances and problems, and to discuss any other areas of concern or achievements.

3.A.7 *Cost Management Report* — A periodic report of the status of costs compared to the Cost Plan. Data is used to: report actual and projected accrued costs; evaluate performance against plan; identify actual and potential problem areas; construct cost experience for projects and budgeting efforts; and, to verify the reasonableness of contractors' invoices.

3.A.8 *Manpower Management Report* — A periodic report of the status of actual and projected manpower expenditure against the Manpower Plan. Data is used to evaluate performance against plan; identify actual and potential problem areas; and to construct manpower experience for projections and planning efforts.

3.A.9 *Conference Record* — Documentation of the contractor's understanding of significant decisions, direction or redirection or required actions resulting from any meeting with DOE representatives.

3.A.10 *Hot Line Report* — A hardcopy report by the fastest means available, (TWX, etc) documenting critical problems, emergency situations, and important technical breakthroughs.

3.B.1 *Notice of Energy R&D Project* — A formatted, two-page report to provide information on unclassified DOE R&D projects for dissemination to the scientific, technical, and industrial communities and to the public. Also provides information to the Smithsonian Scientific Information Exchange.

3.B.2 *Technical Progress Report* — A formal, structured technical report, submitted periodically to communicate project results for dissemination to Government agencies, the scientific, technical and industrial communities and the public.

3.B.3 *Topical Report* — A special technical report prepared when a project has reached a point at which a major milestone or a significant phase has been completed, when unexpected results have been achieved, when it is logical to summarize results achieved, or when a new scientific or technological finding is deemed to warrant prompt publication.

3.B.4 *Final Technical Report* — Technical Progress Report reporting final results of DOE supported RD&D and scientific projects.

3.C *PMS/Mini-PMS*

1) *Cost Performance Report (PMS Application)*

Format 1 — Reports current period and cumulative budget, actual costs and earned value data by work breakdown structure elements. Identifies cost and schedule variances and provides contractor's estimate to complete comparisons to budgets.

Format 2 — Reports current period and cumulative budget, actual costs, and earned value data by contractor functional elements.

Format 3 — Provides periodic updating to the established performance measurement baseline. Incorporates authorized contract changes and internal re-planning into the performance measurement baseline.

Format 5 — Provides a narrative analysis of contract variances.

2) *Cost/Schedule Report (Mini-PMS Application)*— Periodic, usually monthly, report of cumulative budget, actual costs and earned value by summary work breakdown structure elements. Identifies cost and schedule variances and provides contractor's estimate to complete comparisons to budgets.

3) *System Description (PMS Application)* — Contractor's description of the management control system to be used in performing contract work. Must address all elements of the PMS criteria.

4) *Summary System Description (Mini-PMS Application)* — Contractor's summarized description of the management control system to be used in performing contract work.

5) *WBS Dictionary* — Lists and defines work breakdown structure. For more detailed instructions see PMS Manual.

Frequency Codes — Each code must have an identified time period (i.e., As Required — 5 days after event occurrence). These time periods are suggested in the solicitation and negotiated at contract award.

Item 4 — Identify any special reporting requirements not indicated in Item 3 and/or qualifiers to those selected. (Use additional sheets as necessary.)

Item 5 — Check appropriate blocks.

Report Distribution List — A comprehensive informative listing of reports by frequency of submission, addresses and number of copies for each addressee.

Reporting Categories (level of detail) — An identification by WBS level of task elements for which reporting will be required by DOE.

Item 6 — Signature of person or persons preparing the checklist and the date prepared. Preparation is by person or persons responsible for preparation of Procurement Request or Statement of Work.

Item 7 — Signature of the person reviewing the checklist and date reviewed.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978-- 281-130/ 514

ID F-129 (Rev. 08-79)
Ref. DOE 13302
(use with DOE CR-537)

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

REPORT DISTRIBUTION LIST

Contract No.

DE-AC07-79ET27014

Modification No. A005

Number of Report Copies

Addressees	Management Plan	Milestone Schedule & Status Report	Cost Plan	Manpower Plan	Contract Management Summary Report	Project Status Report	Cost Management Report	Manpower Management Report	Conference Record	Hot Line Report	Notice of Energy RD&D Project (SSIE)	Technical Progress Report	Topical Report	Final Technical Report	Cost Performance Report	Cost/Schedule Status Report	Management Control System Description	Summary System Description	WBS Dictionary	
U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401																				
Attn: Susan Prestwich, Program Mgr. Energy & Technology Division					2	2							2	12						
Attn: Nell W. Fraser, Director Contracts Management Division					1	1							1	1						
Attn: E. G. Jones, Director Financial Management Division					1															
Bob Gray U. S. Department of Energy, DGE MS 3344, Federal Building 12th and Penn. N.W. Washington, DC 20461					2	2							2	2						
Duncan Foley UURI 420 Chipeta Way, Suite 120 Salt Lake City, UT 84108					1	1							1	1						

Special Instructions

UNIFORM DOE CONTRACTOR SCIENTIFIC, TECHNICAL AND ENGINEERING REPORT NUMBERING SYSTEM

Effective with the implementation of the Procurement/Contract numbering system as shown in the example below, the following guidelines are established for identifying scientific and technical reports (progress, interim, final topical, etc.) conference papers, proceedings, theses, and translations.

1. All DOE contractors now applying uniquely identifying codes and systems approved by TIC are to continue using such codes and systems.

2. DOE Field Office codes such as ALO, IDO, COO, HCP, NVO, ORO, RLO, SAN, and SRO; and program codes such as FE, DSE, etc., are no longer approved for use by contractors.

3. Contractors having no approved unique codes are to number information products as shown below. All contractors in this category should create unique report numbers by (a) identifying the report with a DOE code, (b) selecting the final seven characters from the applicable contract number (two alphabetic and five numerals), and (c) adding suffix numbers sequentially for each report generated under the contract. For new contracts, the sequential number should begin with 1. For existing contracts the established sequence should continue. Slash marks and hyphens should be applied as shown in the examples.

   Examples: Report numbers generated from contract number DE-AC03-79ET01834.M001:

   DOE/ET/01834-1; DOE/ET/01834-2; DOE/ET/01834-3; etc.

   Note: It is essential that both the final five-digit numeral and the two preceeding alphabetical characters be extracted from the contract number as shown. The modification number, if any, normally shown as M001, etc., following the basic five-digit number is NOT used in the report number.

4. Reports issued in more than one binding, or reissued as revisions or later editions, are to be identified by adding the following aditional suffixes to the basic number: Rev. - Revision; Vol. -Volume; Pt. - part: Add. - Addenda; Ed. - Edition, etc.

   Examples: DOE/ET-01834-1 Rev.
   DOE/ET/01834-1 Rev. 2

   DOE/ET-01834-1 Pt. 1
   DOE/ET/01834-1 Pt. 2

It is intended that report numbers be structured exactly as specified in the examples insofar as possible. If modification to this basic format is essential, it is to be approved through normal channels before being used.

SUBCONTRACT FOR GEOTHERMAL INVESTIGATIONS IN THE YAKIMA AREA, WASHINGTON

to

John Biggane, Investigator
Geological Engineering Section
Department of Civil and Environmental Engineering
Washington State University
Pullman, Washington 99164

From

Washington State Department of Natural Resources
Division of Geology and Earth Resources
Olympia, Washington 98504

Under contract no. DE-AC07-79ET27014 from U.S. Department of Energy for Assessment of Geothermal Resources in Washington.

July 28, 1981

Introduction

Work funded by this subcontract will complete the evaluation of low-temperature geothermal resources in the Yakima area which was begun by Mr. Biggane on August 1, 1980. During the first year of his investigations, Mr. Biggane has assembled all available data from water wells in Yakima County, collected additional subsurface temperature data, subjected the data to statistical analysis, and submitted a preliminary report entitled "The low temperature geothermal resource of the Yakima region, A preliminary report" (Washington State University College of Engineering Research Report 81/15-27).

Objectives

Objectives for the remaining six months of Mr. Biggane's investigations are as follows:

I. Refine and extend the preliminary conclusions of the study by performing:
   A. Additional subsurface stratigraphic correlation through the use of geophysical and driller's logs.
   B. Additional stratigraphic interpretation by means of structural contour maps and fence diagrams.
   C. More detailed investigations of the spatial relationships that exist between aquifer depths, temperatures, and stratigraphy.

II. Identify, assess, and delineate regions according to their geothermal potential.

Schedule

Investigations under this contract will begin on August 1, 1981, and end on January 31, 1982.

Products

A report detailing the findings of the investigator, and all pertinent data and information relevant to the above objectives shall be due on January 31, 1982. In addition, this report shall incorporate all of the data and findings from the August 1, 1980 to July 31, 1981 contract period. The report shall contain appropriate geologic, temperature gradient, heat-flow, and hydrologic maps, cross-sections, and/or diagrams. The report shall be delivered in a format suitable for publication, and it shall be subject to review by the Division of Geology and Earth Resources prior to final acceptance.

Monthly Report

The contractor shall submit a monthly letter report describing progress to date and fiscal status.

Payment

Payment for budgeted expenses incurred up to date of billing will be made at any time upon receipt and approval of an itemized billing from Washington State University on a State of Washington Invoice Voucher (Form A-19). Total payment for the contract period shall not exceed $11,481.

Expense items for which rates are not stated in the attached budget, such as per diem and transportation, shall be paid at the rates officially established by Washington State University.

Expenditures under any budget heading (Salaries, Benefits, Goods and Services, Travel, or Indirect Costs) may exceed the budgeted amount by up to twenty percent without amending this contract, so long as such budget changes do not result in a total expenditure which exceeds the contract budget ($11,481).

In the event that the U.S. Department of Energy terminates its contract with the Washington Department of Natural Resources for any reason, this subcontract will also terminate. If termination should occur, as much advance notice as possible will be given, payment will be made for costs incurred up to the date of termination, and all findings, reports, maps, diagrams, or other information obtained up to the date of termination will be delivered to the Division of Geology and Earth Resources.

Legal Compliance

Washington State University agrees to abide by all applicable state and federal laws in the execution of this subcontract. These include the appropriate legal provisions for subcontractors which are included or referenced in U.S. Department of Energy Contract No. DE-AC07-79ET27014 (copy attached).

Budget

Salaries		
Research Assistant, 1/2 time, 8/1/81-1/31/82	$3,890	
Secretarial	583	
		$ 4,473
Benefits		
8 percent of Research Asst. salary	311	
23 percent of secretarial salary	134	
		445
Goods and Services		1,875
Travel		1,125
Indirect Costs @ 45 percent of total modified direct costs		3,563
		$11,481

Signatures

Thomas A. Faecke
Controller
Washington State University
Pullman, WA 99164

________________________ ____________
signature date

Vaughn E. Livingston, Jr.
State Geologist
Department of Natural Resources
Division of Geology and Earth Resources
Olympia, WA 98504

Vaughn E. Livingston Jr. 8-4-81
signature date

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

PAGE 1 OF 2

1. AMENDMENT/MODIFICATION NO.	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
A006			

5. ISSUED BY CODE
U. S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401

6. ADMINISTERED BY (If other than block 5) CODE

7. CONTRACTOR NAME AND ADDRESS (Street, city, county, state, and ZIP Code) CODE FACILITY CODE

State of Washington
Department of Natural Resources
Olympia, Washington 98504
Attn: J. Eric Schuster

8. ☐ AMENDMENT OF SOLICITATION NO. ________
DATED ________ (See block 9)

☒ MODIFICATION OF CONTRACT/ORDER NO. DE-AC07-79ET27014
DATED 5-8-79 (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

☐ The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers ☐ is extended, ☐ is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning ____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required) AM 1510 Increase DOE's cost share by $203,637 to $794,748; increase Washington's share by $186,641 to $212,492. Increase TEC by $390,278 to $1,007,240. Increase obligations by $128,637 to $794,748.

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) ☐ This Change Order is issued pursuant to ________
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) ☐ The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) ☒ This Supplemental Agreement is entered into pursuant to authority of Clause 52 "Changes" of the contract and agreement of the parties.
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

1. This modification provides for the equitable adjustment in contract amount and term resulting from Modification No. A005 which was issued unilaterally under the authority of the "Changes" article. It also includes a revised Statement of Work to reflect increased funding for the project from the Contractor along with an extension in the term.

2. Article I - Scope of Work is modified to add the work in the attached Modification No. A006 Statement of Work.

3. Article II - Period of Performance is modified to extend the term through July 31, 1983.

CONTINUED..................

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. ☐ CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT ☒ CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN 2 COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY Russell Cahill
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY William C. Drake
(Signature of Contracting Officer)

15. NAME AND TITLE OF SIGNER (Type or print)	16. DATE SIGNED	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
Russell W. Cahill Department Supervisor	10/22/81	William C. Drake	9/29/81

☆U.S.GPO:1980-0-311-153/5520

4. Paragraphs (a), (c) and (d) of Article III - Estimated Cost and Cost Sharing are revised to read as follows:

(a) The total estimated cost of the work under this contract is increased by $390,278 from $616,962 to $1,007,240 for work under the original contract, Modification No. A003, and this Modification No. A006. Of this estimated cost, the amount that DOE will fund is increased by $203,637 from $591,111 to $794,798 for work under this Modification No. A006.

(c) The amount of costs that the Contractor shall fund out of its own resources is increased by $186,641 from $25,851 to $212,492 for work under the this Modification No. A006. In the event that the actual cost of the work under the original contract and this Modification No. A006 exceeds the amount of $1,007,240 it is understood and agreed that the Contractor shall be under no further obligation to thereafter share costs of contract performance hereunder, and in no event shall the Contractor be obligated to contribute an amount from its own resources in excess of $212,492 for work under the original contract, Modification No. A003, and Modification No. A006.

(d) The total amount presently obligated under this contract is increased by $203,637 from $591,111 to $794,798. Amounts obligated under the contract by both parties are summarized as follows:

	DOE Share	Washington Share
Original contract	$296,894	$ 12,984
Increase Mod. A003	294,217	12,867
Increase Mod. A006	203,637	186,641
Totals	$794,748	$212,492

5. Paragraph (e) of Article IV - Technical Direction and Surveillance is modified to read as follows:

(e) The "Technical Manager" for DOE is as follows:

S. M. Prestwich
Energy & Technology Division
U. S. Department of Energy
Idaho Operations Office
550 Second Street
Idaho Falls, Idaho 83401
Telephone (208) 526-1147

Modification No. A006
Contract No. DE-AC07-79ET27014

STATEMENT OF WORK

The Contractor will perform following tasks to complete the work on the geothermal resource assessment of the State of Washington.

Task 1. Complete data compilation for publication by NOAA of a State Geothermal Resources Map and publish a State Geothermal Resource Map.

Task 2. Data Gathering

a. Sample and analyze additional thermal springs and wells; verify rumored thermal springs and wells; interpret and report for dissemination geology, geochemistry, and recommendations for further work and/or development of springs and thermal wells. Conduct temperature gradient logging of wells and springs. Submit a final report on thermal springs and wells incorporating geology and geochemistry.

b. Obtain and report for dissemination soil mercury determinations near selected thermal springs. Submit a final report on findings.

Task 3. Data Compilation and Dissemination

a. Augment, interpret and publish for dissemination data sets pertinent to geothermal assessment and exploration. Data sets will include but not be limited to the following: geology, geophysics (gravity, seismic and areomagnetics) faults, and linements, rock and water geochemistry, temperature gradients and heat flow, and geothermal leasing.

b. Prepare and publish for dissemination a Final Report on Geothermal Potential of Washington which will summarize all present and previous activities under this contract.

Task 4. Project Management

a. Provide overall project management and complete and report on tasks in a timely manner.

b. Provide all management reports, open file and published reports, and final reports as defined by the attached DOE Form CR-537 Reporting Requirements Checklist.

H2-1217H

c. Provide subcontract administration and field monitoring for the subcontracts described in Washington State Department of Natural Resources Proposal dated April 24, 1981, revised June 20, 1981, and July 9, 1981, as follows:

1. Cascade Range Regional Gravity Subcontract with Danes Research Associates; $35,700; last year of four-year program; finalize, compile, and complete report for public dissemination by April 1, 1983.

2. Yakima Area Geothermal Investigations Subcontract with Washington State University; $11,481; two-year program, second year; a final report for the second-year effort containing appropriate geology, temperature gradient, heat-flow, hydrologic maps and cross sections and all other pertinent data and information is due January 31, 1982.

3. Wind River Geology Subcontract with Portland State University; $20,000; eleven month effort; a final report containing data reduction and analytical work, geologic maps, cross sections and interpretive text is due July 31, 1982.

4. Low temperature Geothermal Resources of the Moses Lake-Ritzville-Connel Area, Columbia Basin, Washington; $30,000; procure a subcontract for twelve month effort; final report containing stratigraphic correlation, structural interpretation, thermal aquifers and their characteristics, temperature gradients, and heat flow and identification, and characterization of potential low-temperature geothermal resources is due July 31, 1982.

5. Geologic-hydrologic assessment of low temperature geothermal resources in the Walla Walla area, Columbia River, Washington; $25,000; procure a subcontract for twelve month effort, final report containing stratigraphic correlation, structural interpretation thermal aquifers and their characteristics, thermal gradients, and heat flow and indentification, and characterization of potential low-temperature geothermal resources is due April 1, 1983.

6. Heat-flow and temperature gradient investigation at Columbia Basin; $6,000; procure a subcontract to acquire computer-plotted copies of suites of well logs (400 + wells). Include results in data set report due August 1, 1983.

7. Heat-flow and temperature gradient investigation at Mount Baker; $22,000; procure a subcontract to drill two 500 foot heat flow holes in the area of Mount Baker. Include results in data set report due August 1, 1983.

8. K-Ar Dating of Quarternary rock previously collected from the Cascade area; $5,000; data gathered shall be used for space-time-composition model for South Cascade Range. Report to include age data and analysis due August 1, 1983.

d. Incorporate available data from the DOE-ID funded temperature gradient-heat flow subcontract with Southern Methodist University, Dr. David Blackwell, Principal Investigator, into appropriate final reports.

Modification No. A006 (Cont'd)
Contract No. DE-AC07-79ET27014

SUMMARY OF DELIVERABLES

		Due
1.	Final Report Cascade Range Regional Gravity	8/1/83
2.	Final Report Yakima Area Geothermal Investigations	1/31/82
3.	Final Report Wind River Geology	7/31/82
4.	Final Report Low Temperature Geothermal Resources of Moses Lake-Ritzville-Connell Area, Columbia Basin, Washington	7/31/82
5.	Final Report Low Temperature Geothermal Resources Walla Walla Area.	8/1/83
6.	K-Ar Dating Summary Report	8/1/83
7.	Final Report Thermal Springs and Wells Sampling Based on Geology and Geochemistry	7/1/82
8.	Final Report Soil Mercury Determinations near Selected Thermal Springs	7/1/82
9.	Data Sets	8/1/83
10.	Final Report on Geothermal Potential of Washington	8/15/83 (draft) 9/30/83 (final)

U. S. DEPARTMENT OF ENERGY

REPORTING REQUIREMENTS CHECKLIST

DOE Form CR-537
(1-78)

(See Instructions on Reverse)

FORM APPROVED
OMB NO. 38R-0190

1. IDENTIFICATION Geothermal Resource Assessment in Washington	2. OBLIGATION INSTRUMENT: Modification No. A006 to Contract No. DE-AC07-79ET27014

3. REPORTING REQUIREMENTS

A. PROJECT MANAGEMENT	Frequency	B. TECHNICAL INFORMATION REPORTING	Frequency
1. ☐ Management Plan		1. ☐ Notice of Energy RD&D Project (SSIE)	
2. ☐ Milestone Schedule & Status Report		2. ☐ Technical Progress Report	
3. ☐ Cost Plan		3. ☒ Topical Report	A
4. ☐ Manpower Plan		4. ☒ Final Technical Report	Y
5. ☒ Contract Management Summary Report	M	C. PMS/MINI-PMS	
6. ☒ Project Status Report	M	1. Cost Performance Report	
7. ☐ Cost Management Report		☐ Format 1 WBS	
8. ☐ Manpower Management Report		☐ Format 2 Functional	
9. ☐ Conference Record		☐ Format 3 Baseline	
10. ☐ Hot Line Report		☐ Format 5 Problem Analysis	
		2. ☐ Cost/Schedule Status Report	
		3. ☐ Management Control System Description	
		4. ☐ Summary System Description	
		5. ☐ WBS Dictionary	

FREQUENCY CODES:
A — As Required
C — Contract Change
F — Final (End of Contract)
M — Monthly
O — One Time (Soon After Contract Award)
Q — Quarterly
S — Semi-Annually
X — Mandatory for Delivery with Proposals/Bid
Y — Yearly or Upon Contract Renewal

4. SPECIAL INSTRUCTIONS

A.5., A.6. - Copies are due within fifteen days after end of the calendar month.

B.3. - Submit in draft after completion of work as indicated in Statement of Work. After DOE approval is received, submit copies as required on attached "Report Distribution List."

B.4. - Submit 2 copies in draft forty-five days prior to completion date of contract term. After DOE approval is received, submit in final including one camera-ready copy.

5. ATTACHED HEREWITH:

☒ Report Distribution List ☐
☐ WBS/Reporting Category ☐

6. PREPARED BY (Signature and date):	7. REVIEWED BY (Signature and date):

ID F-129 (Rev. 08-79)
Ref. DOE 13302
(use with DOE CR-537)

U.S. DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE

REPORT DISTRIBUTION LIST

Contract No.

DE-AC07-79ET27014

Modification No. A006

Number of Report Copies

Addressees	Management Plan	Milestone Schedule & Status Report	Cost Plan	Manpower Plan	Contract Management Summary Report	Project Status Report	Cost Management Report	Manpower Management Report	Conference Record	Hot Line Report	Notice of Energy RD&D Project (SSIE)	Technical Progress Report	Topical Report	Final Technical Report	Cost Performance Report	Cost/Schedule Status Report	Management Control System Description	Summary System Description	WBS Dictionary
U. S. Department of Energy Idaho Operations Office 550 Second Street Idaho Falls, Idaho 83401																			
Attn: Susan Prestwich, Program Mgr. Energy & Technology Division					2	2							2	12					
Attn: Nell W. Fraser, Director Contracts Management Division					1	1							1	1					
Attn: E. G. Jones, Director Financial Management Division					1														
Bob Gray U. S. Department of Energy, DGE MS 3344, Federal Building 12th and Penn. N.W. Washington, DC 20461					2	2							2	2					
Duncan Foley UURI 420 Chipeta Way, Suite 120 Salt Lake City, UT 84108					1	1							1	1					

Special Instructions

CONTRACT NO.
DE-AC07-79ET27014

Prepared by JED 2-5-82
Approved by

ITEM:	ORIGINAL BUDGET IN MOD. A006, 8-1-81 to 9-30-83			ACTUAL EXPENDITURES, 8-1-81 to 12-31-81			USDOE		STATE		PROPOSED BUDGET FOR 1-1-82 to 9-30-83		
	1 USDOE	2 STATE	3 TOTAL	4 USDOE	5 STATE	6 TOTAL	7 BALANCE ON 1-1-82	8 PROPOSED CHANGES	9 BALANCE ON 1-1-82	10 PROPOSED CHANGES	11 USDOE	12 STATE	TOTAL
Salaries;													
Geol. II, Stoffel 1/								10876-			10876-		10876-
Geol. III, Korosec 3/		54826-	54826-		10454-	10454-			44372-	<1236>		43136-	43136-
Geol. II, Phillips 2/		47191-	47191-		-0-				47191-	<28352>		18839-	18839-
Clerk-Typist II, Preston 3/		21684-	21684-		3938-	3938-			17746-	<775>		16971-	16971-
Asst. State Geol, et. al.		21833-	21833-		5535-	5535-			16298-			16298-	16298-
Benefits: 20% of salaries 1/		29107-	29107-		3985-	3985-		2175-	25122-	<6073>	2175-	19049-	21224-
Travel: 1/	10150-	6000-	16150-	1776-		1776-	8374-	2905-	6000-		11279-	6000-	17298-
Equipment, supplies, services:	10734-	6000-	16734-	2800-		2800-	7934-		6000-		7934-	6000-	13934-
Subcontracts:													
Cascades Regional Gravity (Danes)	25700-		25700-	7162-		7162-	18538-				18538-		18538-
Detailed Gravity (Danes)	10000-		10000-				10000-				10000-		10000-
Yakima area (Biggane, WSU) 4/	11481-		11481-	6267-		6267-	5214-	1421-			6635-		6635-
- Walla Walla area (WSU) 1/	25000-		25000-				25000-	<25000>			-0-		-0-
Computer time at WSU 1/	-0-		-0-					4350-			4350-		4350-
- Moses Lake-Ritzville-Connell log interp. (Amos, WSU) 5/	30000-		30000-				30000-	4008-			34008-		34008-
Wind River geology (Berri, PSU) 6/	20000-		20000-	3344-		3344-	16656-	<735>			15921-		15921-
Columbia Basin heat flow & temp. grad. investigations 7/	6000-		6000-				6000-	<6000>					-0-
Mount Baker heat flow & temp. gradient drilling 8/	22000-		22000-				22000-	5000-			27000-		27000-
- Age dates (Hammond, PSU) 9/	5000-		5000-				5000-	1000-			6000-		6000-
Overhead: 15.66%	27572-		27572-	3343-		3343-	24229-				24229-		24229-
Totals	203637-	186641-	390278-	24692-	23912-	48604-	178945-	-0-	162729-	<36436>	178945-	126293-	305238-

2/9/82

EXPLANATION OF FOOTNOTES FROM LEDGER SHEET

1/ We propose to abandon the earlier plan to interpret WSU well-log suites for the Walla Walla area, and instead interpret the best quality log suites that remain for the entire Columbia Basin except for the Yakima and Moses Lake-Ritzville-Connell areas where the low temperature resources are being evaluated by John Biggane and Al Amos at WSU. By adopting this plan, we will have detailed evaluations of the low temperature geothermal resources of the Yakima and Moses Lake-Ritzville-Connell areas as well as a less detailed evaluation of the rest of the Columbia Basin. We believe that this will provide better overall guidance to explorationists than a detailed study of the Walla Walla area.

2/ Because of state budget cuts we have been unable to fill our Geologist II-Geothermal position. As of January 1, 1982, we have been able to assign another staff geologist to geothermal work one-half time. This budget change reflects vacancy in the position from August 1, 1981 to December 31, 1981 and one-half time occupancy from January 1, 1982 to September 30, 1983.

3/ These changes are minor salary adjustments that do not imply any change from full-time work on geothermal.

4/ Added funding is to allow John Biggane to include reproducible copies of 49 well-log suites in his final report.

5/ Added funding supports computer use, travel, and minor miscellaneous expenses that were not funded in the original proposed $30,000 budget.

6/ Decreased funding reflects the fact that we were able to contract this work at less than the estimated $20,000.

7/ This proposed activity has been replaced by that proposed under 1/.

8/ Funding increase should adequately support the drilling of two heat-flow temperature-gradient holes. The original budgeted amount of $22,000 would not have done so.

9/ Added funding supports salaries of assistants to process data on rock geochemistry, aerial distribution of Quaternary volcanic rock units, and age dates. The volume of such data is larger than originally anticipated and outside analytical services have not delivered the data as rapidly as anticipated.