

601828

CASCADES RESEARCH PROGRAM

PROGRAM PLAN

Submitted to:

U.S. DEPARTMENT OF ENERGY
Idaho Operations Office

By:

EG&G Idaho, Inc.

and

Earth Science Laboratory
University of Utah Research Institute

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CONTENTS

1.0	Executive Summary	1
2.0	Introduction	2
3.	Program Description	5
3.1	Thermal Gradient Drilling	5
3.2	Data Acquisition	7
3.3	Data Integration and Interpretation	8
3.4	Technology Transfer	9
4.0	Implementation Plan	10
4.1	Management Organization	10
4.2	Responsibilities	10
4.3	Quality Program Plan	13
5.0	Cost and Schedule Summary	14
6.0	References	16

1.0 EXECUTIVE SUMMARY

The purpose of the Cascades Research Program is to conduct research on the geothermal resources of the Cascades Volcanic Region in California, Oregon and Washington. The objectives of the program are to (a) characterize the Cascades geothermal resource potential, (b) stimulate development of the region by making data publicly available, and (c) increase knowledge of both applicable exploration techniques and the depth required to penetrate the overlying cold ground-water system that masks and suppresses surface evidence of the underlying hydrothermal system.

The program's implementation strategy comprises four principal activities: thermal gradient drilling, data acquisition, data integration and interpretation, and technology transfer. DOE will cost-share surface exploration and drilling of deep thermal gradient holes and the extraction from these holes of fundamental subsurface information to identify and characterize the hydrothermal system of the Cascades region. After the drilling is completed, DOE will have up to one year to perform R&D activities at each of the drill hole locations. Data obtained both during drilling and in the one year period following drilling will be integrated and evaluated into case studies and a final report. Additional technology transfer will result from publication of the transactions from workshops and conferences and from reports that will be submitted for publication in professional journals.

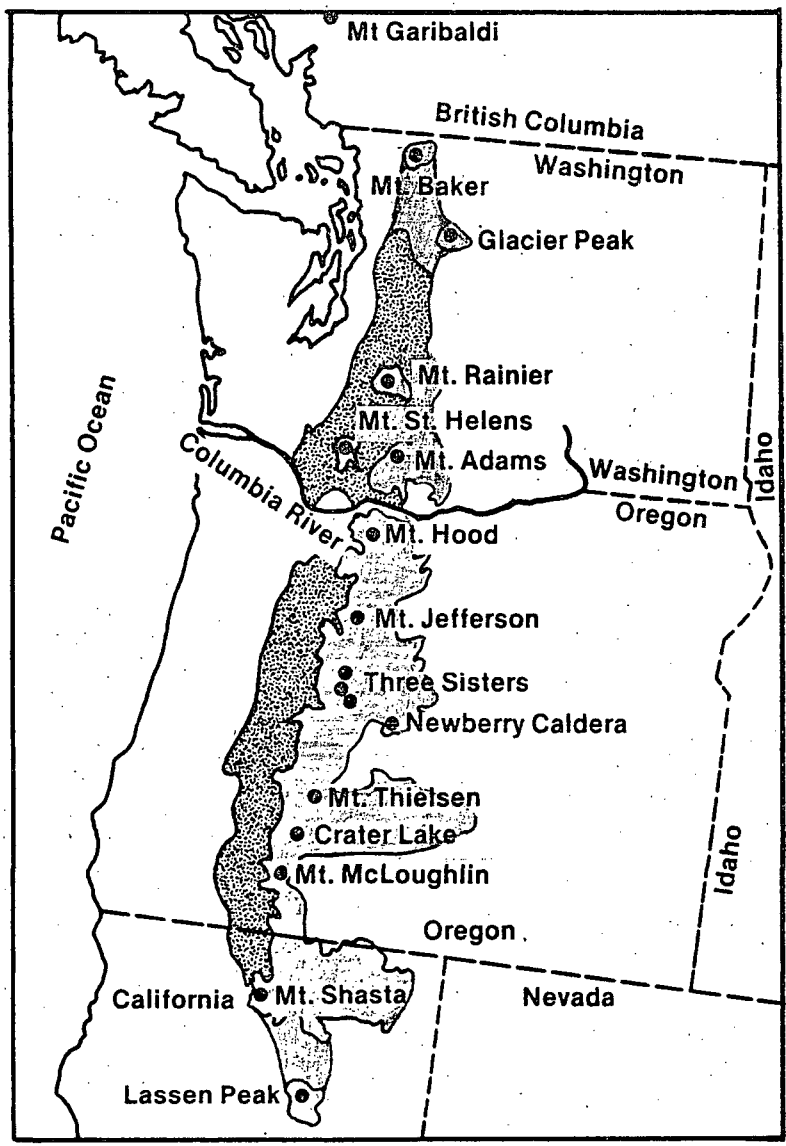
The program will be completed in FY-1987, and the estimated cost by year is: FY-1985--\$1,535K; FY-1986--\$500K, and FY-1987--\$350K.

2.0 INTRODUCTION

The nation's hydrothermal resources represent a vast energy asset that is free of foreign control or interference. These resources should be developed as rapidly and efficiently as possible. If all the hydrothermal resources identified in the United States Geological Survey's Circular 790 in the Cascade Mountains of California, Oregon and Washington were utilized (see Figure 1) the total energy available at the wellhead from resources above 90°C would be greater than 50 quads, which is equivalent to 9 billion barrels of oil. And, the same source estimates that the undiscovered accessible resource base in the Cascade Mountains could be twenty times as great as the identified resources. Even though these are hypothetical numbers, the promise of a very large energy resource certainly exists.

However, high temperature geothermal systems in the Cascades have remained elusive exploration targets, with confirmed resource temperatures present only at Meager Creek in British Columbia, Newberry Caldera in Oregon, and Lassen Peak in California. The most widely accepted premise used for the apparent lack of geothermal systems in this province rich in volcanic heat sources is that the resource is masked by the cold ground water system. If geothermal systems are present, it is clear that exploration will be both expensive and risky. Both the risk and expense can be mitigated somewhat through the development and application of valid exploration strategies. Each strategy must be developed and applied with cost in mind, progressing from less expensive methods early in the program to more expensive methods utilized to site expensive production-scale wells. In this way, the financial risk can be limited.

Although few high-temperature geothermal systems are known in the Cascades Province, producing geothermal systems occur in similar settings in other parts of the world. These include the Neovolcanic Belt of Mexico, the volcanic belt of Central America, and the island arc environments of New Zealand, Japan, Indonesia, and the Philippines. Data are available for most of these environments and can be used in establishing conceptual models



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Figure 1. Cascades Geothermal Area.

for geothermal systems in andesitic volcanic environments in general. In addition, abundant data are available for fossil hydrothermal systems in these environments, that is, hydrothermal ore deposits in sub-volcanic settings. This literature can provide valuable information on the character of fracturing and faulting in these environments and the ability of these channels to carry hydrothermal solutions.

During the past five years, the U.S. Geological Survey, working partly under funding provided by DOE-DGHT, has been conducting fundamental earth science studies in the Cascades region aimed at obtaining a better understanding of the geothermal resources. Most of this work has been regional in nature. It has consisted of collection and interpretation of a large variety of data including geologic mapping, aeromagnetic surveys, gravity surveys, active and passive seismic surveys and geochemical studies. These data have been evaluated largely in terms of developing a regional geologic picture and have been applied specifically in only a few areas. The results of this work, as well as the basic data and to a certain extent the USGS personnel working on the project, will be available to researchers on the present program and will provide substantial assistance.

The Cascades Research Program is expected to contribute materially to knowledge of heat flow and other aspects of potential Cascades geothermal environments. Data generated from this program will require integration into available data bases, and interpretation and publication in order to maximize their utility to industry and stimulate geothermal development.

3.0 PROGRAM DESCRIPTION

The Cascades Research Program consists of DOE cost-shared surface exploration and drilling of deep thermal gradient holes and the extraction from these holes of fundamental subsurface information to identify and characterize the hydrothermal system. It is also planned that the program will increase knowledge of both unique exploration techniques and the depth required to penetrate beneath the extensive regional cold ground-water system that suppresses surface evidence of underlying hydrothermal systems (i.e., the "rain curtain").

This program plan defines a program designed to support industry efforts in the identification, evaluation, extraction and utilization of geothermal resources in the Cascades as an alternative energy source. The plan, with its major program elements and work subsets, is shown diagrammatically in Figure 2. A discussion of these major elements follows. A cost and schedule summary is presented in Section 5.0.

3.1 Thermal Gradient Drilling

DOE issued a "Solicitation for Cooperative Agreement Proposals (SCAP) Number DE-SC07-85ID12555" for the drilling of deep thermal gradient holes in the Cascades region of Washington, Oregon, and California late in FY-1984. To qualify for consideration, the proposer had to meet the following criteria:

- 1) The proposed site must be located within the Cascades volcanic region of the United States as delineated by Figure 1.
- 2) The proposal must include a cost-share plan in which DOE's share shall not exceed 50 percent.
- 3) The proposer must agree to complete the hole and allow DOE access to the hole for data acquisition.

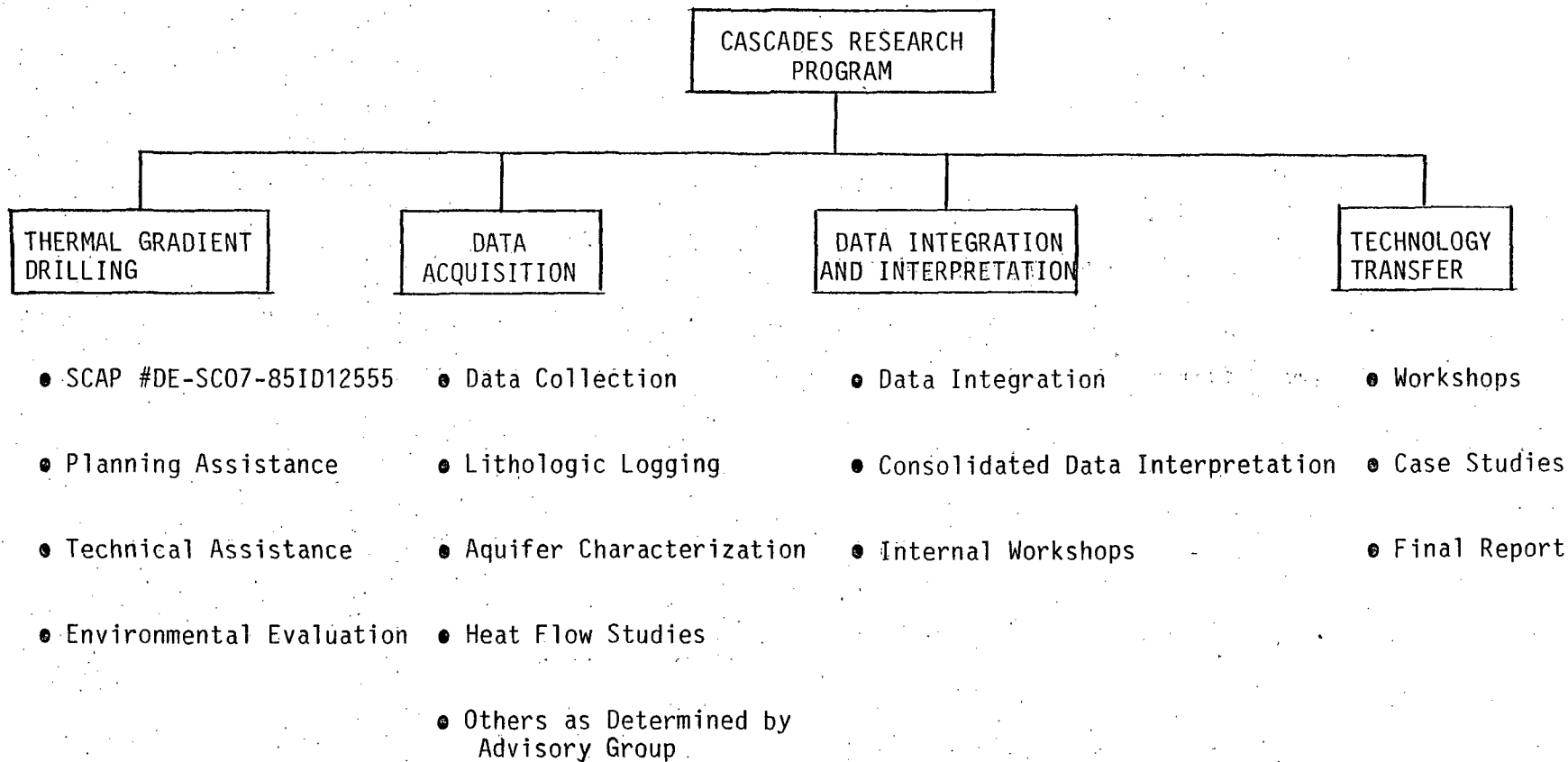


Figure 2. Program Work Elements
6

- 4) Each proposer must provide, as part of its proposal, documentation in the form of a lease, agreement, or ownership providing it an existing right of access for geothermal exploration to the proposed drill site.

The proposer is required to submit both a technical proposal and a business proposal. Some of the requirements that must be included in the technical proposal include a geological description of the resource, drilling plans, a data collection plan, hole completion and maintenance plans, and abandonment plans. He is also required to address institutional considerations such as environmental issues. Some of the requirements that must be included in the business proposal are a financial plan, cost-share plan, cost/budget summary and organizational information. All of the data and information obtained during and after drilling will be available to the public.

As stated in the SCAP, the proposer must agree that the hole will be completed and maintained by the proposer such that DOE will have access to the hole for a specified period of time. During that period, DOE will perform at its own expense further data gathering and tests for equilibrated thermal gradients and resource parameters. A selected proposer may independently acquire additional data from the hole during the DOE access period on a non-interference basis.

UURI will provide DOE with planning assistance for the drill site selection and technical assistance for the drilling operations as required. EG&G will make certain that environmental concerns are accounted for in the drilling program.

3.2 Data Acquisition

Activities included in the R&D effort include data collection and analysis, lithologic logging, aquifer characterization, heat flow studies, and any other work as determined by the advisory group.

UURI will establish sampling procedures for lithologic samples acquired in the drilling operation and will archive splits of the drill chips and fluid samples in the Geothermal Sample Library. This data will be released to the public by open-filing as instructed by DOE. Also, UURI will produce lithologic logs of the cuttings and core and will interpret the logs in relation to the local surface geology.

UURI will also have the lead role in aquifer characterization and supplemental data collection. One of the key objectives of DOE's program is the evaluation of the effects of stacked aquifers and cold water flow that has been postulated in these aquifers on surface geothermal manifestations. They will evaluate the extent of cold water overflow in each drill hole and will obtain several temperature profiles in each hole until an equilibrium profile is obtained. Another component will be to add chemical tracers to the drilling fluid. These tracers will allow the determination of the amount of drill fluid contamination of water samples collected for chemical analysis and the calculation of chemical geothermometers. Hydrothermal alteration in drill chip and core samples will be investigated to determine the maximum temperatures experienced by the rocks and these will be compared with the present temperature measured in the holes. Other data that may be required will be determined by DOE's advisory group.

David Blackwell of Southern Methodist University has been measuring and interpreting heat flow values in the Cascades region for many years and is the recognized expert on this topic. It is planned that he be funded to measure precise temperature gradient and thermal conductivity on the DOE holes and core samples for the purpose of heat flow determination and to interpret the results.

3.3 Data Integration and Interpretation

Integration, evaluation and interpretation of the new data obtained from drilling and research activities will be the responsibility of the state resource assessment teams in Washington, Oregon and California, UURI, USGS, and others as appropriate.

The new data collected will need to be integrated into the regional and site specific data bases collected by the USGS and the state resource teams. Then a consolidated interpretation will be needed in order to develop conceptual geologic models of Cascades-type hydrothermal resources. The scientists working on this project will meet in one or more internal workshops to insure that the best consolidated interpretation of the data is made.

3.4 Technology Transfer

It will be important to communicate results of the above work to industry, and a series of workshops and conferences will be conducted. Transactions of these meetings will be published to help document results, and the findings will be presented at professional meetings and reports will be submitted for publication in professional journals.

Also, topical reports generated by research tasks and case studies will be prepared to cover the work at each of the drill sites, and a final report will be written that includes a review of existing literature, a discussion of the siting criteria used for the thermal gradient holes, and the results of topical reports, open-file data, and other geoscientific work done.

4.0 IMPLEMENTATION PLAN

The following section describes the approach DOE has adopted to execute the technical program.

4.1 Management Organization

The Geothermal and Hydropower Technologies Division (DGHT) has overall management responsibility for the Cascades Research Program. The Idaho Operations Office of the U.S. Department of Energy (IDO) has been assigned by DGHT the program management support and coordination responsibilities. IDO will assign the technical performance of specific program tasks to DOE national laboratories, USGS, universities, states and others as appropriate who possess the proper expertise to properly perform the work required by the program. The relationship among the participating organizations is shown in Figure 3.

4.2 Responsibilities

1. Division of Geothermal Hydropower Technology (DGHT):
 - o Establish overall program policy, objectives, and direction
 - o Approve program plans and periodic updates
 - o Provide program guidance and financial resources to field offices
 - o Evaluate program effectiveness and redirect activities as needed

2. Idaho Operations Office (IDO)
 - o Provide program management, coordination, and implementation as delegated by DGHT
 - o Develop and coordinate planning for the program
 - o Provide direction and coordinate performance of program elements performed by national laboratories, and university- and industry-contracted participants

GEOTHERMAL & HYDROPOWER
TECHNOLOGIES DIVISION
WASHINGTON, DC

IDAHO OPERATIONS OFFICE
IDAHO FALLS, ID

SCAP
Participants

EG&G
Idaho, Inc.

UURI

LBL, USGS,
Others

• Drilling

• Environmental Support

• Planning Assistance

• Research

• Technical Assistance

• Technology Transfer

• Research

• Technology Transfer

Figure 3. Management organization.

- o Perform necessary procurement actions
- o Provide periodic reporting on program progress, expenditures, and plans to DGHT
- o Conduct periodic appraisals of program effectiveness and obtain DGHT approval for program changes that affect scope, cost, and schedule

3. University of Utah Research Institute (UURI)

- o Planning Assistance
- o Technical Assistance for Drilling
- o Data Collection and Dissemination
- o Lithologic Logging
- o Aquifer Characterization
- o Supplemental Data Collection
- o Case Studies
- o Exploration Strategies
- o Technology Transfer
- o Final Report

4. EG&G Idaho, Inc.

- o Environmental Evaluations

5. Southern Methodist University

- o Heat Flow Studies

6. Others

- o State Resource Assessment Teams
- o DOGAMI
- o LBL
- o UURI

4.3 Quality Program Plan

The SCAP for Cascades Thermal Gradient Drilling was reviewed by the DOE quality assurance staff, and it is recommended that the resulting contract include the quality requirements outlined in ANSI Standard Z1.8-1971, "Specification of General Requirements for a Quality Program". Particular sections of the SCAP to which the Quality Requirements apply were itemized and will be included in the finalized document.

5.0 COST AND SCHEDULE SUMMARY

The Program Plan Schedule is shown on Figure 4. In FY-1985, participants for the Cascades thermal gradient drilling will be chosen, procurement activities completed, and drilling activities will be completed. Monitoring methods and procedures which assure compliance with environmental concerns will be instituted, studies will be conducted, and UURI will do research which may be required in support of thermal gradient hole selection. Guidelines for the DOE research effort will be determined by an advisory committee comprised of USGS, state geologists, program researchers and industry participants.

In FY-1986, heat flow studies and other research will be performed on the thermal gradient holes with the ultimate goal being the characterization of the Cascades geothermal resource. Participants in the effort will be UURI, EG&G Idaho, Oregon Division of Geology and Mineral Industries, Southern Methodist University, Washington Department of Natural Resources, and California Division of Mines and Geology. Data analysis will be started and technology transfer activities begun as applicable.

In FY-1987, the research started in FY-1986 will be concluded. The data obtained will be integrated into topical reports and case studies will be prepared to cover the work at each of the drill sites. A final project report will include a review of existing literature, a discussion of the siting criteria used for the thermal gradient holes, and the results of topical reports, open-file data, and other geoscientific work done on each hole. Workshops will be conducted and transactions of these meetings will be published to help document the results of the research effort.

The estimated total program costs for the above work are as follows:
FY-1985--\$1,515,000; FY-1986--\$500,000; FY-1987--\$350,000.

CASCADES RESEARCH PROGRAM

PROGRAM PLAN SCHEDULE

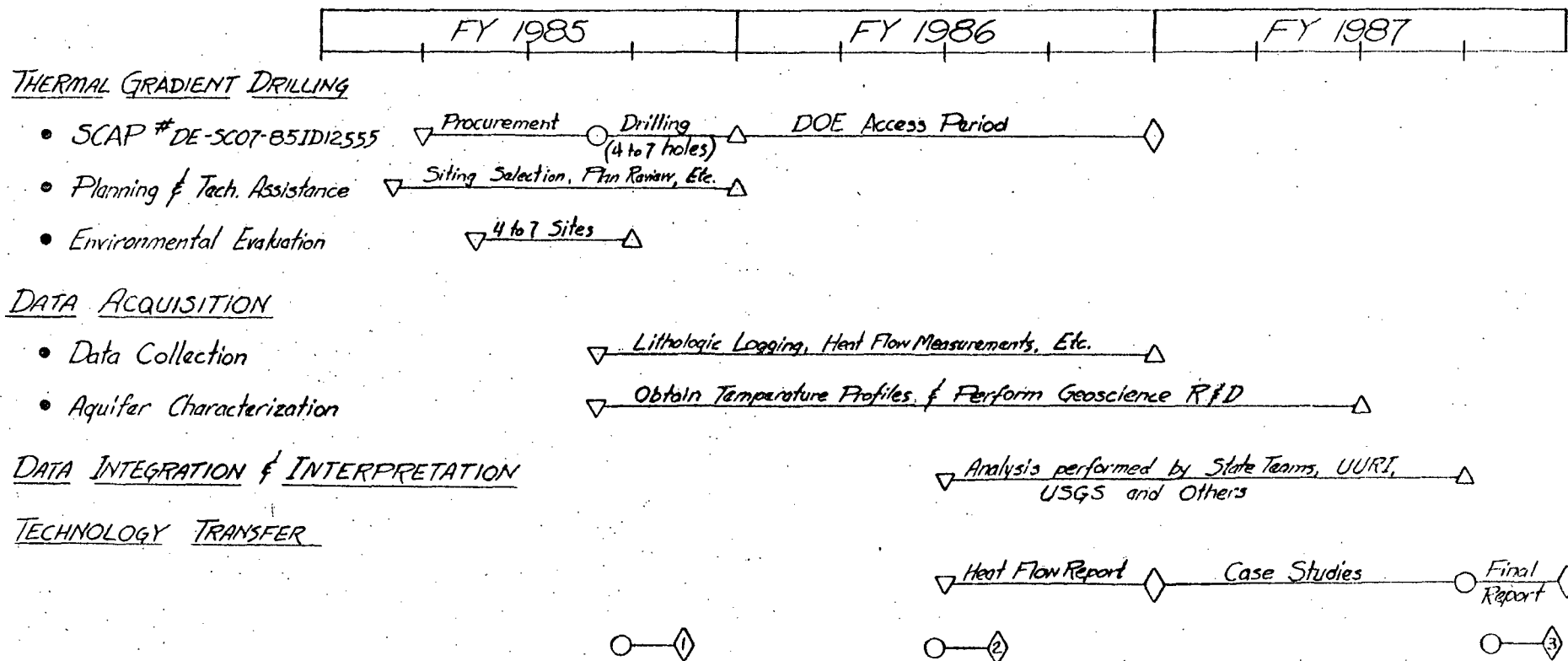


Figure 4. Program schedule.

6.0 REFERENCES

1. "Cascades Thermal Gradient Drilling", Solicitation for Cooperative Agreement Proposals (SCAP) Number DE-SC07-85ID12555.
2. Muffler, L.J.P., 1979, "Assessment of Geothermal Resources of the United States--1978", Geological Survey Circular 790.



**U.S. DEPARTMENT OF ENERGY
FIELD TASK PACKAGE PROPOSAL/AGREEMENT
TASK REQUIREMENTS FOR OPERATING/EQUIPMENT—COSTS AND OBLIGATIONS**

IDF-5700.C (Rev. 11/84)
Ref: DOE Order 5700.7

Contractor Name	Field Work Package Number	Field Task Package Number	Task Sequence Number	Revision Number	Date Prepared
DOE-Idaho	7AC1	7AC119	05		03 15 85
Field Task Package Title					
CASCADES RESEARCH PROGRAM					
20. Staffing (in full person years)	FY-1985	FY-1986 Budget			FY-1987
		President's	Revised	Authorized	
a. Scientific	0		0		0
b. Other Direct	0		0		0
c. Total Direct	0		0		0
21. Obligations and Costs (in thousands)					
a. Total Costs (BO)	\$ 1535	\$	\$ 500	\$	\$ 350
1. Total Direct Costs	\$ 1515	\$	\$ 475	\$	\$ 331
(a) Direct Salaries	10		13		9
(b) Materials & Supplies	5		6		4
(c) Subcontracts	0		0		0
(d) Travel	5		6		3
(e) Computer Services	0		0		0
(f) Low Value Capital Equipment	0		0		0
(g) Other <u>DOE-ID Contracts</u>	1495		450		315
2. Total Overhead Costs	\$ 20	\$	\$ 25	\$	\$ 19
(a) Direct Labor Burden	8		9		7
(b) G&A Expenses	5		7		5
(c) Common Support	7		9		7
b. Total Obligations (BA)	\$ 1535	\$	\$ 540	\$	\$ 350
c. Uncosted Obligations @ 9/30/1984 \$	0				
22. Equipment (in thousands)					
a. Equipment Costs (BO)	\$ 0	\$	\$ 0	\$	\$ 0
b. Equipment Obligations (BA)	\$ 0	\$	\$ 0	\$	\$ 0
c. Uncosted Obligations @ 9/30/1984 \$	0				
23. Other Costs and Obligations (not in 21.)					
a. Inventory Change Costs (BO)	\$ 0	\$	\$ 0	\$	\$ 0
b. Inventory Change Obligations (BA)	\$ 0	\$	\$ 0	\$	\$ 0
c. Uncosted Obligations @ 9/30/1984 \$	0				
d. Other Costs (BO)	\$ 0	\$	\$ 0	\$	\$ 0
e. Other Obligations (BA)	\$ 0	\$	\$ 0	\$	\$ 0



FIELD TASK PACKAGE PROPOSAL/AGREEMENT
TASK REQUIREMENTS FOR OPERATING/EQUIPMENT—COSTS AND OBLIGATIONS

IDF-5700.E (Rev. 11-84)
 Ref: DOE ORDER 5700.7

Contractor Name DOE-Idaho	Field Work Package Number 7AC1	Field Task Package Number 7AC119	Task Sequence Number 05	Revision Number	Date Prepared 03 15 85	
Field Task Package Title CASCADES RESEARCH PROGRAM						
24. Five Year Plan (in thousands) (Based on Constant 1987 Dollars)		FY-1987	FY-1988	FY-1989	FY-1990	FY-1991
a. Total Operating Costs (B0)		\$ 350	\$ 0	\$ 0	\$ 0	\$ 0
b. Total Operating Obligations (BA)		\$ 350	\$ 0	\$ 0	\$ 0	\$ 0
c. Total Operating Staffing (Person Years)		0	0	0	0	0
d. Total Equipment Costs (B0)		\$ 0	\$ 0	\$ 0	\$ 0	\$ 0
e. Total Equipment Obligations (BA)		\$ 0	\$ 0	\$ 0	\$ 0	\$ 0
f. Inventory Change Costs (B0)		\$ 0	\$ 0	\$ 0	\$ 0	\$ 0
g. Inventory Change Obligations (BA)		\$ 0	\$ 0	\$ 0	\$ 0	\$ 0
25. Milestone Schedule		Proposed Schedule		Authorized Schedule		
		Begin	End	Begin	End	
Procurement activities		1/85	6/85			
Drilling (4 to 7 holes)		6/85	10/85			
Advisory Committee Meeting		8/85	8/85			
DOE logging, testing, data collection		10/85	10/86			
Workshop No. 1		5/86	5/86			
Workshop No. 2		9/87	9/87			
Final Report		6/87	9/87			



U.S. DEPARTMENT OF ENERGY
FIELD TASK PACKAGE PROPOSAL/AGREEMENT
DETAIL ATTACHMENTS (CONTINUATION SHEET)

IDF-5700.F (Rev. 11-84)
 Ref. DOE ORDER 5700.7

Page 4 of 6

Contractor Name	Field Work Package Number	Field Task Package Number	Task Sequence Number	Revision Number	Date Prepared
DOE-Idaho	7AC1	7AC119	05		03 15 85

Field Task Package Title
CASCADES RESEARCH PROGRAM

19. Detail Attachments (continuation sheet): List in alphabetical order per squares filled in on Page 1.

b. PUBLICATIONS

1. "Cascades Thermal Gradient Drilling", solicitation for Cooperative Agreement Proposals (SCAP) Number DE-SC07-85ID12555.

c. PURPOSE

The purpose of the program is to conduct research on the geothermal resources of the Cascades Volcanic Region in California, Oregon and Washington. The objectives of the program are to (a) stimulate development of the region by making data publicly available which will characterize the geothermal resource and, (b) increase knowledge of both applicable exploration techniques and the depth required to penetrate the overlying cold ground-water system that masks and suppresses surface evidence of the underlying hydrothermal system.

d. BACKGROUND

The Cascades Volcanic Region has long been suspected to contain considerable geothermal potential, as evidenced by recent volcanism and other thermal expressions. However, there are few known surface manifestations of geothermal energy in spite of the obvious occurrence of heat sources. One possible explanation is that the downward percolation of the extensive regional cold ground-water system forms a so called "rain curtain" that suppresses surface evidence of underlying hydrothermal systems. This hypothesis will be tested by drilling below the rain curtain depth, and the data obtained will be used to define the geothermal potential of the Cascades Volcanic Region.

e. APPROACH

The program will consist of DOE cost shared surface exploration and drilling of deep thermal gradient holes and the extraction from these holes of fundamental subsurface information to identify and characterize the hydrothermal system of the Cascades region. It is also planned that the program will increase knowledge of both unique exploration techniques and the depth required to penetrate beneath the rain curtain. DOE will cost share up to 50% of the allowable cost of drilling and associated data collection, but the proposer must agree that the hole will be completed and maintained by the proposer such that DOE will have access to the hole for a specified period of time. During that period, DOE will perform, at its own expense, further data gathering and tests for equilibrated thermal gradients and resource parameters. Hole plugging and related abandonment costs may be considered as a cost shared project cost if incurred immediately after DOE's access period.



U.S. DEPARTMENT OF ENERGY
FIELD TASK PACKAGE PROPOSAL/AGREEMENT
DETAIL ATTACHMENTS (CONTINUATION SHEET)

IDF-5700.F (Rev. 11-84)
 Ref: DOE ORDER 5700.7

Page 5 of 6

Contractor Name	Field Work Package Number	Field Task Package Number	Task Sequence Number	Revision Number	Date Prepared
DOE-Idaho	7AC1	7AC119	05		03 15 85

Field Task Package Title
CASCADES RESEARCH PROGRAM

19. Detail Attachments (continuation sheet): List in alphabetical order per squares filled in on Page 1.

f. TECHNICAL PROGRESS/JUSTIFICATION

FY-1985

Participants for the Cascades thermal gradient drilling will be chosen, procurement activities completed, and drilling activities will be completed. Monitoring methods and procedures which assure compliance with environmental concerns will be instituted. R&D studies will be conducted, and UURI will do research which may be required in support of thermal gradient hole selection. Guidelines for the DOE research effort will be determined by an advisory committee comprised of USGS, state geologists, program researchers and industry participants.

FY-1986

Heat flow studies and other research will be performed on the thermal gradient holes with the ultimate goal being the characterization of the Cascades geothermal resource. Participants in the effort will be UURI, EG&G Idaho, Oregon Division of Geology and Mineral Industries, Southern Methodist University, Washington Department of Natural Resources, and California Division of Mines and Geology. Data analysis will be started and technology transfer activities begun as applicable.

FY-1987

The research started in FY-1986 will be concluded. The data obtained will be integrated into a case study of the entire program. This case study will include a review of existing literature, a discussion of the siting criteria used for the thermal gradient holes, and the results of topical reports, open-file data, and other geoscientific work done on each hole. Workshops will be conducted and transactions of these meetings will be published to help document the results of the research effort.

g. FUTURE ACCOMPLISHMENTS

The program will be concluded in FY-1987.

h. RELATIONSHIPS TO OTHER PROGRAMS

1. State-Coupled Resource Assessment Teams - Providing information on viable resource areas to the private sector on a state level.
2. Reservoir Definition Program - Program run by SAN to better understand geothermal reservoirs.



U.S. DEPARTMENT OF ENERGY
FIELD TASK PACKAGE PROPOSAL/AGREEMENT
DETAIL ATTACHMENTS (CONTINUATION SHEET)

IDF-5700.F (Rev. 11-84)
Ref: DOE ORDER 5700.7

Page 6 of 6

Contractor Name	Field Work Package Number	Field Task Package Number	Task Sequence Number	Revision Number	Date Prepared
DOE-Idaho	7AC1	7AC119	05		03.15.85

Field Task Package Title
CASCADES RESEARCH PROGRAM

19. Detail Attachments (continuation sheet): List in alphabetical order per squares filled in on Page 1.

i. ENVIRONMENTAL ASSESSMENT

Each participant is required to prepare and submit an Environmental Evaluation (EE) within 60 days of award. The EE is prepared in accordance with guidelines provided by DOE and must be approved by DOE prior to the conduct of ground disruptive activity such as site preparation or thermal gradient drilling. It is not anticipated that an Environmental Assessment (EA) will be required for this field task.