GL01819

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7 June 1985

Mr. Marshall Reed, Program Manager
U.S. Department of Energy
Geothermal and Hydropower
Technologies Division
5G030 Forrestal Bldg.
1000 Independence Ave., S.W.
Washington, D.C. 20585

Dear Marshall:

In reply to your request for practical research activities that can be done to support the DOE-Industry cost-shared program for thermal gradient drill holes in The Cascades, I submit the enclosed FTP/A entitled "Cascade Range Geophysics" for detailed EM soundings around each hole.

The proposed work could be done in one of two ways. First, we could spread the work over FY85 and FY86, beginning the work in August-September using part of any uncommitted money from the Cascade Drilling Program. Alternatively, we could do the work entirely in FY86. From a cost standpoint there are only slight differences, as reflected in the cost comparison summary in the FTP/A and in Table 1 attached. My preference would be to commence the work as soon as possible, completing the soundings before drills and equipment are brought on-site and before the weather turns horrible.

Reflected in the estimated project costs are the assumptions that detailed investigations will be made around four holes, that the field work will span two months but that three months of equipment rental will be needed as a precaution against unforeseen problems, such as bad weather.

Obviously there is some flexibility in this scope of work. For instance, the proposed method may not be equally suitable for all areas.

If you have any questions, comments or suggestions regarding the FTP/A and the concept please do not hesitate to call me.

Sincerely,

Norman

Norman E. Goldstein

NEG/dlj

Enclosure: FTP/A, Table 1
cc: Marty Molloy DOE/SAN
Clayton Nichols DOE/IDO
Susan Prestwich DOE/IDO

Table I

Proposal Cost Summary

Cascade Range Geophysics

A. Begin field work in FY85 and complete in FY86

	FY 85	FY 86
Labor (total LBL salaries and fringe benefits)	$15,449	$ 32,502
Graduate student, UC Berkeley	2,500	15,000
Equipment rental	10,500	21,000
Miscellaneous supplies and expenses (e.g., vehicle expenses)	2,500	2,500
Travel and field living expenses	5,000	10,000
Publications, reporting	0	3,000
Computer charges	1,500	5,000
Other burdens and indirect costs	26,703	62,525
Total	$64,152	$151,527

B. Begin and complete work entirely in FY86

Labor (total LBL salaries and fringe benefits)	$ 49,381
Graduate students, UC Berkeley	17,500
Equipment rental (3 months)	31,500
Miscellaneous supplies and expenses	5,000
Travel and field living expenses	15,000
Publications, reporting	3,000
Computer charges	6,500
Other burdens and indirect costs	71,617
Total	$217,775

U.S. DEPARTMENT OF ENERGY

FIELD TASK PROPOSAL/AGREEMENT

1. WORK PACKAGE NUMBER	2. TASK NO.	3. REV. NO.	4. PROJECT NO.	5. DATE PREPARED	6. CONTRACTOR NUMBER
				06-01-85	4666-XX

7. TASK TITLE	8. WORK PACKAGE TITLE
CASCADE RANGE GEOPHYSICS	CASCADE DRILLING PROGRAM

9. BUDGET AND REPORTING CODE	10. TASK TERM Begin:	End:	11. CONTRACTOR NAME	12. CODE (see instructions)
AM 10-15-10	08-01-85	OPEN	University of California Lawrence Berkeley Lab.	

13. CONTRACTOR TASK MANAGER (Name: Last, First, MI) (FTS No.)	14. PRINCIPAL INVESTIGATORS (Name: Last, First, MI)
McEvilly, Thomas V. 451-7347	Goldstein, N.E.

15. WORK LOCATION (See instructions): Name of facility, City, State, Zip Code	16. Is this task included in the Institutional Plan?	17. Does this task include any management services efforts?
Lawrence Berkeley Laboratory Berkeley, California 94720	☐ YES ■ NO	☐ YES ■ NO

18. TASK DESCRIPTION (Approach, relation to work package, in 200 words or less)

The DOE-Industry cost-shared program for thermal gradient holes in The Cascades will begin in FY 1985 and will result in a number of holes, probably core-drilled, to depths of about 3000 feet, or deep enough to obtain an accurate estimate of the thermal gradient. To supplement cores and well logs for assessing the volcanic stratigraphy, including permeable interflow units and fractured zones, we propose a program of surface electromagnetic soundings around each hole. The purposes of these investigations are:

1. to establish the major correlations between the resistivity sections from surface and borehole meaurements, and

2. to use this information to extrapolate subsurface conditions away from the holes and develop a 3-D model that can be used to develop a better hydrogeologic model for the areas drilled.

19. CONTRACTOR TASK MANAGER

(Signature) (Date)

20. DETAIL ATTACHMENTS (See instructions)

■ a. Facility requirements	■ d. Background	☐ g. Future accomplishments	☐ j. Explanation of milestones
☐ b. Publications	■ e. Approach	☐ h. Relationships to other projects	☐ k. ZBB Detail
■ c. Purpose	■ f. Technical progress	☐ i. Environmental assesment	☐ l. Other (Specify):

TASK REQUIREMENTS FOR OPERATING/EQUIPMENT OBLIGATIONS AND COSTS

CONTRACTOR NAME: University of California, Lawrence Berkeley Laboratory

WORK PACKAGE NUMBER	TASK NO.	REV. NO.	DATE PREPARED	CONTRACTOR NUMBER
			6-01-85	

21. STAFFING *(in staff years)*	PRIOR YEARS		BY-1 (1985) PRESIDENT'S	BY-1 (1985) REVISED	AUTHORIZED	BY-FY 1986
a. SCIENTIFIC				0.25		0.5
b. OTHER DIRECT						
c. TOTAL DIRECT				0.25		0.5
22. OBLIGATIONS AND COSTS *(in Thousands)*						
a. TOTAL OBLIGATIONS				65		152
b. TOTAL COSTS						
23. EQUIPMENT *(in Thousands)*						
a. EQUIPMENT OBLIGATIONS						
b. EQUIPMENT COSTS						
24. OTHER COSTS *(specify)*						
a.						
b.						
c.						
d.						

25. OPTIONAL FIVE-YEAR PLAN *(in Thousands)* Constant BY dollars	BY+1	BY+2	BY+3	BY+4	TOTAL TO COMPLETE
a. TOTAL OPERATING OBLIGATIONS					
b. TOTAL OPERATING COSTS					
c. TOTAL EQUIPMENT OBLIGATIONS					
d. TOTAL EQUIPMENT COSTS					

26. MILESTONE SCHEDULE	PROPOSED SCHEDULE	AUTHORIZED SCHEDULE
Begin field work	1 August 1985	
Complete field work	31 October 1985	
Complete interpretations and modeling	31 March 1986	
Report	30 June 1986	

CONTRACTOR NAME	CONTRACTOR CODE	CONTRACTOR NUMBER	
sity of California nce Berkeley Lab.		4666-XX	
RINCIPAL INVESTIGATOR	DATE PREPARED	TASK NUMBER	REVISION NUMBER
oldstein, N.E.	06-01-85		

20. DETAIL ATTACHMENTS:

a. Facility Requirements

No new facilities at LBL are required.

c. Purpose

The purpose of this task is to develop 2-D and 3-D hydrogeological models of the region around each deep thermal gradient hole by means of detailed EM soundings and modeling coupled to information from geophysical well logs, lithologic logs and well tests.

d. Background

Beginning in FY1985, DOE will initiate a cost-shared program with private geothermal companies to drill a number of temperature gradient holes in The Cascade Range. These holes will be drilled to depths of 3000 feet or more, deep enough to penetrate the cold-waters of the so-called "rain curtain". The holes will yield an accurate measure of the thermal gradient and other information bearing on volcanic stratigraphy and hydrogeology. In addition to cores, it is expected that a full set of temperature and other geophysical logs will be run in each hole, and that this information will provide a basis for making a preliminary assessment of the local hydrogeology. Because the hydrogeologic information from each well will be limited by hole diameter, DOE's access to the well, the availability of information from nearby wells, and cost factors, it is proposed here to conduct detailed electromagnetic (EM) soundings around each well as a means for developing a more complete three-dimensional picture of the subsurface conditions. The EM soundings are useful for determining the configuration and extent of major permeable zones, and for mapping near-vertical discontinuities that affect the hydrology, such as large-displacement normal faults and igneous intrusives. On the basis of our prior experience and model calculations, time-domain electromagnetic soundings (TDEM) using a detector in the center of the loop (central loop sounding) is a useful technique for several reasons:

1. no electrical contact to the earth is needed,

2. the sounding data are highly specific to conductors in the volume of rock directly below the transmitter loop, and

3. when used in the horizontal profiling mode, the technique is extremely sensitive to near-vertical discontinuities.

Used together with the geophysical well logs obtained in the DOE-Industry holes and neighboring holes, the surface EM results provide a means for developing an improved model for the local hydrogeology.

CONTRACTOR NAME	CONTRACTOR CODE	CONTRACTOR NUMBER	
University of California Lawrence Berkeley Lab.		4666-XX	
PRINCIPAL INVESTIGATOR	DATE PREPARED	TASK NUMBER	REVISION NUMBER
Goldstein, N.E.	06-01-85		

20. DETAIL ATTACHMENTS:

e. Approach

A series of electromagnetic soundings will be made as systematically as terrain and access permit around the subject holes. These soundings will be focused in a 2 km radius from each hole, but some sounding sites may be more distant depending on local conditions and the location of neighboring holes for which geophysical logs are available.

The soundings will be made using either a relatively portable, commercial time-domain electromagnetic system (TDEM), a controlled-source AMT system or the tensor audio-frequency magnetotelluric (AMT) system developed at LBL. Preliminary calculations will be run to determine which system is best for the areas. For this initial field work we might also use our large-moment EM-60 controlled-source system, which is designed for deep exploration. Approximately 10 days to two weeks of field work, including travel and set-up time, will be carried out in the area around each hole.

Sounding data will be returned to Berkeley where the raw data will be processed and interpreted. The data will be inverted to produce 1-D (layered-earth) resistivity sections, the accuracy of which will be improved by using the resistivity well logs to help constrain some of the layer parameters.

The 1-D sections will be recompiled as 2-D and 3-D diagrams, and from these we will attempt to make a preliminary hydrogeological interpretation. Input and review from geologists and others working on the project will be factored into the geophysical results. The geohysical data will be reinterpreted using either 2-D scale models or numerical (computer) modeling, as necessary, to verify the 1-D interpretations.

f. Technical Progress

As this would be a new project, there is no specific progress to report. In general, however, continual progress in EM sounding techniques, instrumentation and interpretation has been made at LBL over a period of at least 10 years. We now possess unique capabilities in EM and MT sounding and interpretation.