GL01924

Bruce Sibbett

UNIVERSITY OF UTAH RESEARCH INSTITUTE

UURI

EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

MEMORANDUM

TO: P. M. Wright

FROM: H. P. Ross

Tom Box - Head - Manager Freeport MacMorain

SUBJECT: Geyser Geothermal Co. Drill Core Stored at Mt. Shasta, California

DATE: September 15, 1986

The drill core is stored in five storage units, numbered 10; 129; 130; 131; 132, at the Mt. Shasta Mini Storage, 5815 Truck Village Drive, Mt. Shasta. The telephone number for the storage units manager is (916) 926-3779. The mini storage is about 0.5 miles from the Truck Village Drive exit of Interstate 5, about four miles north of Mt. Shasta City.

Mr. Joe Beall did not indicate which or how many storage units were intended for our inspection and core transfer, but the on-site manager of the storage facility indicated five units were rented to Geyser Geothermal, and I have inventoried all five. An inventory is attached. The core boxes are generally in good condition, mostly NC core, and organized by drill holes in rows of boxes generally 10-15 boxes high. The core is not stored on pallets and will require hand lifting.

A rough sketch of the storage layout is attached. It appears that even an 18 wheel trailer rig can back into units 129, 130, 131, 132. It may also be able to back into unit 10 but this will be very tight in turning around the Manager's office - living area.

The drill core represents about 22,600 ft. of drilling for 8 drill holes. The core begins at depths of 200 - 400 feet, varying for different holes, so the actual drill core footage is about 19,630 feet at 10 feet per box. Core recovery is generally good, about 80-100%, but may be as little as 30% for many boxes. Thus a total weight estimate is anybody's guess but should be based mainly on full core boxes.

The NC boxes measure 15-1/5 x 25 x 3 inches; a stack of 60 boxes in piles 10 high measures about 7'9" long x 30" high x 26" deep.

The NX boxes measure 12-1/2 x 25-1/2 x 2-1/2; a pile of 14 boxes measures 33" high x 25 1/2-deep x 12-1/2" wide.

A list of local (Happy Camp and Fort Jones) and Redding Motor Freight firms is attached. I have retained the two storage unit keys since Joe Beall told Mrs. Wheeler, whom he left them with, that he did not expect to return until ski season.

See me for any additional details.

HPR

Howard P. Ross

HPR:leo

Encl.

DRILL CORE INVENTORY

Hole #	Boxes	Td	Storage Unit
Shasta #52-4	220 @ NC	2548 ft.	10
M. Lake #36-28	194 @ NC	2146 ft.	10
B. L. #27-27	255 @ NC	3000 ft.	129, 130
B. L. #18-34	244 @ NC	3500 ft.	130
B. L. $18-34	61 @ NX		130
Burnt Lava #86-23	314 @ NC	3503 ft.	131
alt. $ py. Burnt Lava #62-21	139 @ NC	~2000 ft.	131
Med. Lake #68-16	256 @ NC	2939 ft.	132
Med. Lake #57-13 (Modoc)	280 @ NC	2964 ft.	132
8 holes	1902 @ NC 61 @ NX	~22,600 ft.	5 units
			16
2 holes A	~140 NC		
B	~140 NC		
	~2182 @ NC 61 @ NX		6 units

Joe Beall (707) 578-2725

Box (707) 57[illegible]

To: P.M. Wright, W.L. Forsberg Date: 9/16/86
From: H. P. Ross

Subject: Geyser Geothermal Co. Drill Core
Revised Inventory

A telephone conversation with Joe Beall indicates that G.G.C. had six storage units at Mt. Shasta Mini Storage instead of the five units identified to me by the on site manager. The missing unit is a small one, number 16, and by Joe's (fuzzy) recollection held about 2/3 the amount of core of unit 10. This would be about 280 additional core boxes (probably NC) from 1 deep hole (3000-3500 ft.) or two shallow-intermediate (2000 ft.) holes. The additional core weight is estimated at about 11,675 lbs.

Our revised and estimated total freight shipment are:

Boxes ~ 2182 boxes NC
61 boxes NX
2243 boxes NC+NX

Weight: 92,000 lb. (max) to 80,000 lb. (min)

H. Ross

July 19, 1985

MEMORANDUM

TO: Sue Prestwich

FROM: Mike Wright

SUBJECT: Cascades Drilling -- UURI Monitoring Role

As I see our role, these are the basic tasks, which are expanded and discussed below:

1. Daily contact with DOE contractor;
2. Daily contact with DOE/ID;
3. Site visits;
4. Quality assurance;
5. Data archiving and open-filing, and
6. Documentation.

1. Daily contact with DOE contractor. UURI will maintain at least daily phone contact with the DOE contractor and or the driller during drilling, logging and completion, including weekends. More frequent contact will be made as necessary. The contractor should name the point of contact and at least 1 alternative who will be cognizant at all times. For UURI it will be Bruce Sibbett with Dennis Nielson as an alternate. UURI will keep drill records, progress reports, reports of problems, casing reports, etc. up to date. UURI will also keep a running estimate of expenditures to date. Copies of all written documents pertaining to these subjects should be forwarded to UURI by the contractor on a periodic basis, probably weekly.

2. Daily contact with DOE/ID. UURI will make daily reports on project status to ID. At ID's option, these will be telecopied or telephoned. We suggest telecopy except in times of drilling trouble, when telephone reports may be necessary to supplement. These reports will include status, daily drilling progress, assessment of problems if any, plans, anticipated problems, noteable events such as lost circulation, stuck pads, etc. and mitigation measures. The Friday reports will anticipate occurrences expected during the weekend.

3. <u>Site Visits</u>. If and when it becomes apparent that a moderate or serious problem has developed with the project, UURI will be prepared to visit the site at any time to lend advice, give first-hand status reports to ID, and act as ID's representative in communications with the project to the extent legally allowed.

4. <u>Quality Assurance</u>. UURI will perform an independent assessment of sample and data collection techniques and of the quality of data collected. This quality assurance program will include collection of rock samples, collection of fluid samples, geophysical well logging, lithologic logging of samples, mud logs and reports kept on the rig by the driller or DOE contractor, and all other items. We will report to DOE on these matters and endeavor to work with the site personnel to maximize quality of all data, samples and procedures.

5. <u>Data Archiving and Open-Filing</u>. UURI will collect and archive copies of all data as well as DOE's share of all samples collected in this program. We will make samples available for inspection and use by others and we will open-file copies of all public data according to standard UURI procedures, worked out during the Industry Coupled Program.

6. <u>Documentation</u>. UURI will write, release and publish written reports on each project to document the project and all data collected. The nature and extent of these reports will depend on the reports that the DOE contractors themselves publish, and will be agreed with ID.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Intra Office Memo

To: Mike Wright Aug. 29

From: Bruce Sibbett

Subject: Cascade Drilling Program.

Item 1. The DOE environmental concern is only that they need 5 copies of the BLM EAR and Ponsy (?) for the drilling.

Item 2. News letter: Sue P. is concerned that some of the Data from GEO holes is proprietary until Chan pub. or releases it So we need to get Chan's ok signature on our News letter before it goes out. Also Sue talked about including other Cascades news of company &/or University activity outside of the DOE drilling Program in the news letter.

I made no real comment on this idea, but ~~ask you if~~ do we want this news letter to be DOE Cascades Program or Cascades Geothermal Activity in general?

Bruce Sibbett

Bruce

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July 29, 1985

MEMORANDUM

TO: ESL Scientific Staff

FROM: Mike Wright

SUBJECT: Cascades Drilling Program

Attached to this memo are copies of paper generated over the past few weeks on behalf of DOE/ID to get our portion of Cascades program underway. The information will give you a good idea of our involvement in the program.

We basically have two areas of involvement: (1) monitoring of each of the drilling projects for DOE, and (2) research. As you know, $100K was cut from our Cascades budget this year, and this money must come from the research effort since ID will need us to monitor the drilling in any event.

In order to optimize results from the remaining research money it is imperative that we work as a team. I would therefore like to suggest the following program management:

	Responsibilities	Territory
Wright:	Program coordination, geophysical research	Regional and site geophysical data, geophysical well logs, physical property data
Nielson:	Geologic research, alternate for Sibbett on monitoring	Regional geologic studies, permeability development
Moore:	Geochemical research	Geochemical study of surface and subsurface fluids, drill samples, etc., including isotopes, fluid inclusions, alteration
Sibbett:	Monitoring	Lithologic and petrographic study of drill samples, geology and structure of drill site areas

These individuals will be responsible for each of the designated areas and for the management of work by others in their areas. They will meet periodically to discuss progress, problems and plans.

PMW/jp

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July 19, 1985

MEMORANDUM

TO: Sue Prestwich

FROM: Mike Wright

SUBJECT: Cascades Drilling -- UURI Monitoring Role

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CONFIDENTAL

MEMORANDUM

May 29, 1985

TO: Susan Prestwich

FROM: Mike Wright

SUBJECT: Recommendations on Cascades Scientific Drilling

As a result of the meeting which I convened in Menlo Park at your request and of further thinking on the specific Cascades proposals in light of what I have learned of the gaps in knowledge of Cascades geothermal systems, I would like to make some points and recommendations that may be of use to you.

1. In my opinion, a serious omission of the current proposals for Cascades drilling is lack of adequate plans for obtaining fluid samples. Especially at the Thermal Power and Blue Lake proposed locations for drilling, there are unanswered questions about movement of fluids at depth. None of the research programs to date (USGS, DOGAMI, SMU) have answered the questions about possible westward flow of thermal waters from the volcanically active High Cascades. If the known thermal springs along the boundary between the High Cascades and Western Cascades are an indication of this outflow, the net permeability along the flow path is high, which has great exploration significance. We need subsurface fluid samples (as well as very deep drilling) to get at this problem.

2. Adequate temperature-gradient and heat-flow values can be obtained by periodically reading bottom-hole temperature during drilling with a

maximum-reading thermometer. Precise temperature logs in cased holes taken at intervals after drilling would be nice, but could be done without if the sacrifice meant being able to obtain fluid samples.

3. I recommend that if possible the contacts be so negotiated that either; (a) The holes are left uncased until a fluid sample can be obtained, even at the risk of losing part of the hole before a precision temperature log can be made. If the hole is lost we could rely on BHT's during drilling; or (b) the black iron pipe is not cemented in. It would then be possible to remove it with an appropriate rig and to try to produce the well by air lift, and/or to obtain downhole fluid samples. The casing could be left in the hole long enough to obtain an equilibrium temperature profile.

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May 29, 1985

MEMORANDUM

TO: Susan Prestwich

FROM: Mike Wright

SUBJECT: Meeting on Scientific Objectives of Drilling in the Cascades Range

On 23 May 1985 I convened a short meeting at your request of a select group of scientists who were attending the USGS Cascades workshops in Menlo Park for the purpose of discussing potential scientific objectives of drilling in the Cascades Range. The information gained at that meeting may be useful to you in evaluating the proposals written in response to the latest SCAP on the same topic. Several people in attendance at the meeting were also on the Technical Advisory Panel for the SCAP. We deliberately stayed away from discussion of any material related to the response to the SCAP, and instead treated the topic in a generic sense, i.e. what specific types of information do the scientific community want and what are the priorities.

In attendance at the meeting were: Marshall Reed, Clay Nichols, Marty Molloy, Norm Goldstein, Marcelo Lippman, Patrick Muffler, Bob Mariner, Mike Sorey, George Priest, Dave Blackwell and Mike Wright.

A summary of conclusions from the meeting is given below:

1. Three types of information are nearly equally important to obtain from the drilling:

   (a) core or cuttings samples, carefully acquired, for lithologic information;
   (b) a temperature log; and
   (c) fluid samples from the various aquifers.

   These items are in their order of priority, but they are all very important.

2. Blackwell noted that it will be important to get bottom-hole temperatures at each stopping point in the drilling by lowering a maximum-reading thermometer in the hole. This will help in planning completion and temperature logging.

3. It was agreed that fluid samples from drill holes are important for research into the fluid flow regime in the Cascades. Speaking as a member of the TAC, I believe that a serious deficiency exists in lack of plans in the current proposals to obtain water samples. There are essentially three ways in which water samples could be collected:

   (a) By producing and sampling water at the well-head. This will require either a down-hole pump or an air lift. Provision must be made at the surface to handle and dispose of a sufficient volume of water to thoroughly clean the hole of drilling fluids before sampling;

   (b) By use of a down-hole sampler. Slim-hole samplers are available. If used in conjunction with (a) above, it may be possible to separate the effects of various aquifers. Otherwise the sampler would have to be used weeks to months after drilling in the hope that fluid flow in aquifers had flushed drilling fluids away. This is clearly not compatible with putting permanent casing in the holes.

   (c) By doing one or more drill stem tests during drilling. The test would have to be conducted for a large enough period to acquire uncontaminated samples, which would require fluid handling facilities on the surface. The availability of slim-hole DST equipment was questioned.

4. For the purpose of obtaining good heat-flow measurements, it will be better to cement casing into the well. However, this precludes other useful work, such as removing the casing at some time to acquire fluid samples after casing is set.

5. Another important parameter, but of lesser importance than those listed in (1) above, is obtaining a measure of permeability at depth. This could conceivably be done with an injection test, but injecting cool water into a hot zone will perturb the data interpretation.

6. Geophysical well logs are important to obtain in the well and can be used to help characterize porosity, permeability and perhaps changes in native fluid characteristics.

7. There was some discussion on the advisability of setting up a steering committee to help advise DOE on matters such as potential completion techniques, etc. as the drilling progresses.

DRILL SAMPLE COLLECTION AND CURATION POLICY FOR THE CASCADES DEEP THERMAL GRADIENT DRILLING PROGRAM

Introduction

Core and cuttings recovered during exploration drilling are an important resource for research and evaluation of the geothermal potential. When the cost of drilling is considered, it is evident that the core and cuttings are an expensive and valuable product of the exploration effort. Lithologic samples are the first products recovered from a drill hole and the possibility that the hole may be lost before wireline logs are run or fluid samples are collected further indicates the value of the core and cuttings recovered.

The Cascades Deep Thermal Gradient Drilling Program is a combined effort of industry and public agenices in a potential resource area where subsurface data, particularly in the public domain, are very limited. The data gained through this program will be of value to industry, public agenices and private researchers. It is therefore the purpose of this drill sample collection and curation policy to provide procedures for sample handling that will ensure preservation and equitable distribution of sample for the maximum benefit of the program. Sample handling procedures must be uniform enough to protect sample integrity and reasonable enough for well site personnel to follow without undue extra work.

Well-Site Core Handling

The core will be transferred from the core barrel either to the core trough or directly into core boxes if a core trough is not available. Care will be taken during handling to ensure that all pieces of core remain in their original orientation and sequence. Directly after removal of core from the core barrel, all core pieces with length equal to or greater than core diameter will be marked with an arrow pointing downhole using a grease pencil or permanent felt tip marker (Fig. 1). If the core needs to be washed this will be done while it is in the core trough. When the core is placed in the core box, a wooden block labeled with the bottom depth of the core run will be placed at the end of the core from that run. If a core run did not directly follow the previous core run because of rotary drilling or other non-coring operations, a wooden block labeled with the beginning depth of the core run will be placed at the top of the run such that beginning and ending depth of each run will be indicated. All core will be placed in core boxes following a uniform system: with the box orientation label on the left, the box will be filled from upper left to lower right (Fig. 1). The label on each core box will be completely filled out using care to ensure that lettering is easily legible, as large as practical and done with an appropriate permanent marker. The drilling crew will be responsible for marking orientation arrows on the core, placing the depth labeled blocks at the top and bottom of each core run, and labeling core boxes unless the well-site geologist does these duties personally.

Drill Cuttings Sampling

Drill cuttings samples will be collected from any intervals which are rotary drilled or drilled with a core plug bit. Cuttings will be collected at 10-foot intervals from the shaker table or if a shaker table is not being used, caught from the blooie line with a bucket and/or screen device. Samples will not be taken from a drain ditch or catchment where contamination from surface materials or earlier cuttings may occur. DOE will require 1 kilogram of sample for each 10-foot interval. Drilling mud will be rinsed from the cuttings if needed and the samples placed in bags labeled with hole name and drilling depth. Proper and timely collection of drill cuttings samples is the responsibility of the drilling crew. Bagging and labeling of the sample bags are also the responsibilities of the drilling crew unless the drill site geologist assumes this task while logging the samples.

Logging of Core and Cuttings

Whenever a geologist is present, the samples (core or cuttings) will be logged on site or at a nearby convenient operations base prior to sample splitting or transfer to curation facilities. Responsibility for the initial sample logging will be coordinated between the operating company and Department of Energy, Idaho Office (DOE) or their representative. On-site sample logging is important for several reasons: 1) the log will provide a data base upon which drilling and well-test decisions can be made; 2) the on-site log will be made before any sample split or sampling by collaborating investigators; 3) the on-site log will be made prior to possible sample degradation due to sample drying, disaggregation due to drying and pressure release, oxidation, vibration during transport, possible loss or damage during transport and storage; 4) the on-site log will provide a data base for interpreting wireline logs and for subsequent detailed studies of the rocks drilled; and, 5) on-site logging provides the best opportunity for the geologist to interface with the drilling crew to note any drilling operations or conditions which may affect the quality of sample recovery and reasons for sample loss.

Core and cuttings should be logged on a standard form (see Appendix for our example), previously approved by the operating company and DOE, which provides both uniformity of format and flexibility to facilitate different lithologies drilled. All involved companies, government agencies and collaborating investigators, who request a copy of the field log, will receive a copy in a timely manner consistent with DOE's policies on release of data.

The lithologic log will include project name, well name or number, location, well-head elevation, geologist and date logged. For each core run, the box number, depth in feet and tenths of core recovered, and recovery will be recorded (Fig. 2). Next the lithology will be described followed by fractures, joints, faults and alteration if present. Lithologic descriptions are best given by rock unit which may be thicker or thinner than coring runs. The depth of upper and lower contacts (unit interval) will be stated, followed by a one- to two-word lithologic name, then a description of the unit in appropriate detail. Additional comments may be added for each core run after the unit description for thick but variable units. Lithologic descriptions will be observations rather than interpretations. Core size or bit type, drilling fluid and lost circulation material will be noted as it affects the sample's condition. Cuttings samples for intervals not cored will be logged in the same manner with cuttings and bit type noted. Also depth of all significant drilling operations or events such as setting casing, loss of fluids or bit change will be noted on the core log at the drilling depth that these occur.

Although field lithologic classifications are hand-sample names which may be found to be incorrect by later petrographic or chemical study, they will provide the basis for sample selection and contact depth picks for later, more detailed studies.

Sample Split and Sample Cutting

No sample splits or selected sampling of the core and/or cuttings will be done by any party prior to completion of lithologic logging. After logging, the core will be split and/or selected samples taken by the involved entities and collaborating investigators as agreed upon by the operating company and DOE or their agent(s) for the particular well. Appropriate and timely sample splits and sample selection will be the responsibility of the operating company's site personnel and the project manager or agent for DOE or their delegated representatives. Any samples cut on the drill site after logging will be noted on the field lithologic log and a block of wood or note with the sample interval and entity taking the sample will be placed in the core box in place of the sample taken. After the sample split between the operating company, DOE or their agent and any other involved agencies (i.e. state geologic survey), the curation and sample availability of the DOE split will be the responsibility of DOE or their agent.

Water and Gas Samples

Water and/or gas samples may be collected during drilling or at the completion of a well as agreed upon by the operating company and DOE. Such factors as hole condition and cost may require on site geologist to make final decisions concerning water and gas sample collection. Sample collection, on-site analysis and treatment of samples for proper preservation will be the responsibility of the authorized DOE representative or collaborating investigator. Instructions for fluid sampling are the topic of a separate memorandum.

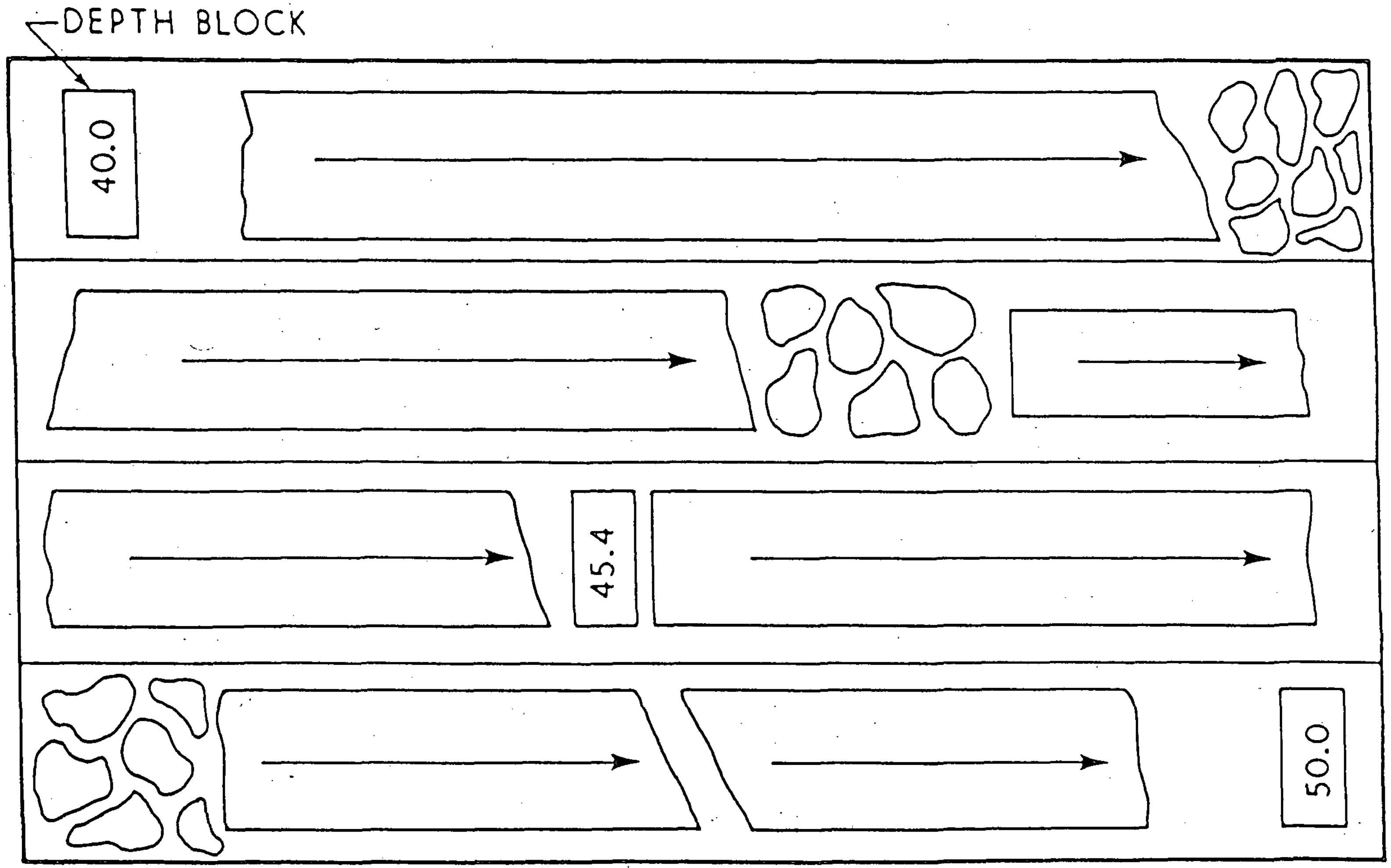

Figure 1. Core box is filled from upper left corner with depth blocks at the end of each run and arrows pointing downhole on core pieces.

CORE LOG

PROJECT ____________________ WELL NUMBER ____________________ LOCATION ____________________

WELL HEAD ELEV. ____________ LOGGED BY ____________________ DATE ____________ PAGE ________

BOX #	Depth	Recovery	Graphic Symbol	LITHOLOGIC DESCRIPTION	Fractures & Alteration	Drilling Information

Figure 2

AMPAD 22-141 50 SHEETS 22-142 100 SHEETS 22-144 200 SHEETS

Hole Locations

GEO - Newberry Volcano - (GRI)

North - NW¼ NW¼ Sec. 24, T. 20S, R 12E
or 4100' north and 500' East of the SW corner Sec. 24.

South SE¼ NW¼ Sec. 25, T22 S, R12E
or 3,500' N, 2450 W? of SE corner sec 25.

Thermal Power Co. Breitenbush River Area

NW¼ SE¼ Sec. 28, T8S, R8E.

Sibbett

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MEMORANDUM

May 29, 1985

TO: Mike Adams, Duncan Foley, Joe Moore, Dennis Nielson, Howard Ross, Bruce Sibbett, Phil Wannamaker

FROM: Mike Wright

SUBJECT: Cascades Research Meeting

Let's get together on Thursday, May 30 at 1300 hours for a second Cascades meeting. The objectives and products of this meeting will be:

1. A review of what was learned by those attending the USGS Cascades workshop

2. Identification of gaps in the current understanding of Cascades geothermal systems

3. A discussion of the Cascades CSDP proposal that is being coordinated by George Priest

4. Formulation of a well-thought out program of Cascades research at UURI

5. Agreements about who shall do what in our work in the Cascades, and

6. A statement of work that I can submit to DOE-ID for their blessing regarding our plans

The following budgets are illustrative of what we can afford to do from now until 1 January 86 on the estimated $200,000 remaining in our budget. Foley is not included herein because I assume any Cascades work he does would be chargeable to State Coupled under technical assistance to Oregon. Wannamaker is not included because it is doubtful that we will get any MT data, but if his help is needed, time could be traded with someone. These budgets are illustrative only, they may be modified as our plans solidify, and they are an appropriate topic for discussion at the meeting.

ILLUSTRATIVE CASCADES BUDGETS

Technical Assistance

	Days	
Sibbett	100	
Nielson	10	
Moore	60	
Adams	40	
Ross	15	
Wright	20	
Sec/Drafting	30	
Technician	20	
Travel		$ 10,000
Geochem/X-ray		3,000
Miscellaneous		2,000
	Total	$120,000

Geophysical Studies

	Days	
Ross	20	
Wright	15	
Technician	20	
Sec/Drafting	15	
Travel		$ 3,000
Computer		2,000
Miscellaneous		7,000
	Total	$41,000

Geological Studies

	Days	
Nielson	45	
Sibbett	10	
Technician	10	
Sec/Drafting	15	
Travel		$ 4,000
Geochem/X-ray		3,000
Miscellaneous		2,000
	Total	$41,000

Grand Total $202,000

PMW/jp

cc: S. H. Ward
W. L. Forsberg

CASCADES PROJECT

1. Money available from 1 May 85 to 1 Jan 86
   $225,000. est.

2. Tasks
   A. Technical Assistance
   B. Geophysical Studies
   C. Magma Chamber Studies

3. Technical Assistance
   (a) Special requests from ID (Fire drills)
   (b) Management / technical support for ID
   (c) Liaison between DOE and Contractors during drilling
   supervise → (d) Sample collection (and dissemination?) skeleton sample for Oregon - Priest
   (e) Case Studies of each drilling area - We will be responsible
   (f) FY86 proposals

Time frame is months down the road.

4. Geophysical Studies
   (a) Technique Modeling
   (b) Interpretation of Available Data
   (c) Technique Testing

5. Magma Chamber Studies
   (a) Sample collection / Data acquisition
   (b) Interpretation in terms of intrusive styles

Cascades Drilling.

Poss. 3 holes this year.
Good chance of more $ next year, 2-300,K

Gaps in USGS Program

- structures
  Permeable pathways

- George Priest Deep hole Proposal
  1. sited on bases of few shallow holes.
  2. funding from several sources.
  3. Penrose Conf. or such meeting about it. Goldstein will put Jur. together.

Our help- 1. mineralizatión in Cascades
2. Attend meeting with publicatión.

ESL Program
1. should be intergrated program.
2. New data should be collected.

- Fracture diffinitión Work shop by Goldstein July 11, LBL

Ed Talyor has mapped Santiam Pass. - Unpublished.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Bruce

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

April 4, 1985

Memorandum

To: Distribution

M. Guffanti P. Muffler /MG

From: Marianne Guffanti and Patrick Muffler

Subject: Preliminary agenda for the Workshop on Geothermal Resources of the Cascade Range

Attached is the agenda for the May 22-23 workshop on geothermal resources of the Cascade Range, to be held in the Building 3 conference room, Menlo Park. It is labeled "preliminary" because some changes will undoubtedly be made by the time of the workshop. The workshop is organized as four related sessions, and we urge you to attend the entire the two days. If you are not giving a talk but plan to briefly communicate research results or points of view during the discussion periods, please contact the moderator of the appropriate session so that he can organize the time better. Abstracts of the talks will be available at the time of the workshop and will be open-filed afterwards to provide a public proceedings.

This workshop will congregate a diverse group of people interested in the geothermal regime of the Cascades. We look forward to seeing you there.

Distribution

David Adam, USGS
David Anderson, Geothermal Resources Council
Charles Bacon, USGS
Forest Bacon, California Division of Mines & Geology
Keith Bargar, USGS
Richard Benoit, Phillips Petroleum Co.
Patricia Berge, USGS
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John Geyer, Bonneville Power Administration
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Marianne Guffanti, USGS
Paul Hammond, Portland State University
Jack Hermance, Brown University
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David Hill, USGS
Steven Ingebritsen, USGS
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Cathy Janik, USGS
Terry Keith, USGS
Donald Klick, USGS
Arthur Lachenbruch, USGS
Joe LaFleur, California Energy Co.
Norman MacLeod, USGS
Robert Mariner, USGS
Alexander McBirney, University of Oregon

James McNitt, GeothermEx
Tsvi Meidav, Trans-Pacific Geothermal
Caryl Michaelson, USGS
Roy Mink, Morrison-Knudson Co.
Martin Molloy, DOE-San Francisco
Walter Mooney, USGS
Patrick Muffler, USGS
Walter Myers, Bonneville Power Administration
Manuel Nathenson, USGS
Clay Nichols, Department of Energy
Frank Olmsted, USGS
Harry Olson, Steam Reserve Corp.
William Orr, University of Oregon
H. Dean Pilkington, Steam Reserve Corp.
George Priest, Oregon Department of Geology & Mineral Industries
Marshall Reed, Department of Energy
Edward Sammel, USGS
John Sass, USGS
Eric Schuster, Washington State Geology & Earth Resources Div.
Douglas Seely, Bonneville Power Administration
Herbert Shaw, USGS
Jeff Sirmon, U.S. Forest Service
James Smith, USGS
Michael Sorey, USGS
Jack Souther, Geological Survey of Canada
Dal Stanley, USGS
Don Swanson, USGS
Edward Taylor, Oregon State University
William Teplow, Trans-Pacific Geothermal, Inc.
Michael Thompson, USGS
Alfred Truesdell, USGS
Joseph Vance, University of Washington
Al Waibel, Columbia Geoscience
George Walker, USGS
Stephen Walter, USGS
Craig Weaver, USGS
Donald White, USGS
David Williams, USGS
Ken Williamson, Union Oil Company
Mike Wright, University of Utah Research Institute
Walter Youngquist, Eugene Water and Electric Co.
Adel Zohdy, USGS

WORKSHOP ON GEOTHERMAL RESOURCES OF THE CASCADE RANGE
PRELIMINARY AGENDA — 4 April 1985

May 22

8:00-8:45	Patrick Muffler & Marianne Guffanti -- Geothermal resource assessment

SESSION I **What is the regional geologic and tectonic setting in which geothermal systems of the Cascades occur?**

Objectives: To describe the Cascades as a regional feature and to provide the context in which to discuss specific magmatic/geothermal systems.

Moderator: Robert Christiansen

8:45- 9:05	Craig Weaver -- Juan de Fuca subduction
9:05- 9:35	Related short, informal communications and discussion
9:35- 9:55	Don Swanson -- Cascades volcanism
9:55-10:25	Related short, informal communications and discussion
10:25-10:45	Break
10:45-11:05	David Blackwell -- Oregon heat flow
11:05-11:35	Related short, informal communications and discussion
11:35-12:00	Open discussion period
12:00- 1:30	Lunch

SESSION II **What are the characteristics of magmatic systems as heat sources in the Cascades?**

Objectives: To summarize what is known about the volume, depth, age, composition, evolution, and eruptive history of Cascades magmatic systems and and relate these characteristics to their geothermal potential.

Moderator: Norman MacLeod

1:30- 3:00 Characteristics of Cascades magmatic systems determined from geologic studies (8 ten-minute talks)

- Robert Christiansen: Mt. Shasta
- Michael Clynne: Lassen volcanic center
- Julie Donnelly-Nolan: Medicine Lake
- Charles Bacon (or alternate): Crater Lake
- Norm MacLeod: Newberry volcano
- Ed Taylor: 3 Sisters to Jefferson area
- Wes Hildreth: Mt. Adams
- Jack Souther: Meager Mountain

3:00- 3:30 Discussion and summary of geology

3:30- 4:00	Break
4:00- 4:20	H. M. Iyer -- Characteristics of Cascades magmatic systems determined from seismic studies
4:20- 4:45	Related short, informal communications and discussion
4:45- 5:05	Carol Finn -- Evidence of magmatic systems from gravity studies
5:05- 5:30	Related short, informal communications and discussion
5:30	Adjourn

May 23

SESSION III What is the hydrothermal expression of magmatism in the Cascades?

Objectives: To discuss the nature of hydrothermal systems in the Cascades (i.e., their distribution, geometry, temperature, evolution, hydrodynamics) and their interaction with underlying magmatic systems, in order to provide a basis for assessing hydrothermal resources of the region.

Moderator: Alfred Truesdell

8:00- 8:20	Robert Mariner -- Geochemical features of Cascades hydrothermal systems
8:20- 8:50	Related, short informal communications and discussion
8:50- 9:10	Michael Sorey -- Constraints on models of hydrothermal systems in Oregon
9:10- 9:40	Related short, informal communications and discussion
9:40-10:10	Break
10:10-10:30	Norm Goldstein -- Mt. Hood investigations
10:30-11:00	Related short, informal communications and discussion
11:00-11:20	Adel Zohdy -- Reservoir characterization from geoelectric experiments
11:20-11:50	Related short, informal communications and discussion
11:50 1:30	Lunch

(continued)

SESSION IV What conceptual models of geothermal resources should guide drilling programs in the Cascades?

Objectives: To outline, in general terms, geologic and hydrologic models of Cascades geothermal systems, as a basis for making recommendations about strategy for geothermal drilling in the Cascades.

Moderator: Clay Nichols

1:30- 2:30	Panel on conceptual models of Cascades geothermal resources Patrick Muffler Robert Christiansen Norman MacLeod Alfred Truesdell Donald White Michael Sorey Craig Weaver Martin Molloy
2:30- 3:00	Break
3:00- 3:20	Marshall Reed -- DOE drilling targets
3:20- 3:40	George Priest -- Program for Scientific Drilling in the Cascades
3:40- 4:45	Discussion on drilling
4:45- 5:00	Patrick Muffler -- Closing remarks
5:00	Adjourn

Bruce

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

February 22, 1985

Memorandum

To: Friends of the Cascades

P. Muffler/MA M. Guffanti

From: Patrick Muffler and Marianne Guffanti

Subject: Workshop on Geothermal Resources of the Cascade Range

The Survey's Geothermal Research Program, with some support from the Department of Energy, has funded a multidisciplinary effort in the Cascade Range since the late 1970's with the goal of understanding the tectonics, geology, and hydrology of the Cascades as a framework for characterizing and quantifying geothermal resources. We are sufficiently far along in this program of research to begin focusing more explicitly on synthesis of information for a regional resource assessment. Accordingly, this spring the USGS Geothermal Research Program is sponsoring a workshop on geothermal resources of the Cascade Range. This workshop also is intended to meet the needs of other organizations, such as yours, that are involved in geothermal activities in the Cascades.

The workshop will be held on May 22-23 at the USGS conference room in Building 3, Menlo Park. Our preliminary agenda calls for four half-day sessions that address the following topics: the regional geologic and tectonic setting in which geothermal systems of the Cascades occur; characteristics of magmatic systems as heat sources; hydrothermal expression; and geological and hydrological models that should guide drilling programs in the Cascades.

A moderator will lead each session, and several people will be invited to speak on specific aspects of the topic. Plenty of open discussion time will be built into the sessions for short, informal communications and pertinent discussion. We hope that this format will keep the workshop well-focused, yet also will provide an opportunity for many peoples' ideas and research results to be considered. We will be sending you a detailed agenda in a few weeks.

Please let us know who from your organization will be attending by returning the enclosed form to Marianne Guffanti (USGS, 905 National Center, Reston, VA 22092, 703/860-6471). We think the workshop will provide a long-needed opportunity to compare results, coordinate efforts, and stimulate our thinking about the Cascades.

Distribution

David Adam, USGS
David Anderson, Geothermal Resources Council
Charles Bacon, USGS
Forest Bacon, California Div. Mines & Geology
Keith Bargar, USGS
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Robert Bisdorf, USGS
David Blackwell, Southern Methodist University
Richard Blakely, USGS
Duane Champion, USGS
Robert Christiansen, USGS
Gene Ciancanelli, Cascadia Exploration Corp.
Michael Clynne, USGS
James Combs, Geothermal Resources International
Richard Couch, Oregon State University
Richard Dondanville, Union Oil Co.
Julie Donnelly-Nolan, USGS
Wendell Duffield, USGS
Carol Finn, USGS
David Fitterman, USGS
Robert Fournier, USGS
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Paul Hammond, Portland State University
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David Hill, USGS
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Cathy Janik, USGS
Terry Keith, USGS
Donald Klick, USGS
Arthur Lachenbruch, USGS
Joe LaFleur, California Energy Co.
Norman MacLeod, USGS
Robert Mariner, USGS
Alexander McBirney, University of Oregon
James McNitt, GeothermEx
Tsvi Meidav, Trans-Pacific Geothermal
Carol Michelson, USGS
Roy Mink, Morrison-Knudson Co.
Martin Molloy, DOE-San Francisco
Walter Mooney, USGS
Patrick Muffler, USGS
Manuel Nathenson, USGS
Clay Nichols, Department of Energy
Frank Olmsted, USGS
H. J. Olson, Steam Reserve Corp.
William Orr, University of Oregon

George Priest, Oregon Department of Geology & Mineral Industries
Marshall Reed, Department of Energy
Edward Sammel, USGS
John Sass, USGS
Eric Schuster, Washington State Geology & Earth Resources Div.
Herbert Shaw, USGS
James Smith, USGS
Michael Sorey, USGS
Jack Souther, Geological Survey of Canada
Dal Stanley, USGS
Doug Stauber, Sohio Petroleum Co.
Edward Taylor, Oregon State University
Michael Thompson, USGS
Alfred Truesdell, USGS
Al Waibel, Columbia Geoscience
George Walker, USGS
Stephen Walter, USGS
Craig Weaver, USGS
Donald White, USGS
David Williams, USGS
Mike Wright, University of Utah Research Institute
Walter Youngquist, Eugene Water and Electric Co.
Adel Zohdy, USGS

UNIVERSITY OF UTAH RESEARCH INSTITUTE
UURI
EARTH SCIENCE LABORATORY
391 CHIPETA WAY, SUITE C
SALT LAKE CITY, UTAH 84108—1295
TELEPHONE 801-524-3422

November 30, 1984

MEMORANDUM

TO: Mike Wright

FROM: Bruce Sibbett

SUBJECT: Drilling Costs in the Cascades

Several companies and individuals were contacted and asked about drilling costs for intermediate depth thermal gradient holes in the Cascade Mountains. Most of the good information was obtained from one drilling company and one geothermal company. However, this sparse data is in fairly good agreement.

Core Drilled Holes:

Core drilling averages \$65 to \$70 per foot for the drilling contract with 10% of the hole depth cased with H casing (4" x 4½"). A contingency of 20% was suggested as reasonable. Mobilization charges are additional. An example is \$6,000 one way to Mt. Shasta for a Salt Lake City based rig.

A four hole average footage cost of \$73.34 per foot with 30% variability includes mobilization-demobilization, water and supervision. The surface casing hole was drilled with rodary and the holes cored below that.

These two average cost figures are comparable to the Ascension Island cost of \$75/ft. which does not include mob-demob and shipping. A 3000 ft. hole at Coso cost ~~is~~ \$63/ft.

Rodary Drilled Holes:

Few intermediate depth holes have been rodary drilled in the area due to lost circulation problems and the available data are sparse and highly variable. Two reported holes (2300 ft. and 4000 ft.) averaged $117 per foot with 36% cost variability. The shallow hole was more expensive.

Primary sources of information were Tonto Drilling and Phillips Geothermal.

Bruce S. Sibbett

BS/cd

Cascades Drilling Costs

John Rowley 667-1378 – AEU
LASAL

DOSAC
Deep Observation Sites
Core holes

George Kolstat
Sunedco

stress measurements - 3-4" diamon core hole

✓ Phase 1 - 1200m (4000 ft) on Flanks Cascades -

Breiton Bush Well - 9000 ft. 1000 ft. younger Volc.
8½" at bottom - $300,000 2.7×10⁶
↳ work over.

Paul Brophy 707-526-1000 Calif. Energy

est. Crater Lake - 5-6 holes -
Budget - 5" - 3" 5000' coring $250K w/out over head.

est. 190K - 3000 ft at Coso. = $63/ft.

2500-3000' holes:

Tonto

$65 ($70) with mud - core - mob to Shasta $8000, one way.
20% Contingency
Casing - 10% of Hole depth H Casing 4×4½"

Oxy hole - ~3 million

Ascension Is

↳ $75/ft - not including mob. & excess materials

Companies Drilling.

Union
Oxy
Phillips Geoth.
Anadarko

John Thurston
303-322-3443
401-726-8226

Drillers.

Tonto
Longyear — Gilbert Speaker
Boyles Brothers - 972-3333

~~237-7200~~ ~~8111~~ ~~581-5283~~

918-622-9330

Dick Harris: Azores Drilling

Drill bits: depth

Phillips: Geothermal 263-6200

Dick Lenzer - Dick Benoit

est. Rodary to 2300' $368,000 exp. $160/ft → $117/ft ± 36%

" " 4000' 300,000 $75/ft

Surface ~~case~~ drilled rodary core drilling $55.55/ft. $75.8/ft include mode & supervision - water.

94.26/ft.

62.26/ft

(Don't drill intermediate holes with rodary)

$73.34/ft. ave. ± 30%

~~over all ave. $88/ft.~~

37% to 80% 13%

/ Earth Science Laboratory

5-85105-3109

Bruce Sibbett

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Mel Boley Company
1404 South State Street
Salt Lake City, Utah 84115

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1 pair	Steel toe safety boots.	

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TELEPHONE 801-524-3422

MEMORANDUM

December 4, 1984

TO: Susan Prestwich

FROM: Mike Wright

SUBJECT: Drilling Costs for the Cascades

Bruce Sibbett, Duncan Foley, and I have talked with about a dozen people who represent drilling companies and exploration groups in our attempt to define Cascades drilling costs. Some of these contacts did not want to be named in print and their information has been included anonymously. Several important points have been brought out and these are discussed along with a summary of the cost estimate figures.

Some Points to Consider

1. Drilling costs vary over a wide range in the Cascades, due largely to (1) present lack of ability to predict exact drilling conditions at a particular site, (2) the difficult and highly variable drilling conditions generally encountered in volcanic terrains, particularly lost circulation and drill pipe becoming stuck, and (3) relative lack of drilling experience in the drilling industry in Cascades drilling, particularly at depths below about 1000 feet.
2. Most of those contacted agreed that core drilling is cheaper (and more reliable?) than rotary drilling. This is due to the highly variable nature of the formations and the extensive occurrence of open zones that cause a significant problem in lost circulation of drilling fluids. Core drilling can continue in zones of lost circulation, whereas rotary drilling generally cannot.

3. There is some evidence that drilling below the permanent water table, i.e. drilling below the level of the lowest permanent streams, is easier than drilling above this level. Presumably cavities have been filled to a somewhat higher degree below the water table, and there are fewer problems with lost circulation (Youngquist, 1979).
4. The most porous and variable rocks, and therefore the most difficult drilling conditions, exist in the post-Miocene, i.e. the youngest volcanics. Older volcanic rocks are collectively known as the rocks of the Western Cascades, and they exist at depth in some locations beneath the rocks of the High Cascades. Western Cascades rocks are less variable in porosity and open spaces, and drilling conditions are more uniform with fewer lost circulation problems (Priest and Vogt, 1983).

What is Included in the Drilling Costs?

Particular cost items may appear in several places in the project budgets. Before drilling costs can be compared among proposals or between each proposal and the cost estimates in this memo, it will be necessary to specify which costs are included with the drilling cost estimates and which costs are included elsewhere in the proposal.

The list in Table 1 shows items that should be addressed in each proposal.

The drilling costs that we discuss below have been made as uniform as we can make them by including in the costs Items 1 through 10 of Table 1, except as noted, and excluding Items 11 and 12.

Core Drilled Holes

Tonto Drilling

Core drilling averages $65 to $70 per foot for the drilling contract with 10% of the hole depth cased with H casing (4" x 4-1/2"). A contingency of 20% was suggested as reasonable. Mobilization charges are additional. An example is $6,000 one way to northern California for a Salt Lake City based rig.

Longyear

Longyear suggests that they could turnkey a 4000 foot drill hole of HQ size (3.98 in. OD, 2.5 in. core) for $50 per foot including all costs. For a larger hole, they could turnkey a 4000 foot hole of 134 CHD size (5.287 in. OD, 3.345 in. core) for $70 per foot. They really recommend the larger size to help ensure being able to reach total depth, but would also feel comfortable in going with the smaller size. They recommend 20% contingency.

Geothermal Exploration Companies

One company reported a four-hole average footage cost of $73.34 per foot with 30% range, including mobilization/demobilization, water and supervision. The surface casing hole was drilled with rotary and the holes cored below that, which is standard practice for deep core holes. A second company estimated that a 2000-ft hole would be in the range of $100-$150 per foot.

UURI Experience

The average cost figures above are comparable to the Ascension Island cost of $75/ft, which does not including mob/demob and shipping or overhead. Ascension is a recent volcanic island whose formation types are similar in many respects to those found in the Cascades.

Rotary Drilled Holes

Few intermediate depth holes have been rotary drilled in the Cascades due to lost circulation problems and so the available data are sparse and highly variable. Two reported holes (2300 ft and 4000 ft) averaged $117 per foot with 36% cost variability. The shallow hole was the more expensive. One source we talked with estimated that as much as $150-$250/ft may be required to rotary drill and case a 7" thermal gradient hole to 200 ft.

A geothermal gradient drilling program in the northern Cascades reported in Youngquist (1979), rotary drilled six holes, ranging in depth between 730 and 1965 feet. Project cost for the six holes, with a total of 8,162 feet drilled, was $450,000 plus some cost overruns on site restoration. The overall project cost in 1979 dollars was therefore $55.13/ft. Cost for individual holes had a wide range with one drilled to 1837 feet at a cost of $22.54/ft. If this cheap hole is deducted, the other 5 holes were drilled for an average cost of $65 per foot. Hole diameter was not given. One hole took a month to drill to 730 feet. Youngquist (1979) believed that the drilling equipment was undersized for the job at hand--none of the holes reached the target depth of 2000 feet.

Conclusions

We anticipate that a wide range of drilling costs may be proposed, due to different drilling techniques, different well designs, and different target depths. Cost differences between core and rotary drilling have been noted above. Hole diameter and casing program are two major aspects of well design that will impact costs. A larger diameter hole provides greater options for handling subsurface conditions, and therefore increases the likelihood of reaching the target depth. A conservative casing program to control lost circulation and caving might call for three strings below surface conductor; even this might not insure success in all cases. Costs will be much less if only one string of casing and an open hole completion are tried, but one contact we had expressed skepticism that open rotary hole completions could reach the target depth.

References Cited

Youngquist, W., 1979, Geothermal gradient drilling, northern-central Cascades of Oregon: Oregon Dept. Geol. Min. Industries, O.F. Report 0-80-12, 47 p.

Priest, G. R., and Vogt, B. F., 1983, Geology and Geothermal Resources of the Central Oregon Cascade Range: State of Oregon, Dept. of Geol. and Min. Industries, Special Paper 15.

Table 1
Components of Drilling Program

Item	Comment
1. Site Preparation and Restoration	This includes physical costs such as drill pad, access road, and mud pits. Environmental costs including permits and reseeding should also be considered.
2. Mobilization/ Demobilization	This cost is generally separate from footage or rig time charges.
3. Drilling	Costs will be either on a per-day or per-foot basis or a combination. Differences in well design, drilling method, and rig size, may be great, therefore leading to wide range in costs.
4. Rig Standby	Will be on a per-hour or per-day basis, for time during logging, cementing casing, etc.
5. Drilling Consultant	If the proposer does not have a staff member with extensive experience in Cascades drilling, a consultant who has such experience should be retained to be available to cope with problems. These costs may or may not be identified separately. It is our experience that consultants are well worth their cost where difficult drilling is anticipated.
6. Drill Mud Service	This should include delivery of mud to the site, and the services of a mud engineer to assist in handling difficulties. The engineer may be included as part of the mud costs, as most mud companies provide this service.
7. Drilling Bits	Casing shoes and shell may be included with footage charge or may be a separate item.
8. Casing and Cementing	This should include the diameters and costs of the casing delivered to the site, a separate casing crew (if required), and the services of a cement company, crew, and supervisor to cement the casing once it is in place, if this is not handled by the drilling company.
9. Wireline Logging	A separate logging company should be identified, with their costs, including travel, specified.
10. Cement Bond Log	Generally not run for intermediate depth cored holes but may be used for larger diameter rotary holes where several strings of casing are used.
11. Mud Logging	This service is not provided by the drilling company. On core holes the site geologist logs mud and core. Rotary holes may require a separate service.
12. Site Geologist	If provided by the operating company, site geologist cost is part of overhead. If a consultant is hired as site geologist, this would be a subcontract.

Earth Science Laboratory — Bruce Sibbett

5-26109-3305

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Salt Lake City, Utah 84108
Telephone (801) 524-3422

RI 200-1384

Aug. 19, 1985

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1575 West North Temple
Salt Lake City, Utah

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2	Ear protectors @ $12.95 each	

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Bruce Sibbett

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Aug. 19, 1985

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Salt Lake City, Utah

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	Safety glasses.

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~~Western~~

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12:55 pm. to Redmond – 1:35 PM
(except Sunday)

Western airlines Flight 355	Leaves SLC 11:10 am	–	arrives Portland 11:52 am

Western airlines Flight 49	Leaves SLC 5:30 pm	–	arrives Portland 6:12 pm

Last connection to Redmond – 8:45 pm

Delta airlines Flight 335	Leaves SLC 9:05 pm	–	arrives Portland 9:39 pm

Western airlines Flight 85	Leaves SLC 9:35 pm	–	arrives Portland 10:17 pm

First Flight to Redmond 5:30 AM – 6:15 arrive
next 8:55 AM – 9:35 arrive

Connections to Eugene

Delta Flight 565	Leaves SLC 11:05am	Arrives Portland 11:39am	Except Saturday and Sunday
Horizon Airlines Flight 437	Leaves Portland 1:05pm	Arrives Eugene 1:45pm	
Delta Flight 565	Leaves SLC 11:05am	Arrives Portland 11:39am	Saturday and Sunday
Horizon Flight 465	Leaves Portland 1:15pm	Arrives Eugene 1:55pm	
Western Flight 355	Leaves SLC 11:10am	Arrives Portland 11:52am	Except Saturday and Sunday
Horizon Flight 437	Leaves Portland 1:05pm	Arrives Eugene 1:45pm	
Western # 355	Leaves SLC 11:10 am	Arrives Portland 11:52 am	Saturday and Sunday
Horizon # 465	Leaves Portland 1:15pm	Arrives Eugene 1:55pm	
United Airlines Flight 1136	Leaves SLC 3:55 pm	Arrives San Francisco 4:32pm	All days
United Flight 1116	Leaves San Fran 5:12 pm	Arrives Eugene 6:33pm	

Connections from Portland to Redmond, OR

Horizon #401	Leave Portland 5:30am	arrive Redmond 6:15am	(Except ~~Sat~~ Sunday)
Horizon #415	Leave Portland 8:55am	Arrive Redmond 9:35am	
Horizon #417	Leave Portland 12:55 pm	arrive Redmond 1:35pm	(Except ~~Sat~~ Sunday)
Horizon #467	Leave Portland 1:35 pm	Arrive Redmond 2:15pm	(Sunday only)
Horizon #421	Leave Portland 2:30pm	Arrive Redmond 3:10 pm	
Horizon #419	Leave Portland 4:35pm	Arrive Redmond 5:15pm	(Except Saturday)
Horizon #339	Leave Portland 8:45pm	Arrive Redmond 9:25pm	