GL01937

No. 1

RESEARCH CORING IN CASCADES

PROGRESS REPORT

Michele Lemieux, Mike Wright and Joe Moore

University of Utah Research Institute

(1)

No. 2

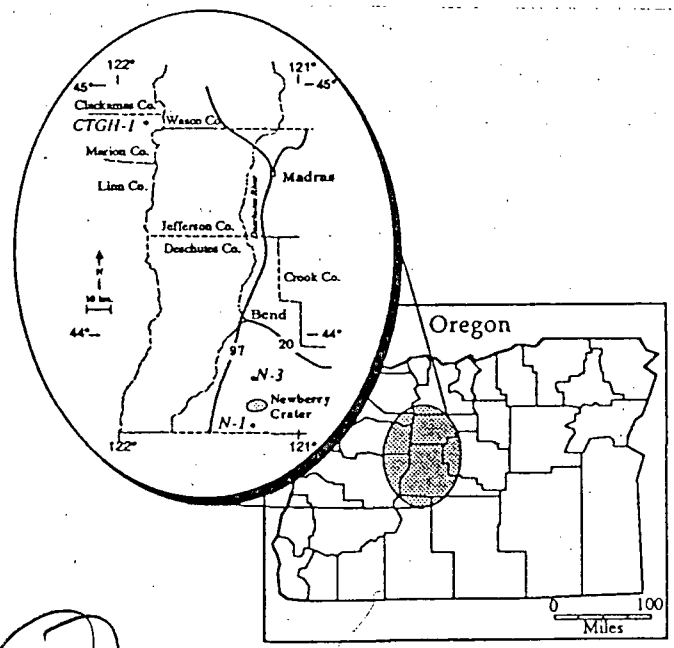
OBJECTIVES: 1. EVALUATE SHALLOW HYDROLOGIC REGIME
2. COLLECT SCIENTIFIC DATA

Spoer → PROGRAM ELEMENTS

- COST SHARE WITH INDUSTRY
- DATA ACQUISITION ~~OF SCIENTIFIC DATA~~
- DATA INTERPRETATION
- OPEN FILE RELEASE OF DATA
- PUBLICATION OF REPORTS

(2)

No. 3



3

① Get rid of county lines
② highlight locations of drill holes

No. 4

DRILLING SUMMARY

	CTGH-1	GEO N-1	GEO N-3
ROTARY DRILLED TO	427'	487'	454'
CORED TO	4800'	4550'	4002'

4

No. 5

(5)

Common Drilling Problems

	CTGH-1	GEO N-1	GEO N-3
SETTING CONDUCTOR	X	—	—
SETTING CASING	X	X	X
BOP TEST	X	X	X
CAVING	—	X	X
STUCK DRILL RODS	X	—	X
Geophysical LOGGING DIFFICULTIES	X	X	X

No. 6

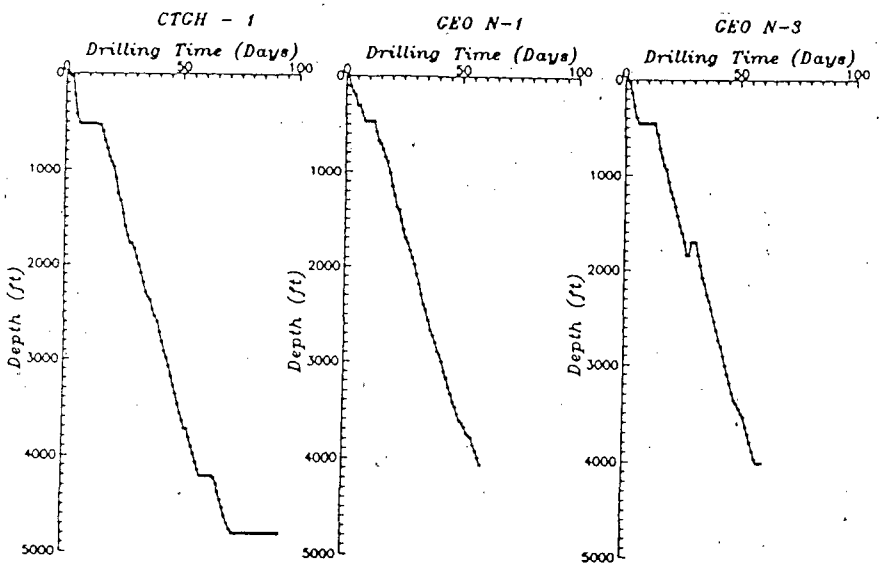
(6)

Comparison of Drilling Histories

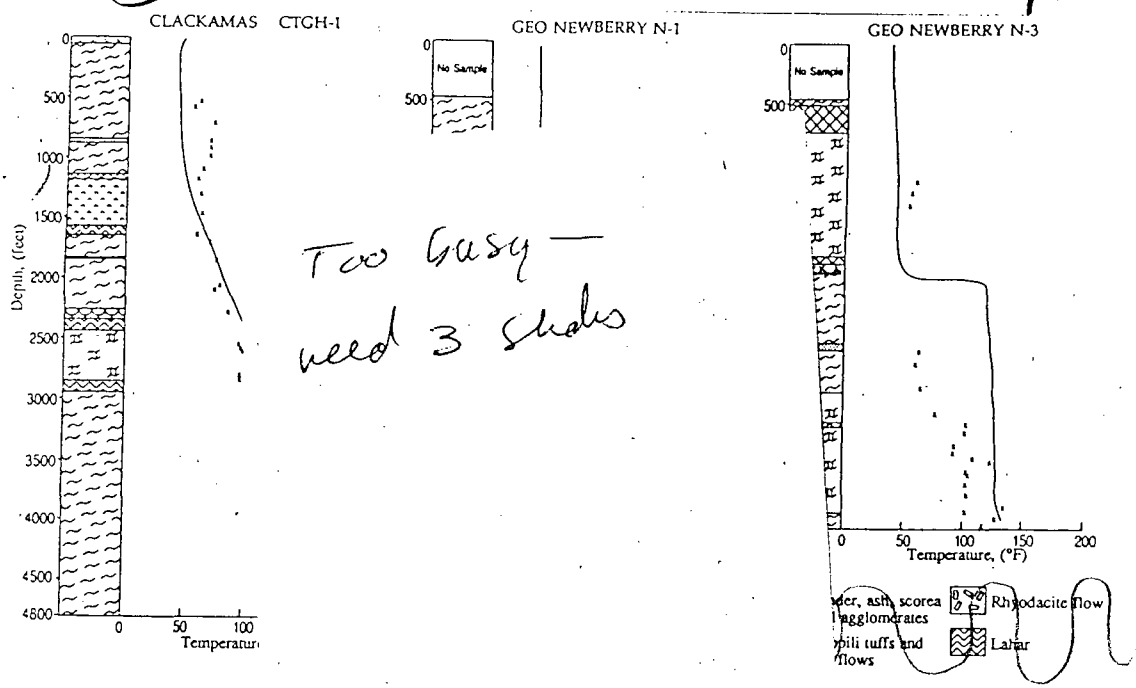
	CTGH-1	GEO N-1	GEO N-3
Daily Penetration RATE	88 ft/day	69 ft/day	68 ft/day
CORE RECOVERY	100%	100%	93%
TOTAL COST	$456,456	515,241 ? one is wrong ~~$429,455~~ ↔ ~~$429,455~~ 478,038	
cost/ft	$ 95/ft.	~~$107/ft~~ ↔ ~~$107/ft~~ $113/ft	$119/ft

No. 7

DEPTH PENETRATION PROFILES



No. 8



——— TEMP recorded by BLACKWELL and STEELE (1987)

x x MRT data

BASALTIC ANDESITE
FLOWS
Intercalated Flows, pyroclastics

CINDERS, ASH
TUFFS, ASH FLOWS

RHYODACITE
LAHAR

No. 9

LOGGED INTERVALS

			GEO N - 3
TEMPERATURE	16 –	Too much information for good shale -- suggest breaking into 1 Shale for each hole	50 - 4002
CALIPER	10 –		690 - 3999
GAMMA RAY	0 - 4		50 - 1692
SPONTANEOUS POTENTIAL	35 –		--
RESISTIVITY 15" - 64"	35 –		--
INDUCTION			--
ACOUSTIC			--
ACOUSTIC FRACLOG			700 - 4001
NEUTRON	0 - 48		50 - 4000
GAMMA - GAMMA DENSITY	0 - 5		--
INDUCED POLARIZATION	4200 - 4799	--	--
LATERALOG	4200 - 4798	--	--
DENSILOG, NEUTRON	--	--	50 - 1692
GUARD RESISTIVITY	20 - 514	--	--

(11) (12) (13)

No 10

GEOPHYSICAL WELL LOGS AVAILABLE FROM:

(14)

ROCKY MOUNTAIN WELL LOG SERVICE
P.O. BOX 3150
DENVER COLORADO
80201

No. 11

150

Scientific Studies ~~Undertaken or Reported~~

	CTGH -1	GEO N-1	GEO N-3
HEAT FLOW	SMU	SMU GEO	SMU GEO
DOWNHOLE Hg	--	GEO	GEO
ALTERATION	USGS	USGS GEO	USGS GEO
VOLCANIC STRATIGRAPHY	DOGAMI	~~Univ. of Wyo~~	~~Univ. of Wyo~~ ← U. Wyo or U. Wy.
~~CORRELATION OF ELECTRIC LOGS WITH ALTERATION/ANALYSIS OF WELL LOGS~~ LOG ANALYSIS →	UURI	UURI	UURI
GEOCHEMISTRY ~~OF FLUIDS AND ROCKS~~	⇒	GEO	GEO
AGE ~~DATA~~ DATES	--	GEO	GEO
PETROGRAPHIC ~~ANALYSIS~~	--	GEO	GEO
~~SYNTHESIS OF DATA TO DEVELOP MODEL~~ PHYSICAL PROP. ~~CORE STUDIES~~	DOGAMI UURI	UURI	UURI

~~NOTE~~

OPEN FILE DATA

16

	CTGH -1	GEO N-1	GEO N-3
DAILY DRILL~~ING~~ REPORT RPT	X ✓	X ✓	X ✓
DRILL~~ING~~ ~~AND~~ COMPLETION ~~HISTORY~~ & CASING REC. ASST.	X ✓		
LITH~~OLOGIC~~ LOG	X	X	X
CORE RECOVERY ~~LOG~~	X ✓	X ✓	X ✓
CORE PHOTOS		X	X
TEMPE~~RATURE~~ DURING DRILL~~ING~~	X	X	X
~~STANDING~~ FLUID LEVEL	X	X	X
TEMPE~~RATURE~~ LOG		X	X
GRAPHIC DRILLING LOG (~~Lithology, temp. from MRI, penetration~~ rate, water level, ~~lost circulation~~ zones) ~~—~~	X ✓		
SECONDARY MINERAL ~~DESCRIPTION~~	X	X	X
~~HOLE~~ COMPLETION SCHEM~~ATIC~~	X	X	X
~~TABLE OF MEASURED~~ THERMAL CONDUC~~TIVITY~~		X	X
FINAL REPORTS	X	X	X

No 13

CRATER LAKE HOLE

17

- Drilled by California Energy Co. to 1400 ft.
- TD Temperature at 107°C (225°F)
- Effects of development being studied
- FUTURE??

No. 14

18

RESULTS

- SUCCESSFULLY COMPLETED THREE CORE HOLES
- SHALLOW Hydrologic Regime defined
- OBTAINED SCIENTIFIC DATA on Temp., Lithology, and heat flow of upper 4000 feet of Central Oregon Cascades.
- OBTAINED EXTENSIVE GEOPHYSICAL LOGS
- MADE DATA available to public

11 12 13

LOGGED INTERVALS

	CTGH-1	GEO N-1	GEO N - 3
TEMPERATURE	16 - 516 ; 0 - 4785	0 - 4000	50 - 4002
CALIPER	10 - 514 ; 4100 - 4800	474 - 3400	1690 - 3999
GAMMA RAY	0 - 4800	0 - 4000	50 - 1692
SPONTANEOUS POTENTIAL	35 - 516 ; 4200 - 4798	1788 - 4000	1788 - 3400
RESISTIVITY 15" - 64"	35 - 515.5 ; 4200 - 4799	—	--
INDUCTION	--	1788 - 4000	--
ACOUSTIC	—	1788 - 4000	--
ACOUSTIC FRACLOG	--	1788 - 4000	1700 - 4001
NEUTRON	0 - 4800 CENTER	--	50 - 4000
GAMMA - GAMMA DENSITY	0 - 510 ;	--	--
INDUCED POLARIZATION	4200 - 4799	--	--
LATERALOG	4200 - 4798	--	--
DENSILOG, NEUTRON	--	--	50 - 1692
GUARD RESISTIVITY	20 - 514	--	--

No 10

14

GEOPHYSICAL WELL LOGS
AVAILABLE FROM:

AIN WELL LOG SERVICE
BOX 3150
COLORADO

Too much information for good slide -- suggest looking into 1 slide for each hole

one slide each hole

* rain curtain may represent a lithologic discontinuity

In Summary

N-3 { - most dist. from volcano center
does not indicate the presense of an exploitable geothermal resource

- at 520 m rods became stuck in place ⇒ causing a reduction in core hole size
- integrity of core hole forced modifications to logging program
- standing water table 455 - 565 m (525 m mode) (1968')
- 580-610 m rapid T buildup ⇒ result of artesian water ascending the annulus of core hole
  enter hole ~ 1160 m (3804')
  exit hole 575-585 m 1918'
- MRT's show no tendency to increase near the water table & in fact readings don't exceed ambient temps until 935 m —
  ∴ rain curtain extends to 915 - 975 m (3198')
- silica enrich fluids below 1050 m (indicates presence of geothermal fluids

mention that since paper was submitted ↗ particularly note final reports
Go through N-3 with log ⇒ correlate thin section descriptions ↗ signific. additional data has become available

mention

the excellent & thourough reports on logs {temp/lithol/rain curtain relations

Is copies of final report available to public? charge?

N-3 cost $1,429,455

DOE 212,580 GEO 216,875

N-1 cost 429,455

DOE 210,433 GEO 219,022

have section mentioning how logs were limited

when talking about logs-

mention relationship between logs/w.t. and R.C. that GEOO provided & clay alteration that USGS is doing

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

1. What is emphasis of well log analysis by UURI? i.e. GeO Operator's main emphasis is using logs to determine water table location washout zone etc. physical prop of rocks now

2. In GEO N-1 we said base of rain curtain is at ~ 3600'. However, 3300' is a better choice and GeO operator seems to agree. Where is our stand on this?

3. Use of word "Rain Curtain". In Geo's paper, they repeatably refer to the "Rain curtain", it is even in title of paper. what is correct usage here?

4. Our Stand on Crator Lake hole - core will be axial penetrating resolution of
   1.) no way will drilling effect crator lake + system
   site papers that say so
   2.) Don't mention one way or the other, just give status

refer to paper see's - say anything about possibilities of completing the hole?

Open file data on crater lake hole & Temperature & Drilling reports available

logs? not open file

mention when core is available

It's our assessment that it is in no way going to damage envir-

mention that it is research hole in terms of scientific value

Misc. Notes on GEOC Final Reports

Notes

Statement of Cost :

MRT
Maximum Recording Therm

N-1 1387m } data and core from upper 1219 m
N-3 1,220 m

uppermost regime (rain curtain)
down 900 to 1000m (3280')
to
transition zone
Thermally conductive regime

N-1 1000 m rain curtain [Swanberg + Combs 1986]

N-1 378 to 549 caving + sloughing →
Rods were pulled to 550m leaving upper 550m of core hole behind pipe, then remainder of hole was open → logs ran from 550m to TD
Temp, ind. gamma ray, calip. sonic
BHC acoustic Rec, ℓ logs
water table is prob. w/in unlogged interval ↑ terminated

- There is question as to whether the isotherm, Temps. Meas. for sev. hund meters below water table, indicate a rain curtain or merely water percolating downward in annulus between completion casing and walls of core hole

2 scenarios — (3296')
R.C. — 1005m — groundwater exits along highly perm. horizons

1) This model favored by fact that volcanic section does in fact change character at depths near bottom of isothermal section & also by MRT — MRT were never > ambient until depths of 500m below WT

2. RC 350m to 400m (1312') whole remaining (Blackwell)
Isothermal interval is a consequence of intra-hole fluid flow RC = WT

ESL-P8012-IP

RESEARCH CORING IN THE CASCADES
A STATUS REPORT

Michele M. Lemieux[1] and Phillip M. Wright[1] and Joseph N. Moore[1]

(1) University of Utah Research Institute, Earth Science Laboratory, 391 Chipeta Way, Suite C; Salt Lake City, UT 84108

ABSTRACT

The High Cascades volcanic province has long been suspected to contain considerable geothermal potential. However, few deep wells have been drilled, and much of the data that have been accumulated are proprietary. In response to the need to obtain a better understanding of the Cascades region, the U.S. Department of Energy, Geothermal Technology Division, sponsored a cooperative research program with industry based around obtaining data from research coreholes. This paper is a progress report on the three coreholes completed to date, including a summary of drilling histories and a description of the scientific studies underway and of the open file data available.

INTRODUCTION

The Cascades is an area with high geothermal potential, but with few surface manifestations. The lack of widespread surface geothermal activity is generally believed to result from the masking of systems by downward and lateral movement of cold meteoric water. In 1986, the U.S. Department of Energy, Geothermal Technology Division, initiated the Caldera Reservoir Investigation Program to evaluate the effects of the near-surface hydrologic regime and to obtain lithologic, hydrologic, and structural data on the Cascades.

The DOE program has four main elements: 1) cost sharing with industry in coring research holes; 2) acquisition of lithologic, geophysical, and hydrologic data within and below the shallow hydrologic regime; 3) data interpretation and integration; and, 4) open file release of data and core, as well as publication of technical reports and case histories.

Summaries of drilling histories and descriptions of the available data and scientific studies are presented in this paper for three holes drilled under the DOE program: Clackamas Thermal Gradient Hole #1 (CTGH-1), drilled by Thermal Power Co.; and GeoNewberry holes # 1 and # 3 (GEO N-1 and GEO N-3), drilled by GEO Operator Corporation. CTGH-1 is located approximately 10 miles north of Mt. Jefferson, while GEO N-1 and GEO N-3 are located on the southern and northern flanks, respectively, of the Newberry volcano. Figure 1 shows the location of these holes.

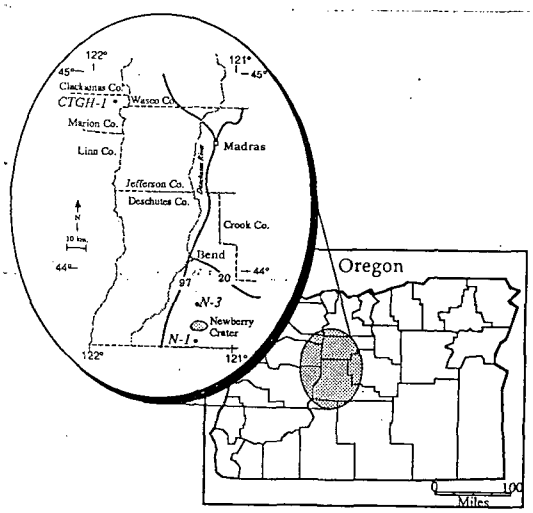


Figure 1. Location map of core holes.

CORING SUMMARY

CTGH-1

CTGH-1 was rotary drilled to a depth of 527 feet, and then diamond cored to a total depth of 4,800 feet. The hole

required 93 days to complete; however, only 58 days were spent drilling. CTGH-1 has not been plugged and abandoned at this point. The hole condition is believed to be good so that deepening may be possible.

There were several unanticipated delays during the drilling of CTGH-1. First, the attempt to run a conductor into the top 40 feet of glacial boulders and till was not initially successful. Later, during the change-over from rotary drilling to wireline coring, there were problems setting the casing to the bottom of the hole. In addition, the initial test of the BOP detected a leak, requiring a new flange. Another significant delay occurred during coring at a depth of 4,203 feet, when the HX rods parted at 823 feet. After unsuccessful attempts at retrieval, coring was continued with NX rods, and the HX rods were left in the hole as casing. This precluded the collection of a full suite of geophysical logs, since some logs can not be run in a cased hole. Finally, at a depth of 4,800 feet, the U.S. Forest Service shut down rig operations because of a Class E fire risk. The results of a temperature survey run nine days after the shutdown, in which the bottom-hole temperature was found to be 99°C (210°F), led to a decision not to continue drilling.

GEO N-1

GEO N-1 was rotary drilled to a depth of 487 feet, and then diamond cored to a total depth of 4,550 feet (Swanberg and Combs, 1986). Data and core obtained to a depth of 4,000 feet are in the public domain. Drilling progressed smoothly; out of the 59 days required to reach a depth of 4,000 feet, 54 days were spent drilling. GEO N-1 has been scheduled to be plugged and permanently abandoned before September of 1988.

There were only a few minor problems in the drilling of GEO N-1. During rotary drilling, the rods parted, leaving the rods, sub and bit in the hole, and requiring removal with a tap. An additional delay occurred during the change-over from rotary drilling to wireline coring, when leaks were detected in the BOP.

GEO N-3

GEO N-3 was rotary drilled to a depth of 454 feet and then diamond cored to the total depth of 4,002 feet. Of the 60 days on site, 46 were spent drilling. GEO N-3 is scheduled to be plugged and abandoned before September, 1988.

There were several technical problems encountered in the drilling of GEO N-3. During the change-over from rotary drilling to wireline coring, the initial attempts at cementing the casing were not successful. In addition, the BOP tested negative due to faulty equipment. One significant problem the other two holes did not have was consistent caving in the cinder/ash units. This was particularly a problem when pulling out of the hole to change bits. In one instance, the caving caused the HQ rods to stick. After futile attempts at retrieval, as well as a loss of 138 feet of previously drilled hole, the HQ rods were cemented in place and the hole was reentered with NQ rods. Once again, this limited geophysical logging.

Comparison of Drilling Histories

Depth penetration profiles are shown in Figure 2 for the three holes. The overall daily penetration rate for CTGH-1 was 88 feet/day. For GEO N-1, the overall daily penetration rate to 4,000 feet was 69 feet/day. Finally, for GEO N-3, the overall penetration rate was 68 feet/day. According to Thermal Power Co. (1987), no systematic relationship between penetration rate, rock type and/or degree of fracturing was discerned. This seems to apply to the Newberry volcano holes as well.

Core recovery was excellent in CTGH-1 and GEO N-1, averaging nearly 100%. In GEO N-3, core recovery was equally good in the basaltic-andesite flows. However, GEO N-3 had several thick sections of cinders and ash where core recovery was significantly lower. During rotary drilling of the upper portions of the hole, cuttings were collected only in CTGH-1. There was continual loss of circulation during rotary drilling of the Newberry holes, with no returns.

A detailed itemization of project expenditures for CTGH-1 is given in Table 1a. Approximate expenditures for GEO N-1 and GEO N-3 are given in Table 1b. The overall unit cost for CTGH-1 was $95/foot; for GEO N-1 the overall cost was $72/foot (not including logging and demobilization); and for GEO N-3 the cost was $90/foot.

DATA ACQUISITION AND AVAILABILITY

A significant amount of data has been obtained on the lithologies, temperature gradients, and hydrologic regimes of the areas penetrated by the coreholes. Simplified lithologic columns for CTGH-1, GEO N-1 and GEO N-3 are given in Figure 3. For more detailed information, refer

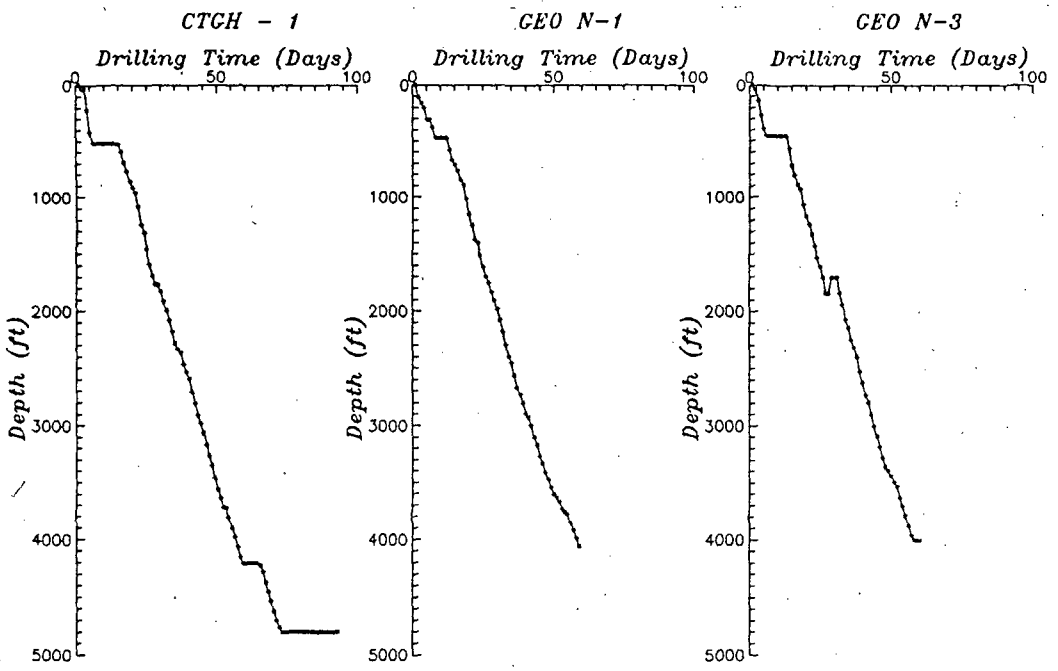


Figure 2. Depth penetration profiles for CTGH-1, GEO N-1, and GEO N-3. Information based on daily drilling reports in open file data.

TABLE 1a.

Detailed Itemization of Expenditures for CTGH-1 (based on CTGH-1 Final Technical Report by Thermal Power Co., 1987).

ROAD, SITE AND LOCATION	$11,544.00
RIG MOB/DEMOB	$10,000.00
RIG	$296,807.00
TRUCKING & HAULING	$3,890.00
DRILL SITE GEOLOGISTS	$26,560.00
MUD & CHEMICALS	$24,618.00
CEMENT MATERIALS	$9,141.00
GEOPHYSICAL LOGGING	$10,032.00
DRILL BITS & TOOLS	$23,493.00
OUTSIDE LABOR	$1,424.00
OTHER EVALUTATION	$6,954.00
OTHER	$14,125.00
CONDUCTOR CASING	$419.00
SURFACE CASING	$10,589.00
WELLHEAD EQUIPMENT	$2,589.00
CAMP & CATERING	$4,271.00
TOTAL:	$456,[illegible].00
OVERALL COST/FT =	$456,[illegible]/4,800ft
=	$95/ft

TABLE 1b.

Estimate of Expenditure for GEO N-1 and GEO N-3 (based on daily drilling reports by GEO Operator Corp.)

	GEO N-1	GEO N-3
RIG MOBILIZATION	$3,000	$8,723
ROTARY DRILLING	$31,953	$24,957
CEMENTING CASING		
INSTALLING BOP	$17,830	~~$23,000~~ 23,500
WIRELINE CORING	$233,776	~~$255,462~~ 265,644
LOGGING AND		
DEMOBILIZATION	?	$37,619
TOTAL COST	$286,559 (to 4000')	$360,443
OVERALL COST/FT	$72/FT	$90/FT

to the open file reports. In general, the lithologies are similar, consisting of basalt/basaltic-andesite flows. All of the holes have interbedded pyroclastic and volcaniclastic units. In GEO N-3, these units are thicker than in the other holes, and since they are poorly consolidated as well, caving occurred in ~~before~~

Figure 3. Generalized lithologic columns and temperature-depth profiles for CTGH-1, GEO N-1, and GEO N-3. Temperature-depth curves based on Blackwell and Steele (1987); MRT data, shown by "x"s, from open file reports. CTGH-1 and GEO N-1 lithologic columns modified from Sibbett, unpublished data.

the drilling of GEO N-3 that was not present in GEO N-1 and CTGH-1.

Figure 3 also compares the temperatures measured by Blackwell and Steele (1987), with those recorded using a maximum recording thermometer (MRT) during drilling. The temperature profiles for GEO N-1 and GEO N-3, after allowing the wells to stabilize, appears to reflect intra-hole fluid flow (Blackwell and Steele 1987). In GEO N-3, they suggest that the temperature distribution results from upward movement of water in the wellbore. Similarly, the thermal profile of GEO N-1 could be produced by downward flow of water within the wellbore.

Since temperatures measured during drilling may be recorded before any significant intra-hole fluid flow had begun, MRT data should provide an indication of the depth to the base of the cold-water hydrologic regime. Figure 3 shows that the MRT temperatures are nearly constant with depth in the upper portions of all three holes. Below this zone, the gradients increase and higher temperature are recorded. We suggest, based on these measurements, that the lower boundary of the cold water regime is located at depths of about 3,600 feet in GEO N-1 and GEO N-3, and at 1,600 feet in CTGH-1.

Comparison of the thermal profiles with the lithologic logs demonstrates that fluid movement may be influenced by rock type. For example, in GEO N-3, flow out of the wellbore occurs around 1,800 to 1,900 feet in an unconsolidated cinder and ash unit. The water appears to enter this well in interbedded pyroclastics and basalts. Additional information on GEO N-1 and GEO N-3 is given by Blackwell and Steele (1987). GEO N-1 has also been summarized by Swanberg and Combs (1986).

Geophysical well logs were run in all three holes shortly after hole completion. In both CTGH-1 and GEO N-3, it was not possible to obtain complete logs due to the casing. Table 2 lists the logs available, and the corresponding depth intervals.

TABLE 2.

Geophysical Well Logs Available. For copies contact: Rocky Mountain Well Log Service; P.O. Box 3150; Denver, Colorado 80201.

	CTGH-1	GEO N-1	GEO N - 3
TEMPERATURE	16 - 516.5 ft; 0 - 4785 ft	0 - 4000 ft	50 - 4002 ft
CALIPER	10 - 514 ft; 4100 - 4800 ft	0 - 4000 ft	1690 - 3999 ft
GAMMA RAY	0 - 4800 ft	0 - 4000 ft	50 - 1692 ft
SPONTANEOUS POTENTIAL	35 - 516 ft; 4200 - 4798 ft	0 - 4000 ft	--
RESISTIVITY 16" - 64"	35 - 515.5 ft; 4200 - 4799 ft	0 - 4000 ft	--
INDUCTION	--	0 - 4000 ft	--
ACOUSTIC	4225 - 4425 ft	0 - 4000 ft	--
ACOUSTIC FRACLOG	--	0 - 4000 ft	1700 - 4001 ft
NEUTRON	0 - 4800 ft	--	50 - 4000 ft
GAMMA - GAMMA DENSITY	0 - 510 ft; 775 - 900 ft	--	--
INDUCED POLARIZATION	4200 - 4799 ft	--	--
LATERALOG	4200 - 4798 ft	--	--
DENSILOG, NEUTRON	--	--	50 - 1692 ft
GUARD RESISTIVITY	20 - 514 ft	--	--

Analysis of the well logs is presently being conducted. There are several other scientific studies underway on the three coreholes. Table 3 lists these studies as well as the entities that are conducting the studies. In addition, an attempt will be made to obtain a fluid sample from GEO N-3 before the hole is plugged and abandoned.

A summary of open-file data is given in Table 4. Core from the three holes is also available for inspection at the University of Utah Research Institute sample library by appointment.

An additional core hole has been drilled along the east side of Crater Lake National Park, Oregon by California Energy as part of the DOE/Industry cost-share program (located south of area shown in Figure 1). The hole has been drilled to approximately 1,500 feet, with a temperature at TD of [illegible] (Blackwell and Steele, 1987). However, drilling has been halted while possible effects of geothermal development on Crater Lake are evaluated. Some of the issues surrounding this evaluation are discussed by La Fleur (1987) and Sammel and Benson (1987). If continued drilling is approved, studies and data similar to acquired on the other holes under the DOE cost-share program will become available for the Crater Lake hole.

SUMMARY

As part of a DOE-industry cooperative research program, three deep holes were cored in the Cascades to depths of 4,000 - 5,000 feet. The main objective of the program was to penetrate the near-surface hydrologic regime and obtain lithologic,

hydrologic and structural data on the Cascades that would be available to the public. The near-surface hydrologic regime was penetrated by all three holes, and the appropriate data collected. At the present, studies on these three holes are still underway.

Table 3.

Scientific Studies Underway or Reported

	CTGH -1	GEO N-1	GEO N-3
HEAT FLOW	SMU	SMU GEO	SMU GEO
DOWNHOLE Hg	--	GEO	GEO
ALTERATION	USGS	USGS GEO	USGS GEO
VOLCANIC STRATIGRAPHY	DOGAMI	Univ. of Wyo	Univ. of Wyo
CORRELATION OF ELECTRIC LOGS WITH ALTERATION/ANALYSIS OF WELL LOGS	UURI	UURI	UURI
GEOCHEMISTRY OF FLUIDS AND ROCKS	--	GEO	GEO
AGE DATA	--	GEO	GEO
PETROGRAPHIC ANALYSIS	--	GEO	GEO
SYNTHESIS OF DATA TO DEVELOP MODEL	DOGAMI	--	--
CORE STUDIES	UURI	UURI	UURI

SMU - Southern Methodist University

GEO - GEO Operator Corp.

USGS - United States Geological Survey

DOGAMI - Oregon Dept. of Geology and and Mineral Industries

Univ of WYO - University of Wyoming Dept. of Geology

UURI - University of Utah Research Institute - Earth Science Laboratory

Table 4.

Open File data available. For copies contact the authors.

	CTGH -1	GEO N-1	GEO N-3
DAILY DRILLING REPORT	X	X	X
DRILLING AND COMPLETION HISTORY	X		
LITHOLOGIC LOG	X	X	X
CORE RECOVERY LOG	X	X	X
CORE PHOTOS		X	X
TEMPERATURE DURING DRILLING	X	X	X
STANDING FLUID LEVEL	X	X	X
TEMPERATURE LOG		X	X
GRAPHIC DRILLING LOG (lithology, temp. from MRT, penetration rate, water level, lost circulation zones)	X		
SECONDARY MINERALOGY DESCRIPTION	X	X	X
HOLE COMPLETION SCHEMATIC	X	X	X
TABLE OF MEASURED THERMAL CONDUCTIVITY		X	
FINAL REPORTS	X	X	

ACKNOWLEDGEMENTS

This program has been supported by the U. S. Department of Energy, Geothermal Technology Division and Idaho Operations Office. Marshall Reed and Susan Prestwich of DOE have managed the program. UURI has been supported under Contract No. DE-AC07-85ID12489.

REFERENCES

Blackwell, D.D., and Steele, J.L., 1987, Geothermal data from deep holes in the Oregon Cascade range: Geothermal Resources Council, Trans., v. 11, p. 317-322.

La Fleur, J.G., 1987, Legend of the Crater Lake hot springs; a product of model mania: Geothermal Resources Council, Trans., v. 11, p. 267-279.

Sammel, E.A., and Benson, S., 1987, An analysis of the hydrologic effects of proposed test drilling in the Winema National Forest near Crater Lake, Oregon: Geothermal Resources Council, Trans., v. 11, p. 293-303

Swanberg, C.A., and Combs, J., 1986, Geothermal drilling in the Cascade Range: Preliminary results from a 1,387 m core hole, Newberry Volcano, Oregon, EOS, Trans. Amer. Geophys. Union, v. 67, p. 578-580.

Swanberg, C.A., Walkey, W.C., Woodruff, M.S., and Combs, J. 1987, GEO Core Hole N - 1, DOE Phase II Submittal-Cooperative Agreement No. DE-FC07-85ID12612: open file report submitted on 12 May 1987 to Idaho Operation Office, U.S. Department of Energy.

Thermal Power Company, 1987, Cascades geothermal drilling, Clackamas 4,800-foot thermal gradient hole, final technical report: open file report submitted on 30 September 1987 to Idaho Operation Office, U.S. Department of Energy.

Slide 18

① Overall, the program was successful in achieving it's main objectives;
② 3 core holes were completed that penetrated the hydrologic regime and obtained scientific data on Temp, lithologies and structure, that is available to the public for study
③ Hopefully this information will encourage further research and exploration in the Cascades region

Slide 16

① This is a brief summary of the OPEN file data that is available on the 3 holes.

② Copies of open file data can be obtained from UURI.

③ In addition, core is available for inspection at the UURI sample library

④ The final reports for all three holes give good summaries of drilling histories and open file data obtained

Slide 17

① an additional hole has been drilled along the east side of Crater Lake National Park by CECI, under the DOE/industry cost share program.

② With a bHT of 107°C at 1400', Crater Lake is a valuable corehole, not only in terms of energy production but for scientific research.

③ HOWEVER, drilling has been suspended while the possible effects of Geothermal development on Crater Lake are studied.

④ Several studies have been completed that indicate drilling in this area will have no effect on Crater Lake.

⑤ It is also our assessment that this research corehole will not damage the environment.

⑥ Nevertheless, a controversy remains and the future of the Crater Lake hole is uncertain

SLIDE 1

① The high Cascades have long since been SUSPECTED to contain considerable Geothermal POTENTIAL.

② In response to the need to OBTAIN a better understanding of the Cascades region, the U.S. DoE Geoth. Techn. DIVISION sponsored a COOPERATIVE research program with industry, BASED around obtaining data from RESEARCH COREHOLES.

③ This presentation is a PROGRESS report on the 3 coreholes completed to date

SLIDE 2

① Although there is hydrothermal POTENTIAL in the Cascades, there are few surface Manifestations

② This is believed to result from the masking of SYSTEMS by downward and lateral movement of cold METEORIC water

③ One of the main OBJECTIVES of this Cooperative research program is to evaluate this SHALLOW HYDROLOGIC REGIME which is often reffered to as the RAIN CURTAIN

④ The other main OBJECTIVE is to collect scientific data, not only on the hydrologic REGIMES, but on the STRUCTURE and LITHOLOGY of the Cascades as well.

⑤ Thus program is unique in that the DOE shared in 50% of the costs incurred in drilling, logging, in addition to sponsering research

⑥ several INSTITUTIONS are working on data interpretation and PUBLISHING REPORTS

This is an unusual program
reiterate cost share

SLIDE 3

① There have been 3 holes COMPLETED to date:
② CTGH-1 which was drilled by Thermal Power Co., located approx 10 miles north of Mt Jefferson, while GEON-1 and GEON-3, both drilled by GEO OPERATOR
③ are located on the flanks of the Newberry Volcano
③ CTGH-1 has HEAT FLOW values that indicate potential for a commercial grade hydrothermal SYSTEM
④ Similiarly GEON-1 also has a heat flow that indicates Geothermal Potential
⑤ GEON-3 on the other hand, which is located more DISTANT from the volcanic center than GEON-1, does not INDICATE presence of a Geothermal resource, it is more typical of a non geothermal system in Cascades

Slide 6

① Core recovery was excellent in all three holes. The LOWER value on GEON-3 is due to the several UNCONSOLIDATED cinder-ash units present, which had significantly lower core recovery than the Basaltic And. flows

SLIDE 5

② The Depth-penetration profiles are good examples of how drilling PROGRESSED and ILLUSTRATE the effect of days not spent drilling due to technical Problems. HISTORY

③ According to Thermal Power Co's final Report on CTGH-1 no SYSTEMATIC relationship between PENETRATION rate, rock, type and/or degree of fracturing was discerned. This seems to apply to the Newberry Volcano holes as well.

④ For ADDITIONAL information on the Drilling histories of these 3 holes refer to the open file reports.

SLIDE 4

① All holes were ROTARY drilled to approx. 500' and then diamond CORED to total Depth.

② At this point, CTGH-1 has not yet been plugged and abandoned. Hole condition is BELIEVED to be good so that deepening may be possible.

③ GEON-1 and GEON-3 are scheduled to be plugged and abandoned this year.

SLIDE 5

① Overall, drilling progressed SMOOTHLY. The most common drilling problems are summarized in this table

② Drilling conditions were difficult in both GEON-1 and GEON-3 when the regional water table was ENCOUNTERED, mainly because of the INCOMPETANT rocks associated with the water table

③ Caving of incompetant rocks in GEON-3 caused drill rods to stick. The RODS ended up cemented in place and the hole size reduced

④ Geophysical logging was limited in all 3 holes. In GEON-3, the rods in the drills caused logging problems since sonde tools can't be run in a cased hole hole. Drill rods were also left in CTGH-3 same problem in logging

⑤ In GEON-1, it was the THEAT of caving from an INCOMPETANT interval that limited the logging program

⑥ an unusual problem faced while drilling CTGH-1 was a 13 day suspension due to high fire danger

The Riverhouse.
Attention Gary
3075 N. Hwy 97
Bend, Oregon
97701

503-389-3111 ask for accty

SLIDE 8

① In CTGH-1, temp. recorded during drilling by an MRT (shown by X's here) as well as the T-D profile recorded by Blackwell indicate, the extent of the cold water regime is approx. 1600'.

② This is shown by both MRT data and post completion temperatures which show a nearly isothermal profile down to 1600'.

③ The profile then shows a conductive regime

④ This isothermal regime is a good indication of how deep the cold meteoric water extends to.

⑤ NOTE that there appears to be some LITHOLOGIC contrast/ow with the end of the cold meteoric water — this particular HORIZON is fractured and unconsolid and perhaps causes the COLD WATER begin to flow laterally and not downward

SLIDE 9

① The shallow hydrologic regime was also penetrated by the 2 Newberry volcano holes GEO N-1, & GEO N-3

② For a particularly good discussion of the "rain curtain" effect, I urge you to read "core hole drilling and the "rain curtain" phenomenon at Newberry volcano, Oregon" by Swanberg, Walkey and Combs

③ In GEO N-3, the post completion T survey may reflect intra hole flow, most likely upward movement of artesian water in annulus of wellhole

④ It appears that the water is entering the hole around 3800', and exiting the hole at 1900' in a thick section of incompetant rock.

⑤ In this case, the MRT data are perhaps a more accurate indication of the extent of the cold water regime, since these were measured during drilling and were recorded before any significant intra-hole fluid flow had begun.

⑥ At approx. 3000' the MRT data begin to increase from initially very isothermal readings - this is likely the extent of the rain curtain for this hole.

GEO N-3 MRT

SLIDE 11

① Geophysical well logs were RUN in all 3 holes shortly after hole completion

② In CTG.H-1 2 logging runs were MADE

③ The First run was prior to setting surface CASING

④ On the SECOND run, a complete suite of LOGS was limited either by the PRESENCE of drill rods that were left in the hole or by HIGH BHT

Slide B

① For GEO N-1, the physical condition of the corehole required 2 logging runs as well

② There was an INTERVAL that was associated with CAVING and the chance of loosing an LOGGING TOOL and perhaps the entire CORE HOLE was Too great to log over this interval. T

③ The RODS were pulled to the base of this INCOMPETANT SECTION and the remainder of hole left open. LOGS were then run from the base of this section to TD

④ The logs were run again from the base of the surface casing to the TOP of the incompetant section

SLIDE B

① FOR GEO N-3 rods had to be cemented in place WHILE drilling and this along with a reduced corehole size limited logging that could be done

SLIDE 14

① If you are interested in copies of these logs, they can be obtained from—

SLIDE 15

① There are several scientific studies underway on these 3 coreholes.

② HEAT FLOW studies have been conducted by Dr. Dave Blackwell of SMU on all three holes, and by GEO OPERATOR CORP for GEO N-1 and GEO N-3

③ Alteration has been extensively studied by the USGS. In FACT, a paper was presented at this conference on MONDAY by Keith Barger on the SECONDARY mineralogy of core from CTG#-1.

④ GEO OPERATOR has also completed a detailed study of alteration mineralogy of GEO N-1 and GEO N-3

⑤ LOG analysis is being studied by URI to determine relationships between physical properties of rocks and the logs

⑥ IN GEO N-1 and N-3, GEO OPERATOR studied relationships of the REGIONAL hydrologic regimes with the logs. A good discussion and presentation of data is given in the final TECHNICAL reports

⑦ GEO OPERATOR has also completed studies on the GEOchemistry of fluids + rocks of N-1 and N-3 in addition to age dating and detailed petrographic analysis

⑧ URI has been undertaking a detailed study of the physical properties of Cascade rocks, in particular induced polarization and Thermal conductivity. A preliminary report on the I-P studies was presented earlier today at this conference