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CONFIDENTIAL

Kelly Hot Springs #1

A program completion report

Submitted to

Geothermal Power Corporation

San Francisco, California

October 14, 1974

REGISTERED GEOLOGIST
W K SUMMERS
No 859
STATE OF CALIFORNIA

C O N T E N T S

INTRODUCTION

Purpose and Scope

Kelly Hot Springs #1 was drilled July, 1974, for Kelly Hot Springs Limited in the search for geothermal energy. The operating partner was the Geothermal Power Corporation. The contractor was Barnes Core Drilling Company, Bakersfield, California. I served as the supervisory geologist under an agreement with Geothermal Power Corporation dated January 15, 1974.

This report is my project completion report. It contains the data obtained and a review of its significance.

Specifically, this report contains

(1) a description of the construction history,

(2) a summary of the measurements obtained during the monitoring program conducted as the well was drilled;

(3) a review of the results of the logging program,

(4) (a) the data obtained from a water well drilled to supply the drilling rig and (b) the sample log and temperature profile of Kelly Hot Springs #2, shallow test hole, drilled a few hundred yards north of Kelly Hot Spring, and

(5) a discussion--with recommendations for future work--of these data in the light of other work that has been completed on the area.

Location

Kelly Hot Springs #1 is in Modoc County, California. It is nominally located in $NW\frac{1}{4}$, Sec.27, T.42N., R.11E., NDBM. It is approximately 2600 feet west and 1300 feet south of northeast corner of the section.

The water well is about 300 feet north of Kelly Hot Springs #1.

The Kelly Hot Springs #2is in the $NE\frac{1}{4}$, Sec.29, T.42N., R.11E.,--about 600 feet west and about 250 feet south of the northeast corner of the section.

WATER WELL

The water well was drilled by Conner's Well Drilling, Inc. at Alturas, California, and was completed during June, 1974. This well was drilled to a depth of 360 feet and was cased with 6-inch, thin-wall (.188-inch gage) casing to 36 feet. The well produced about 75 gallons per minute. The drawdown while pumping was not measured.

Appendix 1 contains the water well driller's report, a chemical analyses of the well water, and a summary of the measured temperature of the water supplied by this well.

For a water of such low total dissolved solid, the water is rich in silica, boron, sodium, and potassium. Using Fournier and Truesdell's empirical Na-k-Ca geothermometer for natural waters to determine the temperature at which these water were last at equilibrium gives 241°C (467°F).

According to Roy Conners, the driller (personal communucation, July 2, 1974), the well yield increased in direct proportion to depth. We may assume then that the observed water temperature of 77°F is an average for the entire water yielding interval (20 to 360 feet).

DRILLING

Plate 1 gives the penetration rate log and the discharging mud temperature, and gross lithology of the rocks penetrated. Plate 2 is a graphic expression of the history of the construction of Kelly Hot Springs #1. Appendix 2 contains the tabular data relevant to the well.

Hole size, depth, casing

The well was drilled to total depth of 3396 feet bkb (below the kelly bushing) or 3386 below the land surface. The cellar is four feet by four feet and six feet deep. The conductor pipe consists of 32 feet of 16-inch casing, cemented to 36 feet.

The hole was drilled with 15-inch bits to a depth of 544 feet (bkb), where 13 3/4 inch, 32-pound casing was set and cemented with 490 sacks of class G cement under a final pressure of 500 psi.

Marshall Reed of the California Department of Oil and Gas tested the blowout preventor.

The hole from 544 to 3396 was drilled with 9-5/8 inch bits and was not cased. A string of 2 7/8 inch tubing was hung in the hole and the mud was flushed from the hole by circulating clear water through the tubing.

Appendix 2 contains (2) synopses of Magcobar Drilling Mud Report and a bit history, and (2) the driller's log.

Lost Circulation

Circulation was lost at the several depths as follows:

Depth	Remarks
1384	not serious
1782	began using lost circulation material
2163	
2259	drilled hereafter only with partial returns
2760	driller reported bit dropped 5 feet.

Lost circulation was handled by drilling without returns and by adding lost circulation material to the drilling mud. The lost circulation material added included coarse and medium walnut hulls, cotton seed hulls, and mud fibers. The mud was mixed to a maximum viscosity. The actual viscosity was not measured owing to the presence of the lost circulation material.

MONITORING PROGRAM

As the well was being drilled, we had hoped to monitor using Geolograph Oil Field Services Co. equipment, the following parameters:

(1) penetration rate
(2) weight on the bit
(3) relative flow rate
(4) pump pressure
(5) pump strokes
(6) mud temperature at pump intake in pit
(7) temperature of discharging mud
(8) mud weight

The mud weight was never recorded. None of the other recorders worked well. The instruments are driven by air pressure and the line to rig air pressure became disconnected on several occassions. The temperature recorders did not retain calibration.

The penetration rate indicator worked about 60 percent of the time, but the depth gage never did record accurately.

In general the Geolograph Co. equipment was most useful for determining penetration rate (but not depth at the time) and relative mud temperature. During the drilling operation we routinely measured the discharging-mud temperature recording both time and depth. These measurements are plotted on plate 1. Discharging-mud temperature during the interval for which we had close calibration on the geolograph record of mud temperature are also shown.

Mud temperatures in the pit were measured at pump intake as follows:

Date	Hour	°F
7/3/74	0205	94
7/4/74	1245	106
	1330	104
7/10/74	1400	94

The geolograph record of mud temperatures at the pump intake indicate that the temperatures observed on July 4th were the warmest that the mud in the mud pit ever achieved. Because the lost circulation problem was severe new mud was continually being made up with water at a temperature of about 75°F.

I believe the average temperature of the fluid entering the drill stem was probably 94°F.

Plate 1 contains the penetration-rate log deduced from (1) the partial geolograph record, (2) the drillers' log, and (3) notes at the site.

LOGS

Lithologic

Samples were collected routinely of the cuttings suspended in the discharging mud. A description of these samples is included in Appendix 2.

These samples were far from ideal for these reasons:

(1) During periods of rapid drilling we could not collect samples rapidly enough.

(2) Cuttings from and below the lost circulation zones flowed into the zone and did not reach the surface or were so throughly mixed with the lost circulation material they could not be recovered.

(3) The sample collection did not deliberately take into account the time required to transfer the cuttings to the surface. Consequently the samples collected for the deeper depths are for somewhat shallower depths than that indicated in the descriptive log.

Plate 1 shows the generalized lithology of the rocks penetrated by the drill.

Welex

At 1600 hours July 7th the first appreciable lost circulation zone occurred at a depth of 1783 feet (bkb). We had hoped to drill-stem test, but prior to testing we had the Welex Co. run a series of wire line logs.

These logs included

(1) induction-electric:

18" normal

induction

16" lateral

conductivity

SP

(2) compensated acoustic velocity log:

travel time

caliper

SP

(3) temperature.

Unfortunately during the first attempt to log the hole the temperature probe would not pass 1227 feet. The hole was reentered, reamed, and circulated and a second attempt was made to temperature log the hole. The probe would not pass 1108 feet. The hole was then thoroughly reamed again and circulated and the mud was saturated with lost circulation material. The induction-electric and compensated acoustic velocity logs was then run to the total depth.

Because the lost circulation material was added to the mud and was setting the hole, the concensus of opinion was that any attempt to set a drill-stem test packed would be fruitless. Drilling was resummed without testing and without obtaining a satisfactory temperature log.

Schlumberger

When the hole reached the total depth of 3396, wire line logs were run by the Schlumberger Corp. These logs include:

(1) Induction-electrical log:

16-inch short normal

induction

conductivity

SP

(2) Borehole compensated sonic log:

interval transit time

caliper

SP

(3) Compensated formation density log:

Bulk density

gamma ray

caliper

(4) Depth determination:

SP

(5) Temperature log:

These logs were produced under the supervision of R.M. Brimhall, Williams Brothers Engineering Co., who has prepared a detailed report entitled:

"Interpretation of electric logs and temperature surveys, Kelly Hot Springs #1, Modoc County, California."

Temperature profile

On August 17, 1974, John H. Sass, U.S. Geological Survey, measured the temperature at two foot intervals from 30 feet to 3342. Sass's data are presented in table 2 and values for intervals of 10 feet are shown on plate 1.

BOTTOM HOLE TEMPERATURE

Bottom hole temperatures were measured on several occassions.

On July 6 when the hole was 1323 feet, the drill-stem with a new bit was run to a depth of 1293 feet and the mud was circulated until the temperature of the discharging mud was a uniform 114°F. At 1855 hours circulation ceased and the Kelly was disengaged and a series of bottom hole temperatures were initiated. A maximum reading thermometer taped to the straight-hole survey line was lowered until it rested on the bit. The thermometer was left on the bottom long enough to reach temperature equilibrium. The data obtained are as follows:

	Hour			
run#	start to bottom	reach bottom	start up	BHT °F
1	1902	1909	1915	121
2	1919	1922	1925	122
3	1932	1934	1939	123+
4	1945	1947	1952	124
5	1957	2000	2040	128

The bottom hole temperature observed during the Welex logging are

Time since circulation stopped (min.)	Depth (ft)	Temp. (°F)
60	1109	136
1200	1227	158
90	1766	130
180	1766	130

Brimhall has summarized the bottom hole temperature data obtained during the Schlumberger logging.

Two other efforts to measure BHT showed only that the temperature was less than 200 °F.

KELLY HOT SPRINGS #2

Late in July a test hole was drilled north of Kelly Hot Spring (NE$\frac{1}{4}$, Sec.29, T.42N., R.10E., NDBM) to depth of 241 feet. A sample description and a temperature profile of the hole are presented in Appendix 3. This hole was drilled with an air rotary by Conner's Well Drilling, Inc. Drilling was terminated when the discharging fluid temperature reached 160 °F.

DISCUSSION

__Lithology__

The logging program revealed the presence of three basic rock types

(1) sedimentary rocks--mudstone, shale, siltstone, and sandstone

(2) crystalline igneous rock--basalt, diorite, granodiorite, basaltic andesite, and latite porphyry

(3) volcanic tuff

These rocks are extensively fractured as indicated by the yield characteristics of the water well and by the number and location of the lost circulation zones. The mudstone, sandstone, and basalt penetrated by the water well yield water uniformly--indicating that the yield of the rock is independent of rock type.

Ergo, fractures are suggested. Similarly the lost circulation zones occur in at least two different rock types--a phenomena which also indicates the presences of fractures.

CONCLUSION: Kelly Hot Springs #1 has demonstrated the presence of the extensive fracture system which was predicted in an earlier report. Inasmuch as regional stratigraphy indicating the rocks at greater depth will be similar to those sampled, we may expect that fractures frequency will be similar at depth.

Temperature

Attempts to learn the distribution of subsurface temperature at Kelly Hot Springs #1 includes:

(1) mud temperature measurements

(2) bottom-hole-temperature measurements

(3) continuous temperature logs (Welex, Schlumberger)

(4) a point temperature profile Sass)

Three factors that obviously have precluded our measuring the original in-situ temperature are

(1) the circulation of drilling mud,

(2) the discharge into the rocks of large volumes of cold (average 94 °F) drilling mud, and

(3) the movement of water in the bore hole from one depth to another.

The temperature logs proved to be misleading below a depth of 2048 feet, because the temperature sensing element became covered with filter cake and effectively insulated the sensor.

In general the circulation of drilling mud introduces relatively cold mud (94°F) at the bottom of the hole. This cools the rock and bit but warms the mud. The mud then moves up the annulus between the rock and the drill-stem where it tends to be warmer than the rock, so it warms the shallow rock but becomes cooler in the process. Thus, the discharging-mud temperature must be less than the bottom hole in-situ temperature but more than the minimum undisturbed temperature near the surface.

Below a depth of 1384 feet lost circulation was a problem. That is, drilling mud at a temperature of 94 °F or larger moved into the rocks. Below 2200 feet a significant portion of the drilling fluid moved into the rocks,-- from 5 to 100 percent of the total volume of mud circulated. Zones which recieved cold fluids showed up on the temperature logs or profile as a change in the temperature gradient.

In the Kelly Hot Spring region several lines of evidence point to the occurrence of a local and a regional groundwater flow system. In these systems water moves both vertically and horizontally. So any open bore hole serves as a conduct for the moving water. As a result of this movement temperatures in the bore hole are changed. Movement of this sort also shows up as a change in the temperature gradient on a temperature log or profile.

Brimhall predicted that the bottom hole temperature would stablize at 228 °F and predicted a temperature of 350 °F at a depth of 5500 feet. Brimhall's predictions are based on these assumptions:

(1) All cooling in the bore occurred as a response to circulating mud (i.e., no change was due to fluid loss).

(2) No cooling occurred after circulation stopped.

If no fluid movement occurs then Brimhall's estimates of temperature predicts the maximum in-situ temperature.

If fluids move toward (or away from) the bottom of the hole at a relatively uniform rate, then Brimhall's estimate predicts the temperature when equilibrium is achieved, but not the original in-situ temperature.

Considered en mass the temperature data are amenable to three interpretations:

(1) The in-situ temperatures at a depth of 3396 is 228 °F.

(2) The in-situ temperature at a depth of 3396 is less than 228, but the movement of warm fluids from the formation into the hole raises the temperature not only at the bottom but to a depth of about 1700 feet and 228 °F is the equilibrium temperature.

(3) Cold fluids are moving from about 1700 feet toward the bottom of the hole and the in-situ temperature at 3396 is larger than the predicted equilibrium temperature.

If (1) above occurs, the observed temperature gradient at the bottom of the hole can be used to estimate the temperature a greater depth. The apparent gradient (approx. 2.5 °C/100 meter or 45 °F/3000 feet) gives a predicted temperature of 6300 feet of 273 °F.

If (2) above occurs, the predicted temperature at greater depths should be less than or equal to the 273 °F estimated for (1).

If (3) above occurs, than all temperatures below a depth of 1700 feet are not characteristics and are less then and probably significant less then the in-situ temperatures. That is, temperatures as high as 410 °F (210 °C) could be masked by fluid moving down the well bore.

All observors, including Brimhall and Sass, believe that the temperature data for Kelly Hot Springs #1 reveal fluid movement below 1700 feet.

Whether the fluid flow is according to (2) or (3) is not obvious.

Using Sass's temperature for 30 feet and 360 feet we obtain an average temperature for the interval of 79 °F. The temperature of the water discharging from the water well is 77 °F, one might conclude, therefore, that the gradient Sass obtained for the interval from 30 to 1500 feet is close to in-situ gradient. Thus, suggesting that this portion of the temperature domain is unaffected by the temperature of water circulating in the bore hole.

The following table shows the temperatures observed at selected depths on each of the temperature logs.

		Temperature (°F)			
		Schlumberger			
Depth (ft)	Welex	run 1	run 2	run 3	Sass
100	98±	--	--	--	68.7
500	102±	113.8	94.5	87.8	102.9
1000	126±	120.4	116.5	114.8	142.7
1100	130±	121.5	118.0	119.3	152.8
1500	--	140.5	141.5	141.8	200.8
2000	--	147.5	157.0	151.0	217.5
2500	--	151.2	172.5*	176.5*	219.7
3000	--	158.2	175.8*	179.3*	221.0

* influenced by mud on sensor

These data show that temperature at all depths have changed but these at shallow depths have changed more than those at greater depths. We might interpret these observations to favor either (2) or (3).

CONCLUSION: After studying the data in detail, I find myself believeing (without truly substantive evidence to support my belief) that the observed temperatures below a depth of 1500 feet are well below the in-situ temperatures.

RECOMMENDATION: This well should be cased with 7 5/8 inch casing to 3395. The casing should be cemented in place and a series of temperature logs should be intiated to determine the temperature distribution thereafter. These temperature logs should be obtained over a period of 4 weeks. If the temperatures show no change in the bottom hole temperature or a substantive increase over all, the well should be deepened to at least 6000 feet by drilling with air.

COST: I estimate the cost of this program as follows:

Mobilization:	$10,000.00
Case and cement:	50,000.00
Temperature logs:	20,000.00
Drill and test 3000 feet:	200,000.00
Contingencies:	20,000.00
Total	$300,000.00

Other recommendations

Because Kelly Hot Springs #2 encountered temperatures of 160 °F at only 241 feet. A deep test is warranted near that location. The exact location to be determined as the basis of the supplementary ground noise surveys and the reinterpreted resistivity data.

The test hole should be (1) deep enough to test the fracture system adequately i.e. at least 3000 feet, (2) drilled with air, and (2) cased throughout after thorough logging.

I estimate the cost of future test in the area at $200,000.

A P P E N D I X 1

WATER WELL DATA

DUPLICATE
Retain this copy

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do Not Fill In
№ 128967
State Well No.
Other Well No.

(1) OWNER:

Name Geothermal Power Corporation
Address Kelly Hot Springs Limited
2249 Van Nees Ave. San Francisco, Ca. 94109

(2) LOCATION OF WELL:

County Modoc Owner's number, if any
Township, Range, and Section T. 42 N.-- R. 10 E. Sec 27
Distance from cities, roads, railroads, etc. N. W. 1/4 of N.E. 1/4

(3) TYPE OF WORK (check):

New Well [X] Deepening [ ] Reconditioning [ ] Destroying [ ]
If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic [X] Industrial [ ] Municipal [ ]
Irrigation [ ] Test Well [ ] Other [ ]

(5) EQUIPMENT:

Rotary [X]
Cable [ ]
Other [ ]

(6) CASING INSTALLED:

STEEL: X OTHER:
SINGLE [X] DOUBLE [ ]

If gravel packed

From ft.	To ft.	Diam.	Gage or Wall	Diameter of Bore	From ft.	To ft.
0'	36	6"	188			

Type of shoe or well ring: none
Size of gravel:
Describe joint Welded

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.
		NONE		

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes [X] No [ ] To what depth 36 ft.
Were any strata sealed against pollution? Yes [ ] No [X] If yes, note depth of strata
From ft. to ft.
From ft. to ft.
Method of sealing Casing & Cement

(9) WATER LEVELS:

Depth at which water was first found, if known 40 ft.
Standing level before perforating, if known 20 ft.
Standing level after perforating and developing 20 ft.

(10) WELL TESTS: Air Test

Was pump test made? Yes [ ] No [ ] If yes, by whom? Driller
Yield: 80 gal./min. with 180 ft. drawdown after 2 hrs.
Temperature of water 80 Was a chemical analysis made? Yes [ ] No [X]
Was electric log made of well? Yes [ ] No [X] If yes, attach copy

(11) WELL LOG:

Total depth 360' ft. Depth of completed well 360' ft.
Formation: Describe by color, character, size of material, and structure
ft. to ft.

0'-2' Top soil
2'-20' Brown clay
20'-35' Blue sandy clay
35'-75' Blue clay
75'-100' Brown clay
100'-150' Dark brown sandy clay
150'-200' Green sandy clay
200'-250' Brown sandy clay
250'-280' Green sandy clay
280'-290' Black sandy clay
290'-330' Black sandstone
330'-345' Black clay some gravel
345'-350' Black rock
350'-354' Black sandstone
354'-360' Black rock

Work started June 1974. Completed June 1974

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Conners' Well Drilling, Inc.
(Person, firm, or corporation) (Typed or printed)
Address P. O. Box 92 Alturas, Calif. 96101
[SIGNED] Roy O Conner
(Well Driller)
License No. 250 298 Dated July 1, 1974

SKETCH LOCATION OF WELL ON REVERSE SIDE

DWR 188 (REV. 9-68)

67139-760 8-72 30M TRIP OSP

STANDARD WATER ANALYSIS REPORT

Orlando Laboratories, Inc.
P. O. Box 8025A • Orlando, Florida 32806 • 305/843-1661

Report to: Geothermal Power Corporation

Appearance: Clear

Date: July 17, 1974

Sampled by: Client

Report Number: 9019

Identification: Water Sample-W. K. Summers

METHODS

This water was analyzed according to "Standard Methods for the Examination of Water and Wastewater," Latest Edition, APHA, AWWA and WPCF.

RESULTS

Determination	Data Significance	p.p.m.	Determination	Data Significance	p.p.m.
Total Dissolved Solids, @ 105°C.	x.	382	Total Hardness, as $CaCO_3$	x.	54
Phenolphthalein Alkalinity, as $CaCO_3$	x.	0	Calcium Hardness, as $CaCO_3$	x.	42
Total Alkalinity, as $CaCO_3$	x.	174	Magnesium Hardness, as $CaCO_3$	x.	12
Carbonate Alkalinity, as $CaCO_3$	x.	0	Calcium, as Ca	x.	17
Bicarbonate Alkalinity, as $CaCO_3$	x.	174	Magnesium, as Mg	.x	2.9
Carbonates, as CO_3	x.	0	Sodium, as Na	x.	84
Bicarbonates, as HCO_3	x.	212	Iron, as Fe	.x	0.2
Hydroxides, as OH	x.	0	Manganese, as Mn	.x	0
Carbon Dioxide, as CO_2	x.	9	Copper, as Cu	.x	0
Chloride, as C1	x.	3	Silica, as SiO_2	x.	52
Sulfate, as SO_4	x.	56	Color, Standard Platinum Cobalt Scale		0
Fluoride, as F	.x	0.9	Odor Threshold	x.	0
Phosphate, as PO_4	.x	8.4	Turbidity, Jackson Units	x.	1.4
pH (Laboratory)	.x	7.6	Potassium, K		13.2
pHs	.x	7.9	Spec. Cond. /umhos		440
Stability Index	.x	8.2	Arsenic, As		<0.01
Saturation Index	.x	-0.3	Boron, B		0.79

Signed: [signature]
Chemist

(To convert ppm to grains per gallon, divide ppm by 17.1 — p.p.m. = mg/l)

INTERNATIONAL ANALYSIS OF WATER, SEWAGE & INDUSTRIAL WASTEWATER-ENVIRONMENTAL IMPACT STUDIES

Temperature of water discharging from supply well.

		Temperature (°F)	
Date	hour	At discharge from well into storage tank	Make up water measured at mud pit
7/2/74	1045	*	
	1050	68	
	1200	75	
	1315	77	
7/3/74	0212	--	70
7/4/74	0547	--	71
7/10/74	1400	77	75

* pump first turned on

A P P E N D I X 2

KELLY HOT SPRINGS #1

Driller's log

Date	Drilled(ft)	Lithology	Drilling time From	Drilling time To	Non-drilling time From	Non-drilling time To	Explanation
7/2/74	0-222.37	sand & shale	1400	1700	1700	4800	
	222-526	shale	1800	2230	2230	0360	Bit #2
7/3/74	526-544	sand & shale	0200	0800	0800	2400	case and cement, bit #3
7/4/74	544-577	?	1000	1830	0000	1000	Bit #4, BHT
	577-629	?	1700	1200			
7/5/74	629-694	sand & shale	0000	0200			
	694-700	?	00230	0700			
			0730	0900	0900	2400	twist off fish, bit #5
7/6/74	700-764	sand & shale	0200	1230	0000	0200	BH temp. meas.
	764-1318	?	1330	1530	1530	1900	bit #6
					1900	2000	BHT
	1318-1384	?	2100	2200	2200	244	condition mud, lost circulation
7/7/74	1384-1780	sand & shale	0000	0130	0130	300	condition mud, bit #7
	1780-1782		0300	0800	0900	1000	mix mud, lost circulation
					1000	2400	wait on tester
7/8/74					0000	0600	wait on tester
					0600	2400	

Driller's log (continued)

Date	Interval Drilled(ft)	Lithology	Drilling time From	Drilling time To	Non-drilling time From	Non-drilling time To	Explanation
7/9/74	1782-1962	sand & shale	130	245	0	0130	logging
	1962-2259	shale	300	600	245	300	bit #8
			900	1130	600	900	bit #9
			1230	1430	1130	1230	lost circulation
					1430	2400	wait on LCM
7/10/74	2259-2261	?	1500	2400	0	1500	lost circulation, problems
	2261-2300	sand					
	2300-2513	sand & shale					
7/11/74	2513-2636	?	0	600	600	900	bit #10
	2636-2917	sand	900	1130			
	2917-3008	sand & shale	1230	1830	1130	1230	mix mud LCM
			1830	2400½	1830	2400½	mix mud LCM
7/12/74	3008-3124	?	0	330	320	400	mix mud LCM
	3124-3253	?	400	1100	1100	1330	circulating
	3253-3299	?	1330	1600	1600	1900	bit #11
			2100	2400	1900	2100	mix mud LCM
7/13/74	3299-3395	?	0	0600	600	2400	condition hole and log

Synopsis of Magcobar Drilling Mud Reports

		Hole		Circulation		Velocity (ft/m)		Time (min.)	
Rept.#	Date	Dep. (ft)	Volume (cuft)	Bbls/min.	gpm	collor	stem	bottom up	total
1	7/2	520	114	11.7	493	68	57	9	27
2	7/4	550	55	11.7	493	247	142	4	22
3	7/6	1350	131		493			9	28
4	7/8	1782	170		493			12	31
5	7/10	2265	185	6.0	252	127	73	31	48

Note: Mud pit volume 100 bbls.

Rept.#	Cost	Weight (lbs/cuft.)	Viscosity (sec/qt)
1	463.35	68	69
2	201.68	65	40
3	312.10	?	?
4	791.60	not meas.	not meas.
5	3522.74	not meas.	not meas.

Bags Used

Rept.#	Gel	TannAthin	Caustic Soda	other	LCM
1	1100	0	2	1	0
2	19	6	2	3	0
3	53	?	?	?	?
4	112	2	2	2	59
5	786	0	2	2	267

Bit History

Bit No.	Interval	on July 1974	Hour	MFG	Type	Dia. (in.)
1	30-526	2	1400	Smith*	DTT	15"
2	526-544	3	0400	Hughes*	OSC	15"
3	544-574	4	1000	Hughes*	X3C	9 7/8
4	574-700	4	2400	Smith	DGJ	9 7/8
5	700-1318	6	0100	Smith	DTTJ	9 7/8
6	1318-1782	6	2300	Smith	S3J	9 7/8
7	1782-1962	9	0200	Hughes*	OSC	9 7/8
8	1962-2261	9	0800	Smith	SUH	9 7/8
9	2261-2636	10	1500	SEC	MYLGJ	9 7/8
10	2636-3253	11	0900	SEC	S4J	9 7/8
11	3253-3396	12	1600	Reed*	VGJ	9 7/8

* = Retip

Description of Samples

Kelly Hot Springs No. 1 (NW$\frac{1}{4}$ Sec.27, T.42N., R.10E.)
Geothermal Power Corp.
by: Dr. Wm. R. Seager
Earth Sciences
N. Mex. State University

42-100	Claystone, light gray-cream; with minor shale, dark gray, carbonaceous, possible tuffaceous or derived from volcanic ash
100-120	Claystone, cream; minor pyrite coatings
120-130	Claystone, as above; shale, dark gray carbonaceous (?) and tuffaceous fissile
130-140	Claystone, as above; tuff, crystal, light gray
140-210	Claystone, tuffaceous (?) (weathered volcanic ash?)
210-220	Claystone, cream, tuffaceous (?) as above; shale light gray
220-230	missing
230-300	Tuff, volcanic or mudstone, tuffaceous, light greenish brown, andesitic or latitic, (lahar); minor sanidine crystals and quartz crystals; numerous pumice fragments weathered to clay
300-310	Tuff, volcanic or mudstone, tuffaceous, andesitic to latitic in comp. as in 230-300; shale, dark gray
310-330	missing
330-344	Tuff or tuffaceous mudstone, light greenish brown, crystal-rich, andesitic (?); sandstone, tuffaceous, light gray; minor shale, black
344-354	Sandstone as in 330-344; also basalt or basaltic andesite, black, fine-grained
354-364	Sandstone and conglomerate, tuffaceous; andesite porphyry, minor hornblende, and basalt as in 344-354
364-374	Basalt or basaltic andesite, dark gray, very fine grained; minor tuff; shale black; minor pyrite
374-396	Basalt, black-dark gray; minor tuff, gray or mudstone, tuffaceous; scattered pyrite
396-416	Basalt, black-dark gray; tuff, gray, siliceous or mudstone, tuffaceous

416-426 Basalt, black-dark gray; shale; and mudstone dark gray

426-436 Sandstone, siltstone and shale, tuffaceous, light greenish brown; many crystal fragments; and basalt, black-dark gray

436-457 Mudstone, siltstone, and claystone, light greenish brown, tuffaceous; minor basalt, black

457-467 Mudstone, siltstone, and claystone, light-greenish brown, tuffaceous; minor basalt, black; fracture coatings of $CaCO_3$ or another CO_3

467-477 Shale, dark gray with calcite coatings

477-487 Shale, dark gray; mudstone or tuff, light gray, siliceous, tuffaceous with an abundance of drusy quartz in vugs and on fractures

487-497 Shale, medium to dark gray-black

497-507 Shale, light-greenish gray, siliceous (?)

507-517 Shale, light gray-medium gray, siliceous; minor tuff, crystal

517-527 Basalt or basaltic andesite, dark gray-black; minor shale, greenish gray

527-536 Shale, dark gray-medium gray; basalt as in 517-527; diorite, coarsely crystalline (may be a coarse-grained facies of the basalt

536-565 Diorite (coarse-grained basalt?); shale, medium-dark gray; basalt

565-795 diorite, as above

884-899 Sandstone and conglomerate, light greenish brown, muddy, volcanic, probably slightly tuffaceous (ash-fragments weathered to clay)

929-959 Siliceous rock fragments and crystal fragments in clay matrix-probably washed out of very friable soft clayey tuff (latitics?)

959-982 Conglomerate and sandstone, conglomeratic, light brown, very poorly sorted, probably somewhat tuffaceous; crystals and rock clasts (latitic?)

982-997 Siliceous rocks and crystals washed out of soft friable conglomerate, conglomeratic sandstone, or tuff?

997-1012 Tuff or claystone, weathered, cream-colored, massive; also many fragments of siliceous rock types and crystals probably from conglomerate or another tuff

1012-1027 Sandstone, pebbly tuffaceous, light greenish brown; very poorly sorted; siliceous rock types and crystals as grains

1027-1043 Pebbly sand in clayey metrix; various siliceous clasts as well as clay; some glassy black basalt clasts; very poorly sorted, angular

1073-1088 Siltstone, light gray-light tan, tuffaceous; minor sandstone and conglomerate, tuffaceous

1088-1103 Granodiorite (may be exceptionally coarse-grained dacite or quartz latite), quartz, biotite, plagioclase; about 50% mafics

1103-1118 Granodiorite; siltstone, tan

1133-1148 Granodiorite, no sedimentary rocks

1148-1163 Sandstone and siltstone, light tan; granodiorite (or coarsely crystalline dacite) is present too

1283-1313 Siltstone and conglomeratic sandstone, light gray, tuffaceous, (granule size clasts; slightly calcareous)

1323-1383 Shale and siltstone, light gray, tuffaceous, calcareous

1383-1413 Shale and siltstone, light gray, tuffaceous, calcareous, fissile

1413-1443 Shale and claystone, light gray, silty; minor sandstone, pebbly, poorly sorted

1443-1473 Tuff, rhyolitic to latitic, crystal rich (air-fall? or or ash-flow?) crystals are probably sanidine; also many siliceous clasts probably washed from soft matrix; minor shale-siltstone, light gray like 1413-1443

1473-1654 Tuff, crystal (air-fall or ash-flow?) crystal fragments are sanidine, hornblende; crystals are disagrgated from clayey tuffaceous matrix; other fragments (latitic?)

1654-1684 Same as above; many biotite schist fragments (inclusions in the tuff?)

1684-1714 Tuff, light gray, very fine-grained, clayey, rhyolitic

1744-1774 Sandstone and siltstone, light gray, tuffaceous; shale, very light gray

1780-1810 Siltstone (?), red brown, or shells?

1810-1870 Poor returns

1870-1960 Tuff, pale green, crystal, probably andesitic or latitic

1960-1962 Tuff, pale green, andesitic, crystal; obsidian, black, basaltic (?)

1962-1970 Basalt, dark gray, glassy; some obsedian-like fragments

1970-1980 Basalt, dark gray, glassy; and tuff, light gray to greenish gray, andesitic to latitic

1980-2000 Tuff, light greenish-gray, andesitic to latitic, crystals

2000-2040 Tuffa, as above; siltstone, tuffaceous; basalt (?) black-dark gray, glassy

2040-2050 Mudstone and shale, tuffaceous; some siltstone, yellow brown; small amounts of basalt (?), glassy, and tuff crystal

2052-2072 Tuff, light greenish gray, andesitic or latitic, crystal

2072-2102 Tuff, light greenish gray, andesitic or latitic, crystals; crystals decreasing in abundance

2102-2132 Tuff, pale reddish gray, andesitic or latitic, crystal, siliceous; some weathered pumice fragments

2132-2157 Like 2102-2132, also tuff, pale green, andesitic-latitic, crystal

2157-2217 Tuff, light greenish gray, andesitic-latitic, crystal

2217-2230 missing

2230-2265 Tuff, soft, friable, light gray, latitic?

2265-2300 Poor returns - shells

2300-2330 Tuff, gray, vuggy; drusy unidentified minerals in vugs

2330-2390 Tuff, light greenish gray, latitic to andesitic, crystal

2390-2420 Tuff, mostly light greenish gray, latitic to andesitic crystals

2420-2450 Mostly cottonseeds

2450-2480 Mudstone (lahar?), light purplish gray, crystal-rich silty

2480-2510 Basaltic andesite porphyry, medium gray, with vugs

2510-2540 Basalt?, glassy, some obsedian fragments may be rhyolitic instead of basaltic

2540-2570 Sandstone, light greenish gray, soft, very tuffaceous, poorly sorted, rock fragments and crystals

2570-2600 Latite (?) porphyry, medium gray; vapor phase mineral in vugs

2600-2630 Latite (?) porphyry, medium gray; also basalt (?) or basaltic andesite (?), black glassy

2630-2726 Tuff, soft, friable, light greenish gray, crystal, probably andesitic to latitic; some basalt (?), glassy

2726-2756 Poor returns; probably same as 2630-2726

2756-2946 Tuff, soft, friable, light greenish gray, crystal; broken crystal fragments in matrix of ash and tiny crystals; probably andesitic to latitic

2946-2976 Basaltic andesite or basalt, medium dark gray

2976-3006 Basaltic andesite or basalt, medium dark gray; shale and siltstone, red

3006-3036 Basalt or basaltic andesite, medium dark gray; tuff, light greenish gray, crystal

3036-3066 Poor returns- Mudstone, medium gray, poorly sorted; clasts of sand-size rock fragments

3066-3096 No returns - all cottonseed

3096-3126 Tuff, dark reddish-gray, ash-flow with eutaxitic texture; poor returns

3126-3156 Shale and siltstone, red brown; tuff, light greenish gray andesitic to latitic crystal; poor returns

3156-3186 Minor basalt, black, and andesite porphyry, dark red-gray; much light light green gray, siliceous rock and crystal fragments, probably washed from soft crystal tuff

3186-3216 Basalt or basaltic andesite

3216-3246 Basalt or basaltic andesite; and disaggregated crystal tuff? gypsum? needles

3246-3276 Poor returns; like 3216-3246 above

3276-3306 missing

3306-3336 Basalt

3336-3366 Poor returns; basalt as above

3366-3399 Some basalt; mostly crystals and rock fragments washed from soft andesitic to latitic tuffs - possibly coming from up the hole

A P P E N D I X 3

KELLY HOT SPRINGS #2

Sample log; Kelly Hot Springs #2

Description by: Ted Wilton

Date 10/3/74

Interval (ft)	Sample description
0-5	No samples,
5-40	Andesite, medium to dark gray, slightly porphyritic texture. Some limonite staining.
40-50	No samples.
50-100	Tuff, light gray; trace (less than 1%) euhedral, untarnished pyrite at 60'-80'; trace of limonite staining; some white pumice noted at base of unit.
100-110	Andesite, medium to dark gray, non-porphyritic texture.
110-200	Tuff, light gray to gray-yellow; trace of tarnished, euhedral purite.
200-210	Tuff and andesite; possibly interbedded; samples are contaminated; trace of tarnished, subhedral pyrite.
210-220	Pumice, white; some (1 to 2%) slightly tarnished, subhedral pyrite.

Sample log; Kelly Hot Springs #2

Description by: Ted Wilton

Date 10/3/74

Continued

Interval (ft)	Sample description
220-240	Tuff and andesite, interbedded. Samples are very contaminated.