GEOLOGY AND DRILLING HISTORY
OF THE
ASHIDA #1 GEOTHERMAL TEST,
OPIHIKAO PROSPECT,
HAWAII

for

BARNWELL INDUSTRIES, INC.

HONOLULU, HAWAII

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by

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GeothermEx, Inc.
Berkeley, California

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INTRODUCTION AND SUMMARY

The Ashida #1 geothermal exploration well is located approximately 300 feet south of the line of eruptive fissures and cinder cones which are the surface of the southern margin of the Kilauea East Rift Zone on the island of Hawaii (figure 1). The site is in the north-central part of the Opihikao prospect area where the elevation is 800 feet above sea level.

Access to the drill site is by way of a one mile-long gravel road which intersects highway 13 at a point 2.8 miles south of the town of Pahoa in the Puna District of Hawaii.

Ashida #1 was spudded at noon on Tuesday, June 10, 1980. Drilling operations were suspended at midnight of Wednesday, October 29, 1980. Total depth was 8,300 feet. In the course of drilling operations, there were major interruptions in drilling at depths of 1,225 feet and 3,925 feet where 13-3/8" and 9-5/8" casing strings were set, and geophysical surveys run and at a depth of 7,927 feet where the well was tested.

Ashida #1 penetrated a lithologic section of subaerial lava flows (surface to 1,860 feet), shallow marine volcanic rocks and sediments (1,860 to 2,400 feet) and deep submarine lava flows (2,400 to 8,300 feet). There were no zones of lost circulation encountered below surface casing (1,200 feet). The temperatures in the well display profiles which are convex upward, with an increasing gradient at depth (table 4). From surface to 3,000 feet depth, the temperature gradient is less than 1°F/100 feet. From 3,000 feet to 6,500 feet the gradient ranges from 3°F/100 feet to 6°F/100 feet. Below 6,500 feet to total depth the gradient rises to approximately 10°F/100 feet. The maximum temperature recorded was 550°F, measured at total depth.

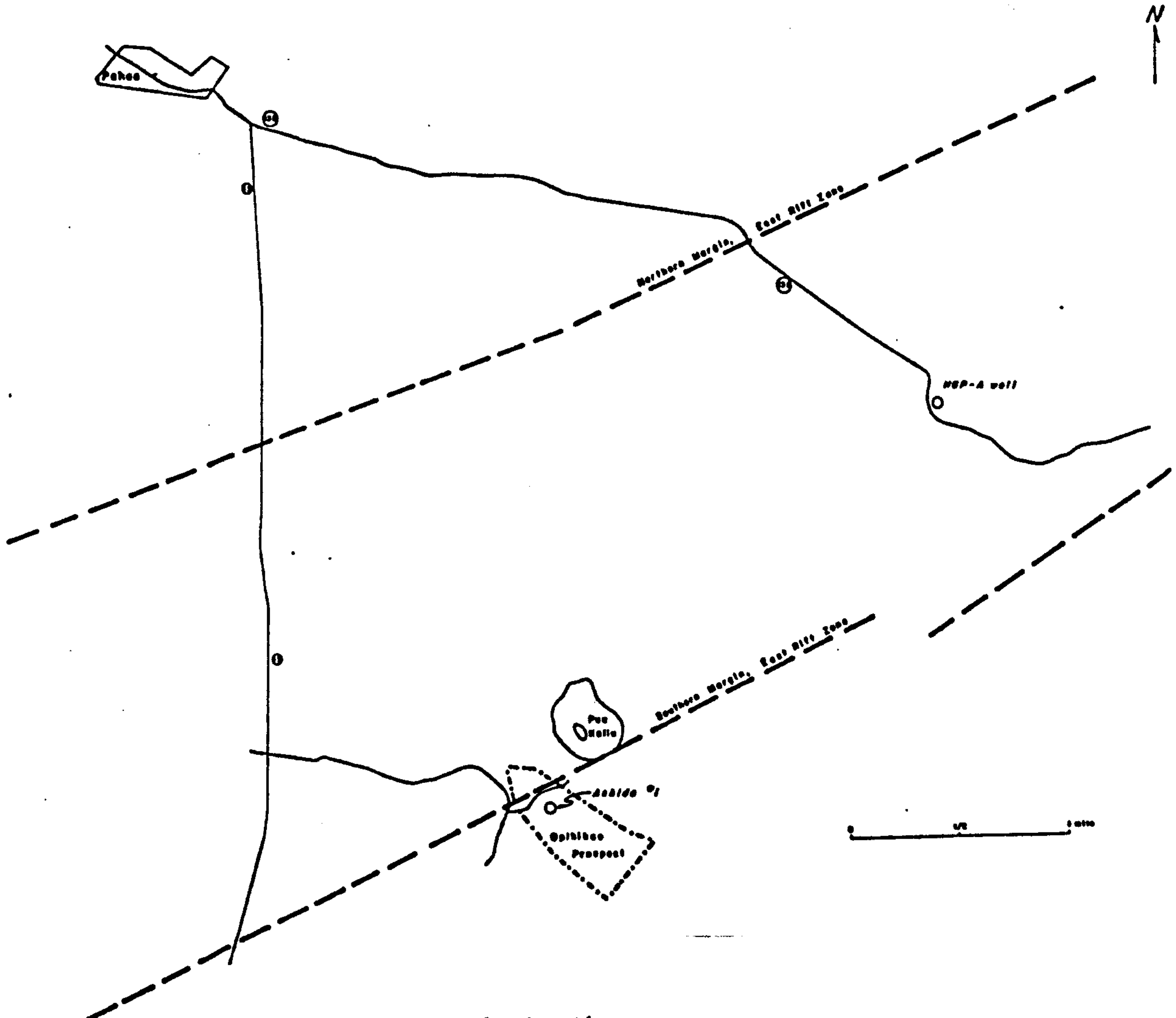

Figure 1. Location map

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DRILLING HISTORY

Phase I - Conductor Hole

The 26-inch diameter conductor hole was drilled in 3 stages. Initially, a 12-1/4-inch pilot hole was drilled; it was reamed open to 17-1/2 inches, and then reamed open to 26 inches (figure 2).

Drilling began at 1700 hours on Tuesday, June 10. Circulation of drilling fluid was lost at 32 feet and not regained during drilling of the conductor hole. The pilot hole was completed to a depth of 164 feet at 2230 hours on Thursday, June 12.

Opening the pilot hole to 17-1/2-inches was accomplished in 13-1/2 hours. Reaming with a 17-1/2-inch Security hole-opener started at 0130 hours, on Friday, June 13, and concluded at 1500 hours, at a depth of 74 feet (Appendix C, drill bits).

The 17-1/2-inch hole was opened to 26 inches on Saturday, June 14, with a 26-inch Smith hole-opener. Operations began just after midnight and ended at 0800. The 26-inch hole was drilled to a depth of 70 feet.

The initial attempt to run 22-inch conductor failed on Monday, June 16, because the hole was crooked. The hole was reamed with a stiff drilling assemblage (figure 2) down to 68 feet. Reaming was completed at 1200 hours on Tuesday, June 17.

Twenty-two (22)-inch, seamed conductor pipe was run to a depth of 69 feet at 1400 hours on Tuesday, June 17. The pipe was cemented from the surface with 270 cubic feet of Redi-mix cement containing a blend of cement and crushed rock mixed in equal amounts with 2% calcium chloride additive. Cleaning of the 12-1/4-inch pilot hole to 164 feet commenced at 0800 hours on Wednesday, June 18.

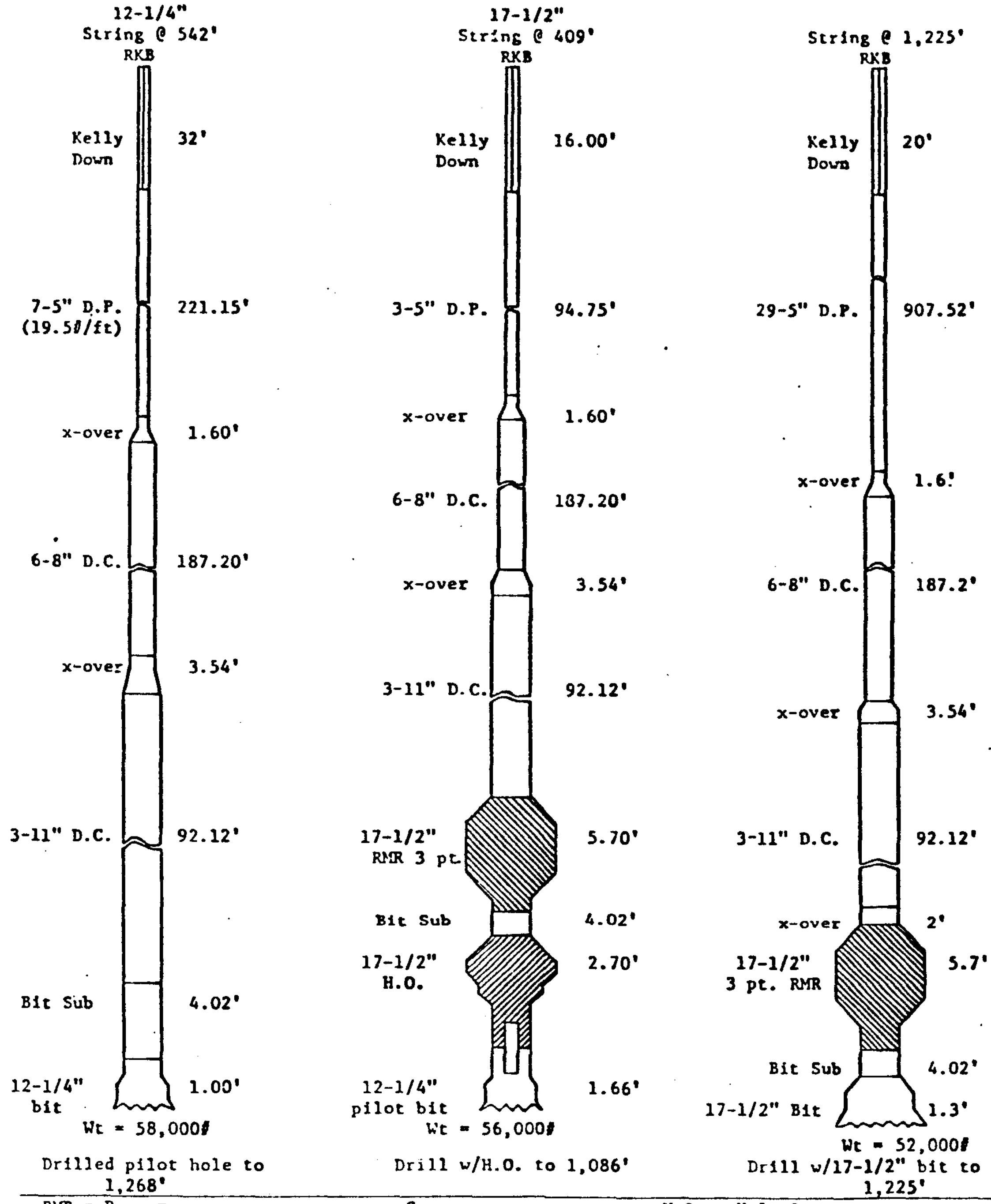
Phase II - Surface Hole

Step 1A: 12-1/4-inch pilot hole

On Wednesday, June 18, the cement plug was drilled at the base of the conductor pipe and the 12-1/4-inch pilot hole was reamed down to 164 feet with an air-foam drilling fluid. Drilling "new" pilot hole began at 1450 of the same day (figure 3).

By Thursday, June 19, at 1000 hours, drilling had reached a depth of 478 feet. The bit was pulled, replaced by a Security "rerun" button bit and drilling resumed.

Figure 3.
Phase II - DRILLING ASSEMBLIES



RMR = Reamer   x-over = Cross-over   H.O. = Hole Opener
D.P. = Drill Pipe   D.C. = Drill Collar

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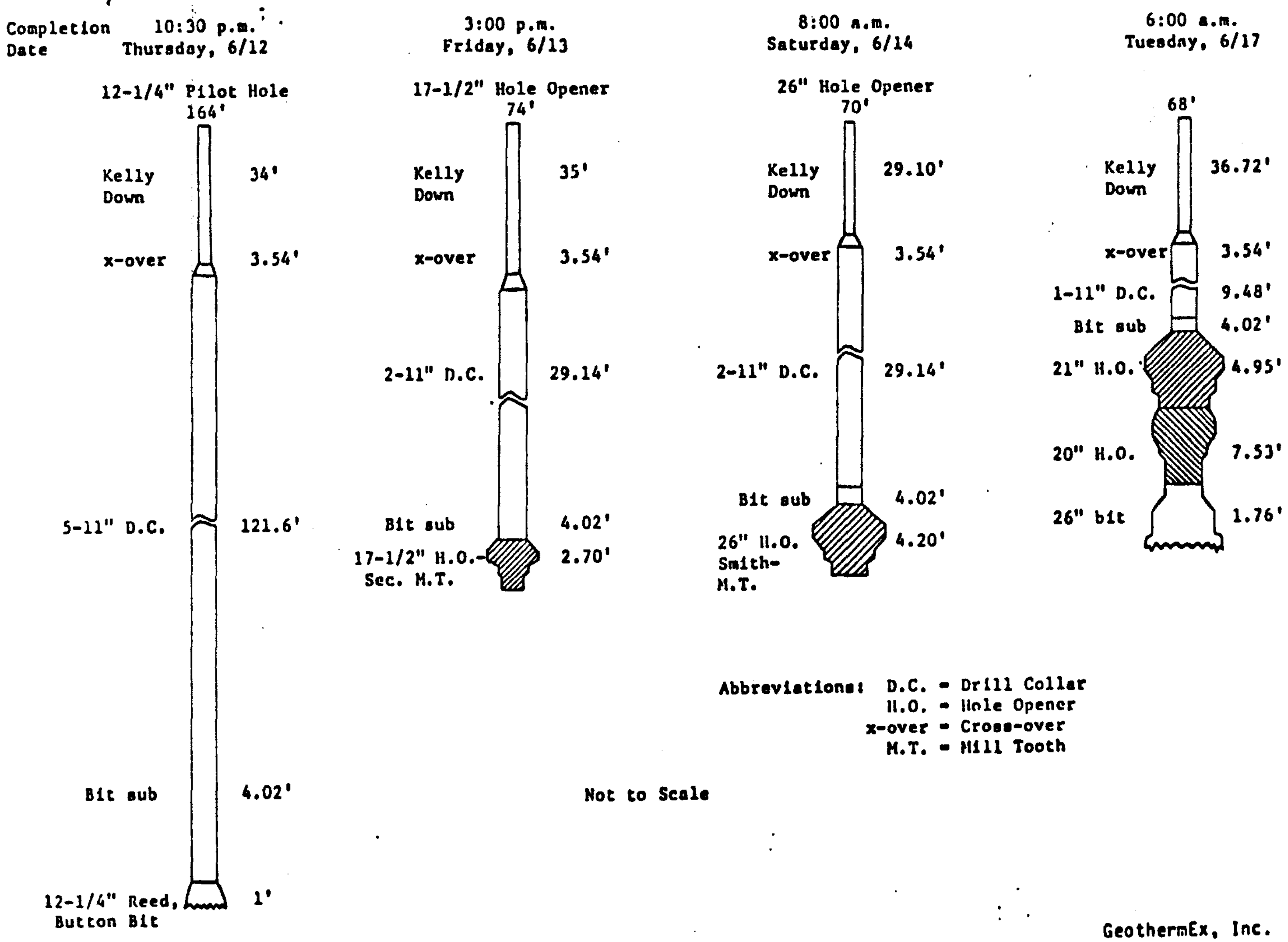
Figure 2.
Phase I - CONDUCTOR HOLE - Drilling Assemblies



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The drilling medium was switched from air-foam to mud-gel at a depth of 827 feet in accordance with Hawaii state regulations for drilling through fresh water aquifers. Circulation of mud-gel fluids was not established, but drilling continued and at 0800 hours on Saturday, June 21, the hole was at a depth of 874 feet. The rig was secured for the weekend.

Step 1B: Bailing the hole

State regulations require that a sample of the fresh water aquifer from all wells be collected and chemically analyzed to establish its potability.

Bailing operations commenced on Monday, June 23, at 0800 hours. At 0730 hours the following day the seven-inch bailer became stuck in the open hole at an approximate depth of 835 feet. After an unsuccessful attempt to jar the bailer free with drill pipe, a fishing spear was manufactured and run into the hole. The initial run failed when the spear cut through the wire line. The second attempt was successful, and at 1600 hours the bailer was pulled from the hole and laid down.

Open-ended drill pipe was lowered into the hole, and a 2-7/8-inch bailer was run down through the pipe, as an alternative bailing technique. At 1300 hours on Wednesday, June 25, three one-gallon samples of fluid were collected from the bailers (Appendix E). Down hole surveys recorded a fluid level of 803.5 feet (RKB) and a temperature of 138°F.

Step 1C: 12-1/2-inch pilot hole

Drilling with the mud-gel drilling fluid resumed at 2000 hours on Wednesday, June 25, still without circulation and returns. At 1200 hours on Friday, June 27, the depth was 1,085 feet (RKB). Drill pipe was removed from the hole and a new Smith button bit was added to the assembly. The used Security "rerun" bit had damaged bearings which allowed individual cones to cut into each other. However, the gauge of the hole appeared to be unaffected.

Drilling continued without returns of the mud-gel drilling fluid until the weekend break. On Monday, June 30, the target depth of 1,268 feet was reached at 1400 hours.

Step 2: Opening the hole to 17-1/2-inch

Opening the 12-1/4-inch pilot hole to 17-1/2-inch began at 0400 hours on Tuesday, July 1. Drilling was without circulation of mud-gel drilling fluid.

Opening the hole had progressed to a depth of 168 feet when the Kelly twisted off above its crossover sub at 1830 hours on Tuesday, July 1. An 11-3/4-inch overshot equipped with a 7-7/8-inch grapple was picked up and run into the hole. By 0100 hours of the following day, the fish had been retrieved, and a new Kelly installed.

Opening the pilot hole to 17-1/2-inch resumed. A 17-1/2-inch reamer was added to the drilling assemblage to keep the hole straight. Initial problems with hole sloughing and with continual plugging of the pilot bit were not eliminated by increasing the mud viscosity. At a depth of 305 feet the drilling medium was changed from mud-gel to air-foam. Circulation was not established despite the change, and reaming was blind, except for partial returns from 580 feet to 618 feet. At a depth of 800 feet the drilling fluid was changed back to mud-gel in accordance with state requirements for protection of fresh-water aquifers.

The target depth of 1,225 feet was reached at 0700 hours on Monday, July 14.

The failure to develop mud cake and establish circulation of drilling fluids resulted in hole sloughing and the inability to remove cuttings from the hole. These problems manifested themselves as stuck pipe and plugged pilot bits. Switching drilling fluids from mud-gel to air-foam or increasing the mud viscosity did not cure the problems. Numerous cleaning runs were made into the 12-1/4-inch pilot hole, and many trips were necessary to unplug the pilot bits.

Step 3: Running 13-3/8-inch surface casing (see Appendix F, for detailed description)

The hole was conditioned with lost circulation material and high viscosity mud-gel prior to running surface casing in an attempt to establish circulation. After 48 hours of conditioning, the fluid level in the hole stood at 205 feet (RKB) at 0230 hours, July 17. Thirty joints of J-55 buttress casing were placed in the hole between 1600 hours on Thursday and 0100 hours on Friday, July 18.

In stage I of the cementing operations, 310 sacks of class G were pumped down through the casing. The cement was chased with a shut off plug and 180 barrels of water. No pressure buildup was observed while pumping the water, indicating that the plug did not reach the baffle. The d.v. tool was opened, and mud was pumped down the hole intermittently for 8 hours.

In stage II of the cementing operations 300 sacks of Class G cement were pumped down the casing and out the d.v. tool. The cement was displaced from the casing with a closing plug and 141 barrels of water. There were no cement returns to the surface.

Temperature surveys run on the following three days (figure 4) indicated that cement in the annulus had risen to within 200 feet of the surface. Subsequently, tubing, run down the annulus, tagged cement at 211 feet.

In Stage III, 918 cubic feet of redi-mix were poured down the annulus, causing the cement level to rise to 128 feet (RKB). An additional 134 cubic feet of class G cement brought the level up to 80 feet (RKB). Another 40.5 cubic feet of redi-mix brought it to 65 feet (RKB), and 25 cubic feet of class G cement brought cement up to the cellar floor.

In all, 2,592 cubic feet of cement slurry or roughly 200% excess volume was pumped down the hole. About 100% excess was lost in stages I and II, and 100% excess was consumed during stage III of the operation. Cement bond logs were run and interpreted to indicate a satisfactory bond along the entire casing string.

Phase III - Intermediate Hole

Step 1: Drilling 12-1/4-inch hole

Blow out preventors were nippled up and tested on the 13-3/8-inch surface casing. The d.v. tool and 15 feet of cement plug above the guide shoe were then drilled out using water as a drilling medium.

On Friday, July 25, the crews mixed mud and prepared to drill out beneath the 13-3/8-inch casing. The drilling assembly was composed of a 12-1/4-inch button bit beneath a 12-1/4-inch reamer (figure 5). Drilling the 12-1/4-inch hole began at 1500 hours at a depth of 1,268 feet. Drilling with full circulation of mud/gel plus lost circulation material went smoothly. At 1200 hours on Wednesday, August 13, the depth was 3,925 feet. At this time the hole was circulated for 4 hours to condition the well for logging. Logging operations (Appendix F) were completed at 0800 hours on Thursday, August 14th. During the interim between Thursday and Monday mornings several temperature surveys were run, and on Sunday, a second electric log was run. Meanwhile, drilling crews reorganized drill pipe and floor equipment, blended cement and prepared to run 9-5/8-inch casing.

Step 2: Running 9-5/8-inch casing (see Appendix F for detailed account).

On Monday, August 18, the hole was conditioned from 1230 to 1530 hours, then crews laid down the 5-inch drill pipe and picked up new 4-inch drill pipe in anticipation of running the 9-5/8-inch casing. The design was to run and cement the casing in two stages. During the first stage, approximately 2,900 feet of casing (with d.v. tool positioned midway along

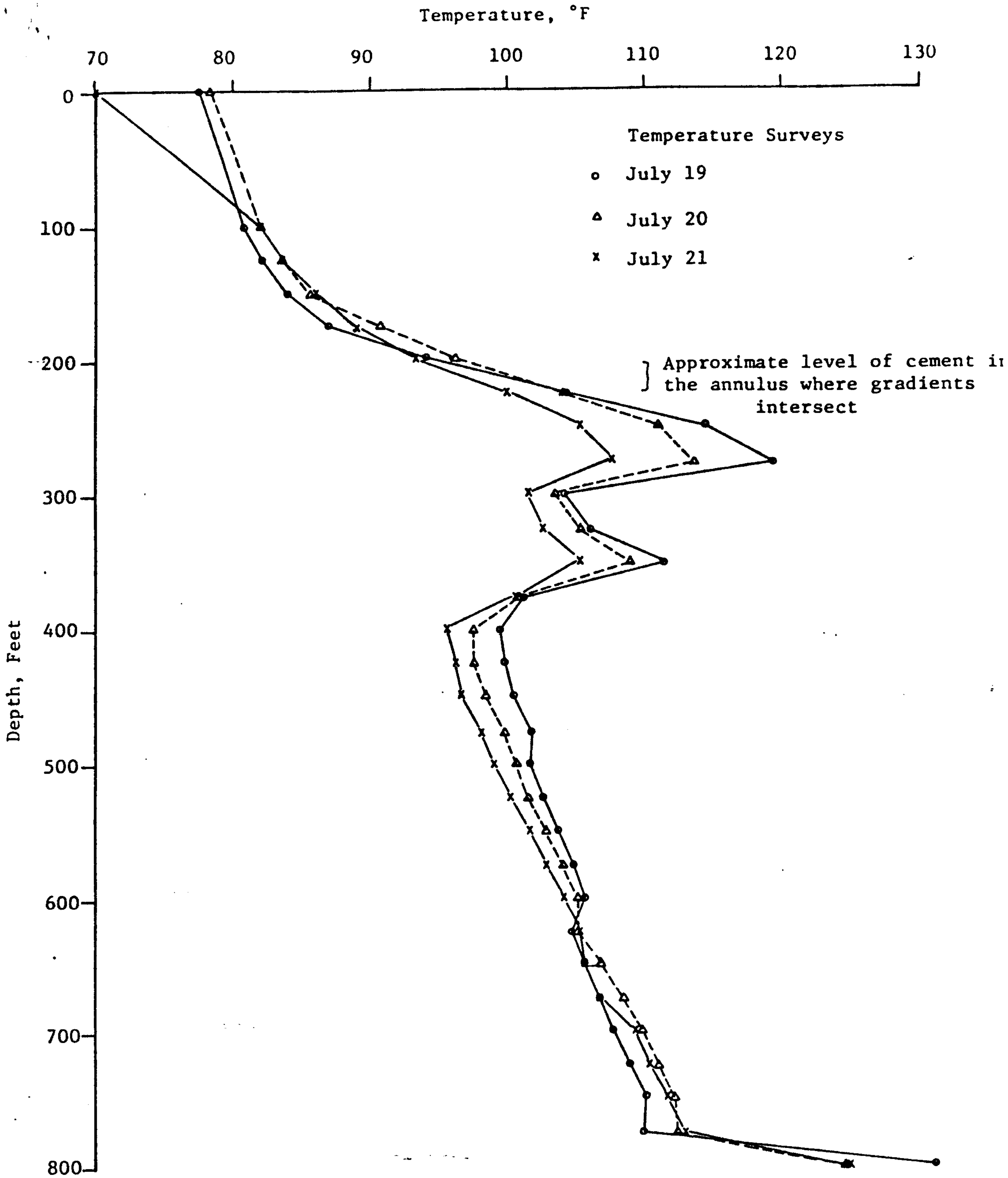
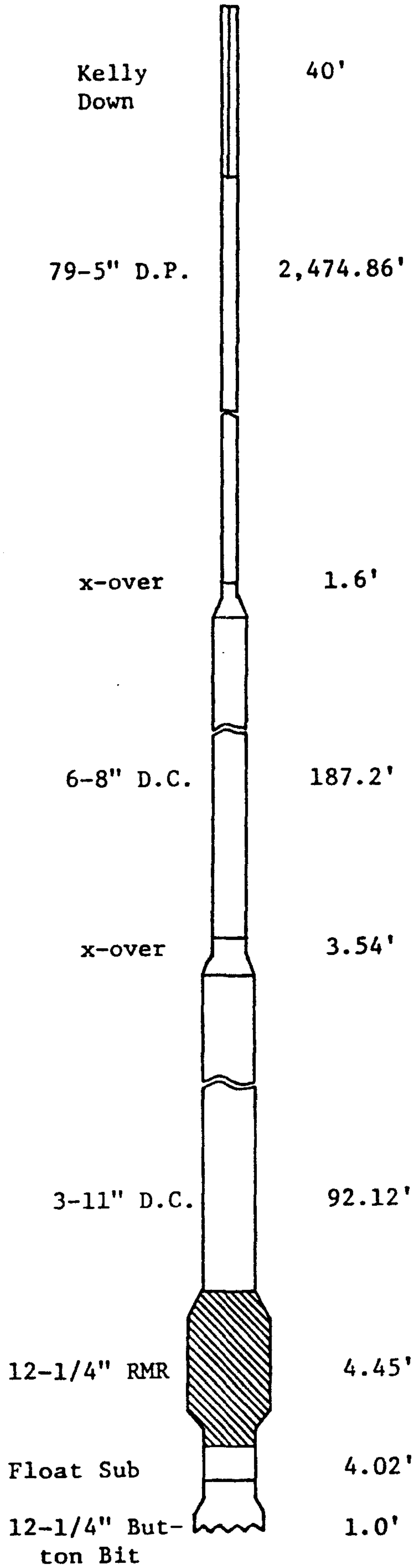


Figure 4. Temperature surveys to detect the level of cement fill-up following Stage II, cementing the 13-3/8-inch casing.

Figure 5.

Phase III - Drilling Assembly

Drill String @ 2,809'



RMR = Reamer
x-over = Cross-over
D.C. = Drill Collar
D.P. = Drill Pipe

Drilled 12-1/4" Hole to 3,925'

Not to Scale

the string) would be lowered down the well on 4-inch drill pipe and hung as a liner near the bottom of the 13-3/8-inch casing.

The first stage of casing was in the hole just before midnight on Tuesday, August 19. Mud was circulated through the casing for about two hours. At 0300 hours on Wednesday 817 cubic feet of class G cement were pumped down the hole and out the shoe of the 9-5/8-inch casing. During displacement, pressures increased from an initial 250 psi to 1500 psi at completion. The d.v. tool was opened, and an unsuccessful attempt was made to circulate through it.

At 0800 hours on Thursday, August 21, drill pipe was run into the hole with a 12-1/4-inch bit. The pipe stopped 10 feet above the top of the liner at 1,022 feet depth. The pipe was worked down to the liner top, and the hole was circulated with clear water.

The same evening the d.v. tool and float collar were drilled out with an 8-1/2-inch drill bit, and the well was circulated prior to running a cement bond log.

The lap area between the 9-5/8-inch and the 13-3/8-inch casing was pressure tested beneath a 13-3/8-inch RTTS packer late Friday night, August 22. The lap area would not hold pressure, and an injection rate of 1.3 bbls/minute at 1,000 psi was established. It was decided to squeeze cement into the lap area beneath a Halliburton Easy Drill packer following the weekend break.

On Monday, August 25, the packer was lowered into the hole with the intention of setting it at 900 feet. However, the packer set prematurely at 68 feet. On Tuesday cementing operations began. After pumping 80% of the calculated volume the pump pressure increased rapidly to 1,500 psi indicating a successful squeeze job. After holding the pressure for 15 minutes the drill collars began to rise out of the hole from the hydraulic lift, breaking several cement lines in the process. On Wednesday, August 27, the Easy Drill packer was drilled out. Cement was tagged at 342 feet and drilled to 974 feet. Pipe was pumped down without the rotary from 974 feet to 1,006 feet. There was no cement in the hole from 1,006 feet to 1,032 feet.

In subsequent tests on August 28 the lap area held pressure, indicating a satisfactory if imperfect seal. The second tieback stage of casing was run and cemented in place without incident. The cement was in place at 2100 hours on August 28.

Phase IV - Production Hole

Step 1: Drilling the 8-1/2-inch hole with mud-gel drilling fluid.

Drilling the 8-1/2-inch hole began at 0300 hours on Thursday, September 4. The drilling assemblage was composed of an 8-1/2-inch button bit, stabilizers and 6-7/8-inch collars (figure 6). The drilling fluid was a light, mud-gel (table 1). At 0800 on Saturday, September 6, a depth of 4,303 feet was reached and the rig was secured for the weekend.

Drilling resumed at Monday noon following a two-hour temperature survey and a period of rig maintenance. Drilling operations went smoothly until Tuesday, September 9, when six hours were consumed in repairs to the desilter suction pump and to mud pumps #1 and #2.

On Wednesday, the penetration rate dropped, and the bit was pulled for inspection. The button bit had lost its inserts. A mill tooth bit and junk sub were added to the drilling assembly, and drilling resumed. After 6 hours of drilling at a very slow penetration rate, the mill tooth bit and junk sub were replaced with a button bit. On Saturday, September 13, the hole was at 4,920 feet depth.

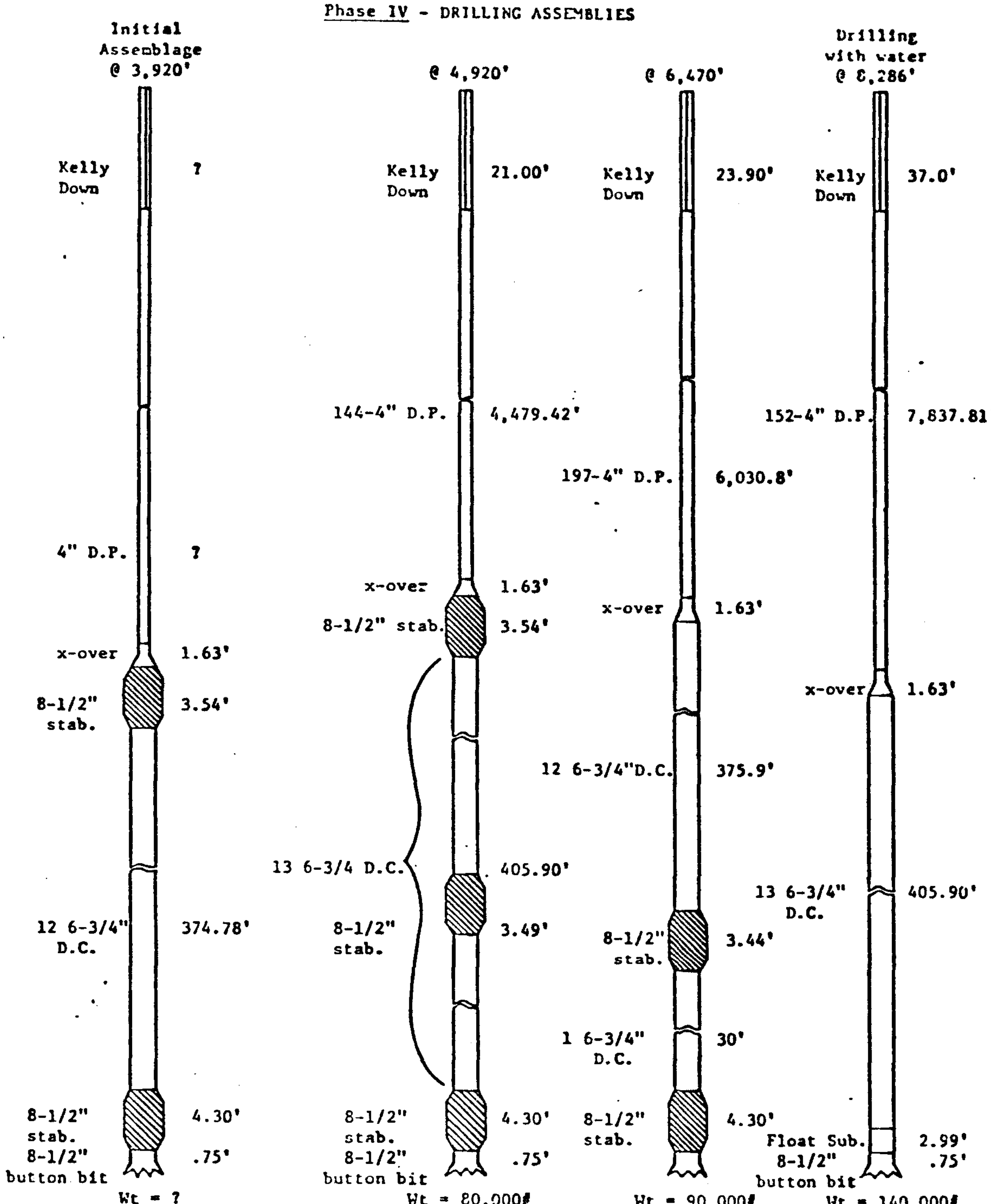
On Monday, September 15, the hole was surveyed for temperature, the old bit replaced and the stabilizers redressed. Drilling began at 1500 hours. By Thursday morning the penetration rate diminished. Total depth was 5,387 feet. The bit was replaced and the middle stabilizer redressed. A survey for bottom hole temperature was quickly dispatched and drilling continued. On Saturday, September 20, the hole was at a depth of 5,685 feet.

On Monday, September 22, the hole was surveyed for temperature and after a new bit was added and a stabilizer redressed, drilling began. Drilling operations went smoothly without major interruption. The hole was at a depth of 6,445 feet on Saturday, September 27.

On Monday, September 29, the hole was surveyed for temperature. Prior to tripping into the hole the crew replaced the bit and reduced the number of stabilizers from three to two. Once again there were no interruptions in drilling during the week, and the hole was at a depth of 7,211 feet on Saturday, October 4.

On Monday, October 6, the shale pit and cooling tower were cleaned. Both stabilizers were removed from the drilling assemblage, and a new bit was added. At 1600 hours the bit was on bottom and drilling under reduced weight as part of the break in procedure. A sudden drop of 20,000 pounds in drill string weight and a reduction of 200 pounds in mud pressure indicated a twist-off down hole. By midnight the crew had chained the drill

Figure 6.
Phase IV - DRILLING ASSEMBLIES



Stab. = Stabilizer
D.C. = Drill Collar
D.P. = Drill Pipe
x-over = Cross-over

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Table 1. DRILLING FLUIDS

ASHIDA #1 GEOTHERMAL EXPLORATION WELL

Summary of Operations	Drilled Interval (feet)	Drilling Fluid	Circulation of Drilling Fluid	Range of Viscosity (sec./qt.)	Range of Weight (lbs./gal.)	Additives to Drilling Mud
Phase I - Conductor Hole						
A. 12¼" pilot hole	surface-164	mud/gel	lost at 32'	---	---	---
B. 17½" hole opener	surface-72'	mud/gel	none	---	---	---
C. 26" hole open	surface-70'	mud/gel	none	---	---	---
Phase II - Surface Hole						
A. 12¼" pilot hole	70-300	mud/gel	none	---	---	---
	300-600	air/foam	none	---	---	---
	600-830	air/foam	full	---	---	---
	830-1,268	mud/gel	none	---	---	---
B. 17½" hole opener	70-192	air/foam	full	---	---	---
	192-270	mud/gel	none	---	---	---
	270-580	air/foam	full	---	---	---
	580-618	air/foam	partial	no data	no data	no data
	618-800	air/foam	none	no data	no data	no data
	800-1,268	mud/gel	none	no data	no data	no data
Phase III - Intermediate Hole						
A. 12¼" hole	1,268-3,925	mud/gel	full	37-52	8.8-9.4	CMC, cottonseed hulls, cellophane, caustic, cc-16

Table 1 (continued)

DRILLING FLUIDS

ASHIDA #1 GEOTHERMAL EXPLORATION WELL

Summary of Operations	Drilled Interval (feet)	Drilling Fluid	Circulation of Drilling Fluid	Range of Viscosity (sec./qt.)	Range of Weight (lbs./gal.)	Additives to Drilling Mud
Phase IV - Production Hole						
A. 8½" hole	3,925-7,925	light mud/gel	full	35-41	8.4-9.2	Driscose, spersene, Xp-20 caustic
B. 8½" hole	7,927-8,300	water	full	---	---	---

string out of the hole, leaving 7 drill collars, a float sub and the bit at the bottom of the hole. An 8-1/8-inch overshot was picked up and run into the hole. This fishing operation was successful, and both pipe and fish were out of the hole by midday on Tuesday. The intense heat at the bottom of the hole had ruined the bit bearings and rendered the almost new bit useless. A new button bit was added and the drill crew began to trip into the hole, pausing to inspect all drill collars for washouts or cracks. Drilling resumed at midnight and continued to 1630 hours on Saturday, October 11, when drilling was halted at a depth of 7,927 feet. The hole was circulated and conditioned for 6 hours prior to logging.

Step 2: Logging and testing the well.

Down hole surveys conducted by Gearhart-Owens technicians began at 0230 on Sunday, October 12, and concluded at 2200 of that same day. Temperature, electric, gamma ray-neutron and cement bond logs were run.

The existing valve on the B.O.P.E. stack was replaced by a new 10-inch WKM valve. Preparations were made to displace the mud from the well with water. The operation began at 0100 on Tuesday, October 14. The mud was displaced in stages. Then the entire hole was circulated with clear water for approximately 2 hours. The operation was completed at 2130 hours on Tuesday.

The air compressor was prepared and hooked up to blow water out of the hole. At 0800 on Wednesday, October 15, the hole had been blown clear to a depth of 3,800 feet. However, as the lift increased, the efficiency of the air compressor decreased. At a depth of 3,915 feet the compressor neared its effective limit. Fluid was blown from the hole until 0930 hours on Thursday. On Thursday and Friday, October 16 and 17, the hole was logged for temperature. It became apparent that the well was not going to flow without stimulation.

The following week all three drilling crews worked at rig repair on one eight hour shift. On Friday, October 24, the hole was logged for temperature.

S+ep 3: Drilling the 8-1/2-inch hole with water as a drilling fluid.

Drilling resumed with water as a drilling fluid on Monday, October 27. Drilling proceeded without interruption until 0930 hours on Wednesday, October 29, when the depth stood at 8,300 feet. At this point the pipe was pulled into the casing and the pipe rams were closed. An attempt to break down circulation with 1,000 psi failed and pipe was pulled from the hole.

Drilling operations were suspended at midnight, Wednesday, October 29.

DRILLING FLUIDS

Table 1 lists the types of drilling medium used during the various stages of drilling the Ashida #1 geothermal exploration well. The upper 1,000 feet of hole penetrated lava flows and interbedded, poorly welded, permeable breccia zones. As a result, circulation of mud/gel could not be established. The use of air/foam permitted only intermittent circulation. Below 830 feet (RKB), the drilling fluid was mud/gel, in accordance with State regulations which require the use of mud/gel drilling fluids in fresh water aquifers, regardless of circulation conditions.

Phase III of the operations involved drilling the intermediate hole from 1,268 to 3,925 feet (RKB) depth. Mud/gel drilling fluids were mixed with various lost circulation materials, and drilling progressed with full returns of the drilling fluid. Formation temperatures were not high enough to affect the chemistry of the fluids.

Phase IV of the operations was the drilling of the 8-1/2-inch production hole. A light mud/gel fluid, viscosity 35-41 sec/qt, weight 8.4--9.2 lbs/gal, was used from 3,925 to 7,927 feet. Mud weight, mud viscosity, solids content, pH, total chlorides, wallcake and fluid loss were closely monitored (table 2). As drilling operations pro-gressed, formation temperatures began to affect the mud chemistry, particularly the mud viscosity (figure 7). The gradual increase in mud weight reflects the addition of chemicals used to keep mud viscos-ity below 40 sec/qt.

From 7,927 feet to total depth at 8,300 feet the drilling fluid was water. There was no problem maintaining full circulation; cuttings size was substantially reduced and drilling torque increased. There is no indication that cuttings remained in the hole.

Table 2.

MUD CHEMISTRY

Ashida #1

Date	Mud Weight in lbs/gal	Funnel Viscosity in secs/qt	Water Loss (c.c.'s)	pH	Percent Solids	Wall Cake (inches)	Chlorid (ppm)
7/28	8.8	52	9.2	9	-	-	-
7/30	8.9	50	9.3	9	3	2/32	-
8/1	8.9	37	10.4	10	1	-	-
8/5	9.0	39	9.2	10	1	2/32	-
8/7	9.2	39	12.1	9.5	<1	2/32	<50
8/9	9.3	40	9.1	10	2	2/32	<50
8/12	9.4	41	9.8	9	1	3/32	<50
9/4	8.4	37	10	10	1/4	-	<50
9/8	8.5	37	8.8	9.0	-	-	<50
9/10	8.7	40	8.5	9.5	-	2/32	<100
9/12	8.8	38	8	10	-	2/32	<5
9/16	9.0	38	8.6	9.0	-	2/32	<7
9/18	8.9	38	8.4	10	-	-	<100
9/19	9.0	39	8.4	10	-	2/32	<100
9/22	9.+	37	9.0	8.5	-	-	<100
9/24	9.1	39	-	-	-	-	-
9/26	9.2	39	-	8.0	1/4	2/32	<100
9/30	9.2	39	8.6	8.0	1/4	2/32	<100
10/2	9.2	39	8.4	9.0	1/4	2/32	<100
10/3	9.2	38	-	10	1/4	-	-
10/8	9.1	38	-	10	1/4	-	<100
10/9	9.2	38	8.4	10	1/4	2/32	<10
10/10	9.2	38	8.4	9	1/4	2/32	<10
10/11	9.3	38	8.6	10	1/4	2/32	<10
10/28	--- WATER ---			∿7			67
10/29				∿7			36

GEOLOGY OF ASHIDA #1

The lithology of Ashida #1 is divided into three distinct zones. Zone 1 extends from surface to 1,860 feet and consists mainly of subaerial basalt flows. Zone II represents the transition between subaerial and submarine pillow basalts erupted at depth. It lies between 1,860 feet and 2,400 feet, and consists of hyaloclastite, clay and oxidized basalt flows. Zone III extends from 2,400 feet to total depth of 8,300 feet. It consists mainly of submarine pillow basalts, with some interbedded clays.

Samples from Zone I were collected at 30 foot intervals between 600 and 820 feet depths and at 10 foot intervals from 1,280 feet to 1,860 feet (Appendix A). Typically, samples are glassy and scoriaceous. Phenocryst content is variable. Plagioclase phenocrysts comprise 1 to 20% of the volume. They are usually colorless, tabular, subhedral and less than 1 mm long. Olivine phenocrysts comprise 1 to 5% by volume. The olivine crystals are green to yellow, equant and less than 1 mm across. Pyroxene phenocrysts are rare. The crystals are dark green or black, prismatic, subhedral and less than .5 mm.

Groundmasses are black to gray and generally vesicular and aphanitic. A few samples contain trachytic feldspar laths and intersertal glass. Some are nonvesicular.

Samples from Zone II were collected at 10 foot intervals. Samples from the 1,850 to 1,870 feet depth interval are brecciated and altered to clay. Samples of basalt are glassy, slightly vesicular, and they contain scattered olivine phenocrysts. From 1,870 to 1,900 feet, samples are composed of basalt and brown, silty clay. From 1,900 to 2,400 feet, samples are glassy and vesicular to nonvesicular. The rocks contain scattered phenocrysts of olivine and plagioclase within glassy matrices. Most samples are coated with red hydrous iron oxide. Zones of oxidation are observed below the water table, where permeability is high enough to permit the free circulation of water. This zone may correlate with and reflect relative changes in sea level during recent periods of glaciation or tectonic events. The presence of hydrous iron oxides is proof of a near surface environment of deposition and subsequent subsidence.

Zone III extends from 2,400 feet to total depth at 8,300 feet. It is composed of pillow basalts and rare intervals of silt and clay. Phenocrysts are restricted to plagioclase, olivine and pyroxene, and relative abundances are variable. Groundmasses are subject to changes in degree of crystallinity and vesicularity. Holocrystalline rocks were penetrated at 5 intervals within the section; they comprise more than 1,000 feet of section or roughly 1/6 of Zone III. Typical holecrystalline or type II basalts are nonvesicular. Phenocrysts of olivine, plagioclase and pyroxene, less than

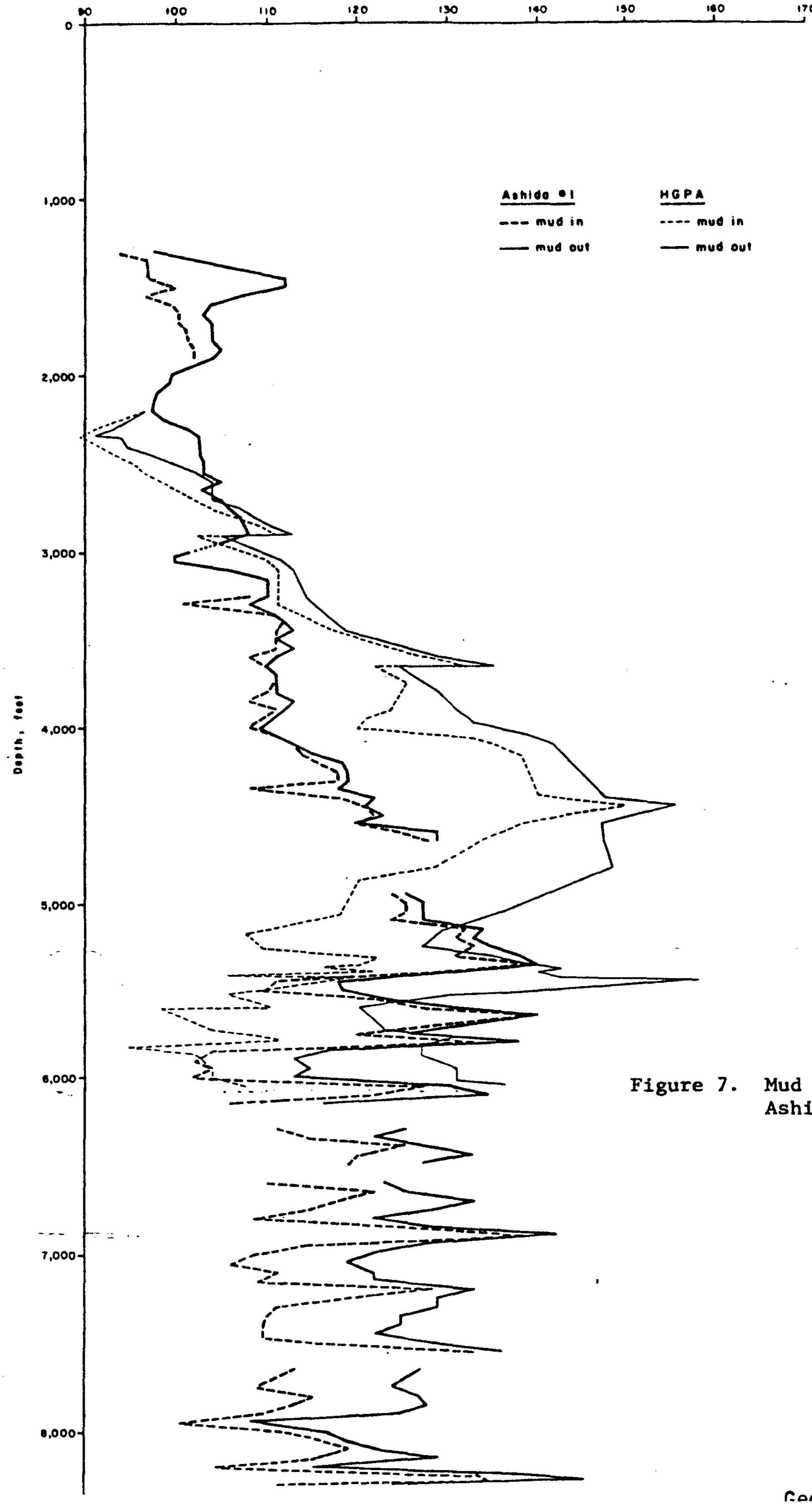

Figure 7. Mud temperatures Ashida #1.

1 mm across, are present in variable but low amounts. Groundmasses are mottled intergranular textures of feldspar laths, pyroxene and iron ore.

The bulk of Zone III is made up of glassy basalt flows. Generally, colorless, translucent plagioclase is the most abundant phenocryst phase with lesser amounts of pyroxene and olivine. Groundmasses range from holohyaline to hyalopilitic. Vesicularity is also variable. Samples from 1,900 to 4,000 feet depth are vesicular to nonvesicular. Samples below 4,000 feet, reflecting greater hydrostatic pressures at eruption, range from slightly vesicular to nonvesicular. Most sampled intervals contain at least a few slickensided clasts. Slickensides probably form during the cooling and contracting of submarine lava.

Pockets of buff-colored silt and clay were penetrated at 4,000 feet, at 4,300 feet and at 4,800 feet.

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<u>APPENDIX A</u>

Lithologic Description of drill cuttings,

Ashida #1

LITHOLOGIC LOG

Ashida #1

Depth Interval, feet		Completion Date: 10/29/80
Surface-600	No samples	
600-822	BASALT Description: Glassy, scoriaceous flows with scattered phenocrysts of tabular, colorless plagioclase within an aphanitic gray to black groundmass. Alteration: Limited to red-brown oxidation of mafic minerals in vesicles and in the groundmass.	
822-1,280	No samples	
1,280-1,300	OLIVINE BASALT Description: Glassy, scoriaceous flows with equant phenocrysts of pale green olivine and darker pyroxene occasionally rimmed by plagioclase within a black aphanitic matrix. Mafic phenocrysts (2-5%) are equant, green to yellow, unaltered and ≤ .5 mm. Plagioclase phenocrysts (1-20%) are tabular, colorless to frosty, subhedral and ≤ .5 mm. Alteration: Pale blue or green chlorophaeite lining vesicles. Traces of pyrite cubes. Some localized oxidation of mafic minerals within the groundmass.	
1,300-1,340	BASALT Description: Glassy to trachytic dense charcoal gray, groundmass with scattered phenocrysts of plagioclase and olivine. Vesicularity is variable. Alteration: Chlorophaeite lining vesicles. Trace amounts of pyrite cubes. Patchy oxidation of groundmass mafics.	
1,340-1,360	OLIVINE BASALT Description: As above. Phenocryst content is variable. Some clasts contain abundant olivine phenocrysts. Alteration: Chlorophaeite, pyrite. Patchy alteration of groundmass plagioclase to chalky white material. Traces of white zeolite in vesicles.	
1,360-1,370	BASALT Description: As above, except low phenocryst count. Alteration: Chlorophaeite and pyrite.	
1,370-1,400	BASALT Description: As above. Alteration: Chlorophaeite, pyrite. Some banded (green and white), soft mineral filling vesicles.	

1,400-1,530	BASALT Description: Glassy, vesicular flows with scattered phenocrysts of plagioclase, olivine and pyroxene. Alteration: Light blue chlorophaeite lining vesicles. Pyrite cubes in trace amounts. Some banded (green and white) mineral filling vesicles.
1,530-1,550	BASALT Description: Glassy, vesicular flows with rare phenocrysts of plagioclase in a charcoal gray to black groundmass. Alteration: Blue chlorophaeite lining vesicles with occasional cubes of pyrite. Trace amounts of botryoidal silica.
1,550-1,560	BASALT Description: Glassy, vesicular flows with rare phenocrysts of plagioclase and olivine within an aphanitic groundmass. Alteration: As above.
1,560-1,570	BASALT Description: As above. Alteration: As above, with trace amounts of white, milky zeolite.
1,570-1,600	BASALT Description: Glassy vesicular flows with rare phenocrysts of unaltered olivine and plagioclase within an aphanitic matrix. Alteration: As above, with some pale green, siliceous scale.
1,600-1,660	BASALT Description: As above. Alteration: Green or blue chlorophaeite lining vesicles with scattered cubes of pyrite. Trace amounts of waxy zeolite. Trace amounts of silica in colorless botryoidal form or green scale.
1,660-1,700	BASALT Description: As above. Alteration: As above, but in lesser amounts. filling some vesicles.
1,700-1,710	BASALT Description: Glassy, dense aphyric flow. Very few vesicles. Alteration: As above, but in lesser amounts.
1,710-1,770	BASALT Description: Glassy, vesicular, aphyric flows. Alteration: Blue and green chlorophaeite lining vesicles associated with pyrite cubes. Milky botryoidal zeolite in some vesicles. Clear botryoidal silica scale in trace amounts. Occasional dull patches in groundmass may indicate incipient alteration.

1,770-1,830	BASALT Description: Glassy, dense to slightly vesicular flows with trace amounts of olivine phenocrysts within an aphanitic groundmass. Alteration: As above.
1,830-1,850	BASALT Description: As above, with patches of black vitrophyre. Alteration: As above.
1,850-1,870	100% BASALT Description: As above. Alteration: As above. Trace of breccia. Description: Brown, very fine. Alteration: Very soft = clay.
1,870-1,880	90% BASALT, as above. 10% Clay, brown, silty.
1,880-1,900	95% BASALT, as above. 5% Red-brown basalt. Alteration: Oxidized and altered to clay.
1,900-1,910	BASALT Description: Vesicular flows with scattered phenocrysts of unaltered, equant olivine (1 mm) and plagioclase (1 mm) within a mottled groundmass of dark glass and mafic minerals and lighter feldspars. Alteration: Chlorophaeite lines vesicles and is associated with pyrite cubes. A few vesicles are filled with a very soft, pale green material. Trace amounts of red hydrous iron oxide coating clasts.
1,910-1,930	BASALT Description: As above. Alteration: As above, with some milky, botryoidal zeolite lining vesicles.
1,930-1,950	BASALT Description: Glassy, vesicular to nonvesicular flows with unaltered equant phenocrysts of olivine and pyroxene (?) and tabular plagioclase phenocrysts within a groundmass of glass, mafic minerals and trachytic feldspar laths. Alteration: As above.
1,950-1,960	BASALT Description: As above. Alteration: As above, except no iron oxide coatings observed.

1,960-1,970	BASALT Description: Glassy and highly vesicular flows with phenocrysts of yellow-green olivine and colorless plagioclase within a matrix of glass, mafic minerals and plagioclase laths. Alteration: Chlorophaeite and pyrite lining vesicles. Abundant milky botryoidal zeolite in vesicles. Some dull red hydrous iron oxide coating clasts.
1,970-2,030	BASALT Description: Glassy, dense to vesicular flows with scattered phenocrysts of olivine and plagioclase within a groundmass of feldspar laths and glass. Some clasts are entirely vitrophyre. Alteration: As above, with some alteration along olivine rims to red-brown iddingsite (?).
2,030-2,050	50% BASALT, as above. 50% BASALT, black vesicular flows with glass stringers. Alteration: As above, but no iddingsite.
2,050-2,060	BASALT Description: Vesicular to nonvesicular flows with phenocrysts of olivine and plagioclase within a black aphanitic matrix with glass stringers.
2,060-2,070	70% BASALT, as above. 30% BASALT, vesicular to nonvesicular flows with phenocrysts of olivine, pyroxene and plagioclase within an intergranular groundmass of feldspar laths, olivine, pyroxene and glass. Alteration: As above.
2,070-2,080	50% BASALT, vesicular to nonvesicular flows with phenocrysts of olivine and plagioclase within an intergranular matrix of plagioclase olivine, pyroxene and glass. 50% BASALT, glassy, nonvesicular flows with phenocrysts in a black aphanitic groundmass with glass stringers. Alteration: As above.
2,080-2,090	15% VITROPHYRE, dense, black. 85% BASALT, vesicular flows with scattered phenocrysts in an aphanitic matrix. Alteration: As above.
2,090-2,110	50% VITROPHYRE, vesicular to nonvesicular. 50% BASALT, as above. Alteration: As above.
2,110-2,120	OLIVINE BASALT Description: Vesicular flows with 2% dark brown to green olivine phenocrysts (< 1 mm) within an aphanitic matrix. Alteration: Chlorophaeite and pyrite lining vesicles. Milky botryoidal zeolite in vesicles and red hydrous iron oxide coating clasts.

2,120-2,140	OLIVINE BASALT Description: Vesicular flows with 2% olivine phenocrysts within an intergranular groundmass of feldspar and mafic minerals. Alteration: As above.
2,140-2,180	BASALT Description: Dense nonvesicular rock with phenocrysts of translucent feldspar and, rarely, brown-green olivine within a fine, intersertal to intergranular matrix of black glass, feldspars, mafic minerals and altered blue-gray material. Alteration: Pyrite, botryoidal zeolite and blue-gray material in the groundmass. Trace amounts of hydrous iron oxide.
2,180-2,190	BASALT Description: Vesicular to nonvesicular flows with scattered unaltered phenocrysts of plagioclase and olivine. Groundmass textures vary from uniform black aphanite to mottled intergranular with patches of blue-gray alteration. Alteration: As above.
2,190-2,210	BASALT Description: Glassy, nonvesicular flows with scattered phenocrysts of plagioclase, and olivine within a groundmass of trachytic feldspar laths and intersertal glass. Alteration: Chlorophaeite and pyrite line the few vesicles observed. Botryoidal silica and pyrite cubes coat some fracture surfaces. Botryoidal zeolite and red hydrous iron oxide on some clasts.
2,210-2,240	BASALT Description: As above, but vesicular to nonvesicular. Alteration: As above.
2,240-2,310	BASALT Description: As above. Alteration: Botryoidal zeolite, pyrite. Some groundmass alteration to blue-gray material.
2,310-2,330	BASALT Description: As above. Alteration: Zeolite, pyrite, red hydrous iron oxide.
2,330-2,360	BASALT Description: As above. Alteration: Zeolite, pyrite. Hydrous iron oxide occurs in cubic pseudomorphs after pyrite in some vesicles. Some groundmass alteration to a blue-gray material.

2,360-2,400	BASALT Description: Glassy, vesicular to nonvesicular flow with phenocrysts of plagioclase and, rarely, of olivine and pyroxene within an intersertal matrix of feldspar laths and glass. Alteration: As above.
2,400-2,470	BASALT Description: Glassy, vesicular flow with widely scattered phenocrysts of plagioclase and olivine within an aphanitic matrix. Alteration: Chlorophaeite and pyrite lining vesicles. Milky, botryoidal zeolite in vesicles.
2,470-2,480	BASALT Description: Glassy, nonvesicular flow with widely scattered phenocrysts of plagioclase and olivine within an intersertal matrix of feldspar laths and glass. Alteration: Zeolite, pyrite. Some groundmass alteration to a pale gray-green material.
2,480-2,500	BASALT (Type II) Description: Nonvesicular to slightly vesicular rock with phenocrysts of plagioclase (.5 mm) and olivine (.5 mm) in a fine, mottled, white and gray-green matrix of feldspar and mafic minerals. Alteration: Pyrite, botryoidal zeolite, chlorophaeite.
2,500-2,530	BASALT (Type II) Description: As above. Alteration: Pyrite, chlorophaeite.
2,530-2,550	BASALT Description: Nonvesicular to vesicular flow with scattered phenocrysts of plagioclase, olivine and pyroxene within a gray-green to black, aphanitic glassy groundmass. Alteration: Pyrite and chlorophaeite lining vesicles.
2,550-2,600	BASALT Description: As above. Alteration: Pyrite and chlorophaeite lining vesicles and some bladed, pale green splays in vesicles.
2,600-2,610	65% BASALT, as above. 35% BASALT (Type II) Alteration: Pyrite and chlorophaeite lining vesicles.
2,610-2,630	BASALT Description: Glassy, vesicular flow with scattered phenocrysts of plagioclase and olivine within an aphanitic groundmass. Alteration: Pyrite and chlorophaeite.

2,630-2,670	BASALT (Type II) Description: Finely crystalline, nonvesicular rock with phenocrysts of plagioclase (.5 mm), and of olivine and/or pyroxene within an intergranular groundmass of feldspar and mafic minerals. Alteration: Trace amounts of pyrite.
2,670-2,690	BASALT (Type II) Description: As above. Alteration: Pyrite and some incipient argillic (?) alteration of groundmass feldspar.
2,690-2,710	BASALT (Type II) Description: As above, but phenocrysts range up to 1 mm across. Alteration: As above.
2,710-2,740	BASALT (Type II) Description: As above, but phenocrysts are $\leq$ .5 mm. Alteration: As above.
2,740-2,770	BASALT (Type II) Description: As above, with abundant black to dark green pyroxene phenocrysts. Alteration: Pyrite. Patchy argillic alteration of groundmass feldspars. Some replacement of mafic phenocrysts with chlorite.
2,770-2,810	BASALT (Type II) Description: As above. Alteration: Pyrite on fracture surfaces. Approximately 50% of the groundmass feldspars have undergone argillic (?) alteration.
2,810-2,820	BASALT (Type II) Description: Finely crystalline, nonvesicular to slightly vesicular rock with 5-10% phenocrysts of green pyroxene and/or olivine and 1-3% phenocrysts of plagioclase ($\leq$ 1 mm) within a gray-green groundmass of intergrown feldspar and mafic minerals with scattered patches of glass. Alteration: Chlorophaeite and pyrite line vesicles. Some argillic alteration of groundmass feldspar.
2,820-2,840	BASALT Description: Glassy, slightly vesicular flows with scattered phenocrysts of plagioclase, pyroxene and/or olivine within gray aphanitic groundmass. Alteration: Blue chlorophaeite and pyrite cubes line vesicles. A few vesicles are filled with a very soft white to gray-green material.
2,840-2,910	BASALT Description: As above. Alteration: Chlorophaeite and pyrite. Trace amounts of white fibrous zeolite (?) in vesicles. Clasts scratch easily, indicating incipient alteration of the groundmass.

2,910-2,930	BASALT Description: As above. Alteration: As above with some vesicles filled with a very soft pale green material.
2,930-2,950	BASALT Description: Highly vesicular flow with widely scattered phenocrysts of plagioclase, pyroxene and olivine within a gray, aphanitic groundmass. Alteration: As above.
2,950-2,990	BASALT Description: Glassy, vesicular flow with scattered phenocrysts of pyroxene, olivine and plagioclase within a black aphanitic groundmass. Alteration: Chlorophaeite and pyrite line vesicles. White fibrous sheaves of zeolite extremely abundant.
2,990-3,020	BASALT Description: As above. Alteration: Chlorophaeite and pyrite line vesicles and coat fracture surfaces. Many vesicles are filled with a very soft pale blue material. White fibrous zeolite is abundant
3,020-3,050	BASALT Description: Glassy, nonvesicular rock with abundant phenocrysts of dark green to black pyroxene and of translucent plagioclase within a green groundmass of feldspar laths, pyroxene and glass (?). Alteration: Pyrite on fracture surfaces. Feldspar laths are commonly white indicating incipient alteration. Green color of groundmass may be chlorite. Some mafic phenocrysts have been replaced by chlorite.
3,050-3,060	BASALT Description: As above. Alteration: As above, with trace amounts of white, fibrous zeolite.
3,060-3,100	BASALT Description: Slightly vesicular to nonvesicular rock with phenocrysts of plagioclase and of pyroxene and/or olivine within a green to black groundmass. Green clasts have visible groundmass minerals -- feldspar and mafics. Black clasts are aphanitic. Alteration: Chlorite replacing mafic minerals in the green clasts, also filling vesicles. Pyrite on fracture surfaces and lining vesicles. Fibrous white zeolite and quartz in vesicles. Some incipient argillic alteration of groundmass feldspars.

3,100-3,120	85% BASALT (Type II) Description: Slightly vesicular rock with phenocrysts of plagioclase, pyroxene and/or olivine with a finely crystalline groundmass of feldspar and mafic minerals. Alteration: As above. 15% BASALT Description: Glassy flow with phenocrysts of plagioclase, pyroxene and/or olivine with a groundmass of black glass. Alteration: Trace amounts of pyrite.
3,120-3,130	BASALT (Type II) Description: As above. Alteration: As above.
3,130-3,160	BASALT (Type II) Description: Slightly vesicular rock with a trace to 2% phenocrysts of plagioclase, pyroxene and olivine within a green, finely crystalline groundmass of feldspar and mafic minerals. Alteration: Chlorite needles replace groundmass mafic minerals. Pyrite is abundant on fracture surfaces. White fibrous zeolite in rare vesicles. Incipient argillic (?) alteration of groundmass feldspars.
3,160-3,180	100% BASALT (Type II) Description: As above. Alteration: As above with trace amounts of botryoidal silica. Trace of vitrophyre.
3,180-3,190	BASALT (Type II) Description: As above. Alteration: As above, with trace amounts of calcite in vesicles.
3,190-3,250	BASALT (Type II) Description: As above. Alteration: As above, but no calcite observed.
3,250-3,270	BASALT Description: Glassy, slightly vesicular rock with phenocrysts of plagioclase, olivine and pyroxene with a green to gray-brown aphanitic groundmass. Alteration: Fibrous white zeolite lines vesicles and some fracture surfaces. Pyrite cubes line vesicles. Some loose, terminated quartz. (Green color of groundmass may indicate presence of chlorite).
3,270-3,330	BASALT Description: Glassy, slightly vesicular rock with phenocrysts of plagioclase and pyroxene within a green to gray-brown groundmass of feldspar laths and intersertal aphanitic material. Alteration: Pyrite, zeolite. Groundmass feldspars have altered to a chalky white material.

3,330-3,380	BASALT Description: Glassy, slightly vesicular rock with phenocrysts of translucent plagioclase and brown-green pyroxene and/or olivine within a green groundmass of feldspar laths and intersertal aphanitic material. Veins of black glass crisscross some clasts. Alteration: As above.
3,380-3,410	BASALT Description: Slightly vesicular rock with phenocrysts of plagioclase, pyroxene (black to green to brown, stubby, subhedral) and olivine (lime green, anhedral) within an aphanitic groundmass. Alteration: Abundant fibrous zeolite, pyrite.
3,410-3,450	BASALT Description: Glassy, vesicular rock with chatoyant feldspar, and pale green olivine and/or pyroxene within a green aphanitic matrix with scattered patches of black glass. Alteration: As above. Green groundmass may contain chlorite.
3,450-3,460	BASALT Description: As above. Alteration: As above, with trace amounts of quartz in vesicles.
3,460-3,510	BASALT Description: As above. Alteration: Fibrous zeolite, pyrite and groundmass chlorite (?).
3,510-3,520	80% BASALT, as above. Alteration: as above. 20% VITROPHYRE, black, vesicular to nonvesicular. No alteration.
3,520-3,530	BASALT Description: As above. Alteration: As above.
3,530-3,540	75% BASALT, as above. 25% VITROPHYRE Description: Black to dark gray with rare phenocrysts of plagioclase, olivine and pyroxene. No alteration.
3,540-3,560	90% BASALT, as above. 10% VITROPHYRE, as above.
3.560-3,570	95% BASALT, as above. 5% VITROPHYRE, as above.
3,570-3,610	BASALT Description: Nonvesicular rock with phenocrysts of plagioclase typically intergrown with phenocrysts of green pyroxene and/or olivine within a gray to green, aphanitic groundmass. Alteration: Pyrite, chlorite as incipient groundmass alteration.

3,610-3,620	90% BASALT, as above. 10% VITROPHYRE, unaltered.
3,620-3,630	100% BASALT, as above. Trace of vitrophyre, unaltered.
3,630-3,680	BASALT, as above.
3,680-3,740	BASALT Description: As above but slightly vesicular to vesicular. Alteration: Pyrite lining vesicles and disseminated in the groundmass. Incipient alteration of groundmass material to chlorite (?). Abundant white, fibrous zeolite in vesicles.
3,740-3,750	98% BASALT, as above. 2% VITROPHYRE. Trace of clay.
3,750-3,760	85% BASALT, as above. 15% Oxidized BASALT Description: Slightly vesicular flow with scattered phenocrysts of plagioclase and mafic minerals within a red-brown aphanitic matrix. Alteration: Pyrite, oxidation of iron ore in groundmass. Trace of vitrophyre, unaltered. Trace of clay.
3,760-3,770	90% BASALT, as above. 8% Oxidized BASALT, as above. 2% VITROPHYRE, black, vesicular.
3,770-3,810	BASALT, as above.
3,810-3,820	100% BASALT, as above. Trace of vitrophyre.
3,820-3,880	BASALT Description: Glassy, slightly vesicular to vesicular flow with scattered phenocrysts of plagioclase, pyroxene and/or olivine within a gray-green aphanitic groundmass with some patches of black glass. Alteration: Pyrite, chlorite and fibrous zeolite in vesicles and fractures. Incipient alteration of groundmass mafic minerals to chlorite. Trace amounts of siliceous scale on fracture surfaces and in vesicles.
3,880-3,900	BASALT Description: As above. Alteration: As above, but no silica observed.
3,900-3,920	BASALT Description: As above. Alteration: Fibrous zeolite, pyrite and silica line vesicles. Pyrite disseminations and cryptocrystalline chlorite in the groundmass.

3,920-3,930	55% VITROPHYRE Description: Extremely soft white to green rock with trace amounts of plagioclase and pyroxene phenocrysts. Alteration: Pyrite and chalcedony coat fracture surfaces. Incipient alteration of groundmass material to clay (?) and chlorite (?). 45% BASALT Description: Nonvesicular to slightly vesicular, aphyric flow of gray to black aphanitic rock. Alteration: Chalcedony, pyrite and calcite coat fracture surfaces in trace amounts. Clay and chlorite occur as incipient alteration of the groundmass.
3,930-3,940	25% VITROPHYRE, as above. 75% BASALT Description: As above, with trace amounts of mafic phenocrysts. Alteration: As above.
3,940-3,960	50% VITROPHYRE, as above. 50% BASALT, as above.
3,960-3,970	65% VITROPHYRE, as above. 35% BASALT, as above.
3,970-3,980	25% VITROPHYRE, as above. 75% BASALT, as above.
3,980-3,990	70% BASALT, as above. 20% Silt, fissile, loosely consolidated, pale brown. 10% Clay.
3,990-4,000	60% BASALT, as above. 30% Silt, as above. 10% Clay.
4,000-4,010	50% BASALT, as above. 50% Clay.
4,010-4,020	BASALT Description: Glassy, nonvesicular flow with abundant phenocrysts of plagioclase, pyroxene and/or olivine within a black aphanitic matrix. No alteration.
4,020-4,030	BASALT Description: As above. Alteration: Pyrite as disseminations within the groundmass and coating fracture surfaces and cryptocrystalline chlorite within the groundmass.

4,030-4,040	BASALT Description: Glassy, nonvesicular rock with scattered phenocrysts of plagioclase, pyroxene and/or olivine within a black to green aphanitic groundmass. Some slickensides. Alteration: As above.
4,040-4,060	BASALT Description: Glassy, slightly vesicular rock with widely scattered phenocrysts of plagioclase, typically intergrown with pyroxene within a groundmass of glass, scattered feldspar laths and mafic minerals. Slickensides. Alteration: Pyrite.
4,060-4,080	90% BASALT, as above. 10% VITROPHYRE, black to gray-brown.
4,080-4,090	BASALT Description: As above. Alteration: White, fibrous zeolites and pyrite in vesicles and coating fracture surfaces. Trace amounts of cryptocrystalline chlorite in the groundmass.
4,090-4,100	BASALT Description: As above. Alteration: Zeolite and pyrite line vesicles. Trace amounts of chalcedony coat fracture surfaces. Alteration of the groundmass to chlorite and/or clay is quite variable, from slight to intense.
4,100-4,180	BASALT Description: As above. Alteration: Abundant veins of pyrite. Trace amounts of fibrous zeolite and chalcedony. Some variable alteration of groundmass minerals to chlorite and/or clay. Some chlorite mineralization on fracture surfaces.
4,180-4,200	95% BASALT, as above. 5% VITROPHYRE Description: Black, nonvesicular. Alteration: Variable alteration to chlorite and clay. Some pyrite nodules.
4,200-4,230	90% BASALT, as above. 10% VITROPHYRE, as above, but with slickensides.
4,230-4,280	90% BASALT, as above. 10% VITROPHYRE Description: As above. Alteration: Pyrite and siliceous scale on fracture surfaces.
4,280-4,300	80% BASALT, as above. 20% VITROPHYRE, as above.

4,300-4,310	90% BASALT Description: Glassy, slightly vesicular flow with scattered phenocrysts of plagioclase (< .5 mm) and pyroxene (< .5 mm) within a black groundmass of abundant feldspar laths, mafic minerals and glass. Trace amounts of slickensides. Alteration: Pyrite disseminations within the groundmass. Some veins of milky chalcedony. A few vesicles are filled with soft white clay (?). Variable alteration of groundmass constituents to clay and/or chlorite. 10% Clay.
4,310-4,330	BASALT, as above.
4,330-4,340	BASALT Description: As above. Alteration: As above, plus trace amounts of fibrous zeolite and trace amounts of chlorite filling vesicles.
4,340-4,360	95% BASALT Description: As above. Alteration: Vesicles are filled with soft, dark green material (chlorite and clay?). Groundmass constituents have undergone pervasive alteration to clay and/or chlorite. 5% Clay, pseudomorphous after BASALT.
4,360-4,460	BASALT Description: As above. Alteration: As above the groundmass and trace amounts of chalcedony coating fracture surfaces.
4,460-4,480	BASALT Description: Glassy, nonvesicular rock with rare phenocrysts of plagioclase, pyroxene and/or olivine within a groundmass of feldspar laths, mafic minerals and glass. Alteration: Pyrite and chalcedony coat fracture surfaces. Variable alteration of groundmass constituents to clay and/or chlorite.
4,480-4,530	BASALT Description: As above. Alteration: Pyrite, chalcedony and calcite in trace amounts coating fracture surfaces. Variable slight to intense alteration of groundmass constitutents to clay and/or chlorite.
4,530-4,660	BASALT Description: Glassy, slightly vesicular rock with widely scattered phenocrysts of plagioclase, pyroxene and/or olivine within a groundmass of abundant feldspar laths and mafic minerals and intersertal glass. Slickensides are common. Alteration: Pyrite, chalcedony and calcite occur in veins. Groundmass constituents have undergone variable slight to intense alteration to clay and chlorite.

4,660-4,690	BASALT Description: As above. Alteration: As above, plus abundant veins of white anhydrite.
4,690-4,740	BASALT Description: As above. Alteration: Vesicles are filled with a soft green material (chlorite and/or clay?). Groundmass constituents have undergone variable moderate to intense alteration to clay and chlorite.
4,740-4,760	BASALT Description: As above. Alteration: As above, plus veins of pyrite, calcite, chalcedony and anhydrite.
4,760-4,770	BASALT Description: Glassy, slightly vesicular aphyric rock. Alteration: Pyrite coats some fracture surfaces. Variable slight to moderate alteration of groundmass constituents to clay.
4,770-4,780	BASALT Description: As above. Alteration: Abundant veins of chalcedony. Lesser amounts of pyrite and anhydrite in veins. Pervasive alteration of groundmass constituents to clay and/or chlorite.
4,780-4,790	85% BASALT, as above. 15% Clay.
4,790-4,840	BASALT, as above.
4,840-4,860	BASALT Description: As above. Alteration: Veins of chalcedony and of pyrite. Trace amounts of chlorite in the groundmass. 20% of the clasts intensely altered to clay and/or chlorite.
4,860-4,870	BASALT Description: As above. Alteration: 90% of the clasts contain veins of chalcedony and pyrite, and trace amounts of cryptocrystalline chlorite in the groundmass. 10% of the clasts are intensely altered to soft clay (?) and/or chlorite.
4,870-4,890	BASALT Description: As above. Alteration: 80% of the clasts contain veins of chalcedony and pyrite, and trace amounts of chlorite in the groundmass. 20% of the clasts are intensely altered to clay minerals and/or chlorite.

4,890-4,910	70% BASALT, as above. 30% BASALT Description: Glassy, nonvesicular rock with scattered phenocrysts of plagioclase and pyroxene within a black, aphanitic matrix. Alteration: None.
4,910-4,920	BASALT Description: Glassy, slightly vesicular rock with scattered phenocrysts of green-brown olivine, black pyroxene and translucent plagioclase within a black groundmass of feldspar laths and intergranular mafic minerals and glass. Alteration: Sparse veins of chalcedony, pyrite and anhydrite. Variable slight to intense groundmass alteration to clay minerals (?) and/or chlorite.
4,920-4,940	90% BASALT Description: As above with minor slickensides. Alteration: As above. 10% Clay.
4,940-4,970	BASALT Description: As above. Alteration: 90% of the clasts display slight groundmass alteration along fractures to clay minerals and/or chlorite. 10% of the clasts are completely altered to clay minerals and/or chlorite.
4,970-4,980	BASALT Description: As above. Alteration: Pyrite in vesicles. Incipient alteration of groundmass feldspars.
4,980-4,990	BASALT Description: As above. Alteration: Chalcedony and pyrite fill vesicles and fractures. Alteration of groundmass constituents to clay minerals and/or chlorite is variable, slight to moderate.
4,990-5,000	BASALT Description: As above. Alteration: 90% of the clasts exhibit slight groundmass alteration along fractures. 10% of the clasts are intensely altered to clay minerals and/or chlorite.
5,000-5,040	BASALT Description: As above. Alteration: Trace amounts of chalcedony, pyrite, calcite and anhydrite in vesicles and lining fractures. Pervasive incipient alteration of groundmass constituents.
5,040-5,050	BASALT Description: As above. Alteration: As above but no calcite observed.

5,050-5,070	BASALT Description: As above. Alteration: Variable incipient alteration of groundmass constituents from patches to entire clasts.
5,070-5,090	BASALT Description: As above. Alteration: Pervasive alteration of groundmass constituents to clay minerals (?).
5,090-5,130	BASALT Description: As above. Alteration: Trace amounts of anhydrite filling fractures. Variable, moderate to intense, alteration of groundmass constituents to clay minerals.
5,130-5,150	BASALT Description: As above. Alteration: As above with a few veins of chalcedony.
5,150-5,200	BASALT Description: As above. Alteration: Pervasive incipient alteration of groundmass constituents to clay minerals (?).
5,200-5,230	BASALT Description: As above. Alteration: Slight alteration of groundmass feldspars.
5,230-5,460	BASALT Description: As above. Alteration: Trace amounts of pyrite and anhydrite lining vesicles. Variable slight to intense alteration of groundmass constituents (predominantly alteration of feldspar laths).
5,460-5,480	BASALT Description: As above. Alteration: Veins of anhydrite, pyrite, chalcedony and calcite. 40% of all clasts have undergone intense alteration to clay minerals and/or chlorite. 60% of all clasts have undergone slight or incipient alteration of groundmass constituents.
5,480-5,490	BASALT Description: As above. Alteration: 50% of all clasts have undergone intense alteration to clay minerals. 50% of all clasts have only undergone incipient alteration.
5,490-5,530	BASALT Description: As above. Alteration: Slight alteration of groundmass constituents.

5,530-5,560	BASALT Description: Glassy, slightly vesicular rock with sparse phenocrysts of plagioclase and mafic minerals within a matrix of feldspars, mafic minerals and intergranular glass. Some slickensides. Alteration: Trace amounts of silica and pyrite on fracture surfaces. Variable, slight to intense, alteration. Most clasts exhibit slight alteration of groundmass constituents to chlorite and clay minerals.
5,560-5,610	BASALT Description: As above. Alteration: Abundant veins of milky chalcedony. Pervasive alteration of groundmass constituents to chlorite and/or clay.
5,610-5,620	BASALT Description: As above. Alteration: Sparse veins of chalcedony, anhydrite and calcite. 50% of all clasts have undergone pervasive alteration of groundmass constituents to chlorite and clay, and 50% of all clasts have undergone incipient or slight alteration of groundmass constituents.
5,620-5,650	BASALT Description: As above. Alteration: Abundant veins of calcedony. 90% of all clasts have undergone pervasive alteration of groundmass constituents to chlorite and/or clay. 10% of all clasts exhibit negligible or slight alteration of groundmass constituents.
5,650-5,660	BASALT Description: As above. Alteration: Abundant pyrite. Sparse veins of chalcedony. Variable alteration of groundmass constituents to chlorite and clay.
5,660-5,670	BASALT Description: Glassy, nonvesicular rock with sparse phenocrysts of plagioclase in an aphanitic matrix. Alteration: None.
5,670-5,680	BASALT Description: As above. Alteration: Rare veins of chalcedony.
5,680-5,700	BASALT Description: Slightly vesicular rock with scattered phenocrysts of plagioclase and pyroxene within a groundmass of feldspar laths, mafic minerals and intergranular glass. Alteration: Rare veins of chalcedony. Slight alteration of groundmass constituents along fractures to clay and chlorite.

5,700-5,710	BASALT Description: As above. Alteration: 40% of all clasts have undergone intense alteration to clay minerals and/or chlorite. 60% of all clasts have alteration restricted to fractures.
5,710-5,720	80% BASALT Description: As above. Alteration: Variable, moderate to intense, alteration of groundmass minerals to chlorite and/or clay. 20% BASALT Description: Nonvesicular rock with phenocrysts of plagioclase and pyroxene within an aphanitic groundmass. Alteration: Chlorite along fractures.
5,720-5,730	95% BASALT Description: Glassy, slightly vesicular rock with scattered phenocrysts of plagioclase, olivine and pyroxene within a matrix of feldspar laths, mafic minerals and glass. Alteration: Variable alteration to chlorite. 5% BASALT Description: Nonvesicular rock with phenocrysts of plagioclase and mafic minerals within an aphanitic groundmass. Alteration: Slight alteration to chlorite along fractures.
5,730-5,740	BASALT Description: Glassy, slightly vesicular rock with scattered phenocrysts of plagioclase, olivine and pyroxene within a matrix of abundant feldspar laths and mafic minerals and intersertal glass. Alteration: 20% of all clasts show no alteration. 65% of all clasts show moderate alteration of feldspar laths and groundmass mafics to clay minerals or chlorite. 15% of all clasts have undergone intense alteration to clay and/or chlorite.
5,740-5,760	BASALT Description: As above. Alteration: Slight alteration to chlorite or clay minerals near fractures.
5,760-5,780	BASALT Description: As above. Alteration: 85% of all clasts have altered groundmass feldspar. 15% of all clasts have undergone intense alteration.

5,780-5,790	BASALT Description: As above. Alteration: Slight alteration of feldspar laths to chalky white material (clay?) and slight alteration of groundmass mafics to chlorite.
5,790-5,820	BASALT Description: As above. Alteration: As above, plus a few veins of chalcedony.
5,820-5,830	BASALT Description: As above. Alteration: Pervasive alteration of groundmass feldspar to chalky white clay (?). Intense alteration of all groundmass constituents to a friable clay (?) and chlorite at fractures.
5,830-5,840	BASALT Description: As above. Alteration: As above, with some vesicles filled with chlorite and some veins of anhydrite.
5,840-5,910	BASALT Description: As above. Alteration: Chalcedony and chlorite in veins and filling vesicles. Patchy alteration of groundmass feldspars to chalky white material. Intense alteration of some clasts to chlorite and clay.
5,910-5,960	BASALT Description: As above. Alteration: As above, but no veins of chalcedony.
5,960-5,970	BASALT Description: As above. Alteration: Trace amounts of chalcedony. Pervasive alteration of feldspar laths to soft, chalky white clay (?). Complete alteration of some clasts to clay and chlorite.
5,970-6,000	BASALT Description: As above. Alteration: Patchy alteration of groundmass feldspars. A few clasts completely altered to friable material.
6,000-6,010	BASALT Description: As above. Alteration: 90% of all clasts have undergone pervasive alteration of feldspar laths. 10% of all clasts have undergone intense alteration of all constituents to a soft, friable material.
6,010-6,060	BASALT Description: As above. Alteration: Trace amounts of quartz veins. 90% of all clasts exhibit patches of altered feldspar laths. 10% of all clasts have undergone complete alteration to friable material.

6,060-6,090	BASALT Description: As above. Alteration: Trace amounts of quartz veins and pyrite disseminations. 50% of all clasts have undergone alteration in patches of groundmass constituents to chlorite and/or clay. 50% of all clasts are completely altered.
6,090-6,110	BASALT Description: As above. Alteration: As above, with abundant veins of quartz.
6,110-6,120	95% BASALT Description: As above. Alteration: 85% of all clasts exhibit patchy alteration of groundmass feldspars. 15% of all clasts are entirely altered to friable material. 5% BASALT (aphanitic) Description: Nonvesicular rock with scattered phenocrysts of plagioclase, olivine and pyroxene within a black aphanitic matrix. No alteration.
6,120-6,130	100% BASALT Description: Glassy, slightly vesicular rock with scattered phenocrysts of plagioclase, olivine and pyroxene within a groundmass of feldspar laths, mafic minerals and intersertal glass. Alteration: Traces of quartz veins. Pervasive alteration of groundmass feldspars. Trace of basalt (aphanitic) Description: Nonvesicular, aphanitic rock. No alteration.
6,130-6,140	95% BASALT Description: As above. Alteration: 90% of all clasts exhibit alteration of feldspar laths. 10% of all clasts are completely altered to a soft, friable material. 5% BASALT (aphanitic), as above.
6,140-6,150	95% BASALT Description: As above. Alteration: 30% of all clasts exhibit alteration of feldspar laths. 70% of all clasts are completely altered. 5% BASALT (aphanitic), as above.
6,150-6,170	BASALT Description: As above, with slickensides. Alteration: Trace of quartz veins. 90% of all clasts exhibit patchy areas of altered feldspar laths. 10% of all clasts are completely altered to a soft, friable material.

6,170-6,210	50% BASALT, as above. 50% BASALT (Type II) Description: Nonvesicular rock with abundant phenocrysts of plagioclase, pyroxene and/or olivine within a fine crystalline matrix of feldspar and mafic minerals. Alteration: Slight patchy alteration of groundmass feldspars.
6,210-6,220	15% BASALT, as above. 85% BASALT (Type II), as above.
6,220-6,240	5% BASALT, as above. 95% BASALT (Type II), as above.
6,240-6,400	BASALT (Type II) Description: As above. Alteration: Pervasive, incipient alteration of groundmass feldspars. A very few clasts have undergone complete alteration to a soft, friable material. Trace amounts of pyrite within the groundmass.
6,400-6,410	BASALT (Type II) Description: As above. Alteration: Trace amounts of pyrite. 80% of all clasts exhibit only incipient alteration of feldspars. 20% of all clasts are completely altered.
6,410-6,440	BASALT (Type II) Description: As above. Alteration: Incipient alteration of feldspars.
6,440-6,450	BASALT Description: Glassy, slightly vesicular rock with scattered phenocrysts of plagioclase and olivine with accessory pyroxene within a matrix of abundant feldspar laths and intersertal aphanitic material. Alteration: Trace amounts of quartz veins. Incipient alteration of groundmass feldspars.
6,450-6,500	BASALT Description: As above. Alteration: Trace quantities of quartz veins and pyrite disseminations. 20% of all clasts show no alteration. 75% of all clasts only exhibit incipient alteration of groundmass feldspar. 5% of all clasts are completely altered to a soft, friable material of clay and chlorite.
6,500-6,530	BASALT Description: As above. Alteration: 50% of all clasts are unaltered. 45% of all clasts exhibit incipient alteration of groundmass feldspars. Slight green color of intersertal material indicates the presence of chlorite. 5% of all clasts are completely altered.

6,530-6,540	BASALT Description: As above. Alteration: Trace amounts of quartz and pyrite vein material. Groundmass feldspars exhibit incipient alteration from translucent to frosty white in patches.
6,540-6,570	BASALT Description: As above with slickensides. Alteration: 50% of all clasts exhibit patchy incipient alteration of groundmass feldspars. 50% of all clasts are completely altered to friable material of clay and chlorite (?).
6,570-6,580	55% BASALT, as above. 45% VITROPHYRE, black. No alteration.
6,580-6,590	50% BASALT, as above. 50% BASALT (aphanitic) Description: Nonvesicular rock with scattered phenocrysts within a black aphanitic groundmass. No alteration.
6,590-6,600	20% BASALT, as above. 80% BASALT (aphanitic), as above.
6,600-6,610	50% BASALT Description: As above. Alteration: Complete alteration of clasts to soft friable material. 50% BASALT (aphanitic), as above.
6,610-6,640	90% BASALT Description: As above. Alteration: Pervasive, incipient alteration of groundmass feldspars. 10% BASALT (aphanitic), as above.
6,640-6,670	50% BASALT, as above. 50% BASALT (aphanitic), as above.
6,670-6,690	BASALT Description: As above. Alteration: Trace amounts of quartz and pyrite vein material. 80% of all clasts show patches of incipient feldspar alteration. 20% of all clasts are completely altered to a soft, friable material.
6,690-6,740	BASALT Description: As above. Alteration: 50% of all clasts exhibit slight incipient alteration. 50% of all clasts are completely altered.

6,740-6,750	BASALT Description: Glassy, slightly vesicular rock with scattered phenocrysts of plagioclase, olivine and pyroxene within a groundmass of feldspar laths and mafic minerals and intersertal glass. Some slickensides. Alteration: 95% of all clasts exhibit slight alteration of groundmass feldspars. 5% of all clasts are completely altered.
6,750-6,760	BASALT Description: As above. Alteration: Trace amounts of quartz and pyrite vein material. 60% of all clasts exhibit slight green coloration of intersertal material, indicating chlorite. 35% of all clasts exhibit slight alteration of groundmass feldspars. 5% of all clasts are completely altered.
6,760-6,800	BASALT Description: As above. Alteration: 95% of all clasts contain slightly altered groundmass constituents. 5% of all clasts are completely altered.
6,800-6,810	BASALT Description: As above. Alteration: 85% of all clasts contain slightly altered groundmass materials. 15% of all clasts are completely altered.
6,810-6,830	90% BASALT, as above. 10% Clay
6,830-6,860	BASALT Description: As above. Alteration: Trace amounts of quartz and pyrite vein material. 35% of all clasts show no alteration. 30% of all clasts exhibit only slight alteration of groundmass constituents. 35% of all clasts are completely altered.
6,860-6,870	40% BASALT, as above. 60% VITROPHYRE Description: Light gray, devitrified, aphyric rock. Alteration: Abundant brown biotite ($\leq$ .5 mm) disseminations, and scattered dark green modules of chlorite (?).
6,870-6,890	20% BASALT, as above. 80% VITROPHYRE, as above
6,890-6,910	15% BASALT, as above. 85% VITROPHYRE Description: As above. Alteration: Trace amounts of biotite, chlorite and pyrite disseminations.

6,910-6,930	20% BASALT, as above. 80% VITROPHYRE, as above.
6,930-6,960	80% BASALT, as above. 20% VITROPHYRE, as above.
6,960-6,970	BASALT, as above.
6,970-6,980	40% BASALT, as above. 60% VITROPHYRE Description: Aphyric, nonvesicular, gray-green, aphanitic rock. Some clasts are brecciated. Alteration: Abundant brown biotite and crypto-cyrstalline chlorite disseminated throughout the rock.
6,980-6,990	90% BASALT, as above. 10% VITROPHYRE Description: Black glass. No alteration.
6,990-7,020	BASALT Description: As above. Alteration: 90% of all clasts exhibit incipient alteration of groundmass constituents. 10% of all clasts are completely altered.
7,020-7,060	BASALT Description: As above. Alteration: Some chlorite coating fracture surfaces. 85% of all clasts have only slight alteration of groundmass constituents. 15% of all clasts are completely altered.
7,060-7,090	BASALT Description: As above. Alteration: 70% of all clasts contained altered groundmass feldspars and abundant chlorite as intersertal material. 30% of all clasts are completely altered to a soft, friable material.
7,090-7,140	BASALT Description: Nonvesicular rock with scattered phenocrysts of plagioclase, olivine and pyroxene within a dull red-brown matrix of feldspar laths and intersertal aphanitic material. Alteration: 95% of all clasts contain altered groundmass feldspars. 5% of all clasts are completely altered.
7,140-7,170	BASALT Description: As above. Alteration: Trace amounts of quartz, pyrite and brown biotite. 80% of all clasts contain altered groundmass feldspar. 20% of all clasts are completely altered.

7,170-7,200	BASALT Description: As above. Alteration: Trace amounts of quartz and biotite. 60% of all clasts contain altered feldspar laths. 40% of all clasts have undergone internal alteration.
7,200-7,210	BASALT Description: As above. Alteration: A trace to 1% biotite, altered to a golden color. Trace amounts of chlorite coating fracture surfaces. Slight alteration of all groundmass constituents.
7,210-7,240	BASALT Description: As above. Alteration: Trace amounts of biotite. 30% of all clasts are unaltered. 70% of clasts exhibit slight alteration of groundmass feldspars and alteration of intersertal material to chlorite.
7,240-7,260	BASALT Description: As above. Alteration: As above, with some chlorite nodules.
7,260-7,280	BASALT Description: As above. Alteration: Variable, slight to moderate alteration of feldspar lath. Intersertal material has undergone slight alteration to chlorite.
7,280-7,300	BASALT Description: As above. Alteration: 90% of all clasts have undergone slight alteration to chlorite. 10% of all clasts have undergone intense alteration to a soft, friable material.
7,300-7,340	BASALT Description: As above. Alteration: 55% of all clasts have undergone slight alteration of feldspars and of mafic minerals to chlorite. 45% of all clasts are completely altered to a soft, friable material.
7,340-7,370	BASALT Description: As above. Alteration: As above, with trace amounts of quartz.
7,370-7,380	BASALT Description: As above. Alteration: Trace amounts of pyrite and biotite. 65% of all clasts are slightly altered. 35% of all clasts are completely altered to a soft, friable material.

7,380-7,440	BASALT Description: As above. Alteration: 90% of all clasts have undergone some alteration of groundmass constituents to clay minerals and chlorite. 10% of all clasts are completely altered to a soft, friable material.
7,440-7,450	30% BASALT, as above. 70% BASALT (aphanitic) Description: Scattered phenocrysts of plagioclase, pyroxene and olivine within a black aphanitic matrix. Alteration: Chlorite coats some fracture surfaces.
7,450-7,460	85% BASALT, as above. 15% BASALT (aphanitic), as above.
7,460-7,470	BASALT, as above.
7,470-7,480	BASALT Description: As above. Alteration: Intense alteration of all clasts to a friable material (clay and chlorite?).
7,480-7,500	BASALT Description: As above. Alteration: 75% of all clasts contain groundmass constituents altered to chlorite and clay. 25% of all constituents are completely altered.
7,500-7,520	BASALT Description: As above. Alteration: 20% of all clasts are unaltered. 80% of all clasts have undergone slight alteration to chlorite and clay minerals within the groundmass.
7,520-7,530	BASALT Description: As above. Alteration: 20% of all clasts are unaltered. 45% of all clasts contain altered groundmass constituents. 35% of all clasts are completely altered to a friable material (clay and chlorite).
7,530-7,540	BASALT Description: As above. Alteration: Trace amounts of chalcedony vein material. 85% of all clasts are only slightly altered within the groundmass to chlorite and clay. 15% of all clasts are completely altered.
7,540-7,560	BASALT Description: As above. Alteration: 35% of all clasts are unaltered. 40% of all clasts contain altered groundmass constituents to chlorite and clay. 25% of all clasts are completely altered to a friable material.

7,560-7,580	90% BASALT, as above. 10% VITROPHYRE, black, dense glass.
7,580-7,590	90% BASALT, as above. 10% VITROPHYRE Description: Slightly vesicular glass. Alteration: Somevesicles are filled with a soft green material = clay and chlorite (?).
7,590-7,600	BASALT, as above.
7,600-7,620	95% BASALT, as above. 5% VITROPHYRE, as above.
7,620-7,630	BASALT Description: As above. Alteration: Pyrite and chlorite as vein deposits. Variable, slight to moderate, alteration of groundmass constituents.
7,630-7,650	BASALT PORPHYRY Description: Nonvesicular rock with abundant (5-10%) phenocrysts of resinous brown anhedral pyroxene ($\leq$ 1 mm) and (1-5%) phenocrysts of plagioclase within a matrix which varies from aphanitic to holocrystalline. Alteration: Groundmass material is altered to chlorite and possibly clay minerals.
7,650-7,660	BASALT PORPHYRY Description: As above. Alteration: Intense alteration of all clasts to chlorite and/or clay.
7,660-7,680	65% BASALT PORPHYRY, as above. 35% VITROPHYRE Description: Slightly vesicular. Alteration: Vesicles filled with chlorite.
7,680-7,690	95% BASALT PORPHYRY, as above. 5% VITROPHYRE, as above.
7,690-7,720	BASALT PORPHYRY Description: As above. Alteration: Variable, moderate to intense alteration of clasts to chlorite.
7,720-7,750	BASALT Description: Glassy, nonvesicular rock with scattered phenocrysts of plagioclase and pyroxene within a matrix of feldspar laths, intergranular mafic minerals and glass. Alteration: Trace amounts of pyrite. Some chlorite pseudomorphs after mafic phenocrysts. Groundmass material slightly to moderately altered to chlorite and possibly clay.

7,750-7,780	VITROPHYRE Description: Nonvesicular, aphyric, devitrified (?) glass. Alteration: Chlorite and pyrite line fractures. Green tint of groundmass indicates pervasive alteration to chlorite.
7,780-7,790	BASALT Description: Glassy nonvesicular rock with scattered phenocrysts of plagioclase, pyroxene and/or olivine within a matrix of feldspar laths and intersertal glass. Alteration: Trace amounts of quartz and pyrite vein material. Slight alteration of groundmass material to chlorite.
7,790-7,800	70% VITROPHYRE, as above. 30% BASALT, as above.
7,800-7,860	BASALT Description: As above. Alteration: Moderate alteration of groundmass material to chlorite.
7,860-7,940	BASALT Description: As above. Alteration: Variable alteration of intersertal groundmass material to chlorite.
7,940-7,990	BASALT (Type II) Description: Nonvesicular rock with phenocrysts of plagioclase, pyroxene and olivine within a fine crystalline matrix of feldspar laths and mafic minerals. Alteration: Trace amounts of pyrite and anhydrite vein material. Slight alteration to chlorite within the groundmass.
7,990-8,030	BASALT (Type II) Description: As above. Alteration: Incipient alteration of groundmass feldspars indicated by their satin luster. Intergranular material has green tint indicating the presence of chlorite and possibly epidote. Several clasts are soft and friable.
8,030-8,060	BASALT (Type II) Description: As above. Alteration: Trace amounts of quartz vein material. Slight alteration of groundmass feldspars to sausserite (?) and intergranular material to chlorite.
8,060-8,100	BASALT (Type II) Description: As above, with a very few brecciated clasts and some slickensides. Alteration: As above.
8,100-8,140	BASALT (Type II) Description: As above, but no brecciated material. Alteration: As above.

8,140-8,170

BASALT (Type II)
Description: As above, with a few clasts of breccia. Brecciated material appears to be glass.
Alteration: Feldspar laths are highly altered. Intergranular material has undergone some alteration to chlorite.

8,170-8,200

BASALT (Type II)
Description: Nonvesicular rock with scattered phenocrysts of pyroxene, olivine and plagioclase within a matrix of feldspar laths and intergranular mafic minerals with traces of glass.
Alteration: As above.

8,200-8,270

BASALT (Type II)
Description: As above.
Alteration: Trace amounts of quartz vein material. 50% of all clasts have undergone slight to moderate alteration of groundmass constituents. 50% of all clasts are completely altered to white, friable material.

8,270-8,290

BASALT (Type II)
Description: Nonvesicular rock with scattered phenocrysts of red-brown pyroxene, green-brown olivine (?) and plagioclase with a fine crystalline matrix of feldspar laths and intergranular mafics.
Alteration: Trace amounts of quartz vein material. Variable, moderate to intense alteration of groundmass mafics to chlorite. Groundmass feldspars may be replaced by sauss rite. Some clasts are completely altered to a white, friable material.

8,290-8,300

BASALT
Description: Glassy, dense rock with scattered phenocrysts of red-brown pyroxene, green olivine (?) and plagioclase within a matrix of feldspar laths and intersertal aphanitic material.
Alteration: Variable, but most clasts show no detectable alteration.

APPENDIX A

Definitions of Petrographic Terms

ANHYDRITE: $CaSO_4$, Anhydrous gypsum.

APHANITIC: The texture of an igneous rock in which the crystalline components are not distinguishable by the unaided eye.

ARGILLIC ALTERATION: Process by which certain minerals of a rock are converted to minerals of the clay group.

BIOTITE: $K(Mg, Fe^{+2})_3(Al, Fe^{+3})Si_3O_{10}(OH)_2$, A mineral of the mica group.

BOTRYOIDAL: Having the form of a bunch of grapes.

BRECCIA: A coarse-grained clastic rock composed of large, angular and broken rock fragments that are cemented together in a finer-grained matrix and that can be of any composition, origin or mode of accumulation.

CALCITE: $CaCO_3$, A secondary constituent of many igneous rocks.

CHALCEDONY: A cryptocrystalline variety of quartz. It is commonly microscopically fibrous, may be translucent or semitransparent, and has a nearly wax-like luster, a uniform tint, and a white, pale-blue, gray, brown or black color.

CHATOYANT: Said of mineral having a changeable luster or color marked by a narrow band of light. It results from the reflection of light from minute, parallel fibers, cavities or tubes, or needle-like inclusions within the mineral.

CHLORITE: A group of platy, monocline, usually greenish minerals. Chlorites are associated with and resemble the micas.

CHLOROPHAEITE: A mineraloid closely related to chlorite in composition and found in the groundmass of tholeiitic basalts.

CLAST: An individual constituent, grain, or fragment of a sediment or rock, produced by mechanical weathering of a larger rock mass.

CRYPTOCRYSTALLINE: The texture of a rock consisting of or having crystals that are too small to be recognized even under the ordinary microscope.

DISSEMINATED: Said of a mineral deposit in which the minerals occur as scattered particles in the rock.

FRIABLE: Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder.

HOLOCRYSTALLINE: Said of an igneous rock composed entirely of crystals, having no part glassy.

HOLOHYALINE: Said of an igneous rock that is composed entirely of glass or whose texture is completely glassy.

HYALOCLASTITE: A deposit that is formed by the flowing of basalt under water and its consequent granulation or shattering into small, angular fragments.

HYALOPILITIC: Said of the intersertal texture of an igneous rock in which the needle-like crystals of the groundmass are set in a glassy matrix.

IDDINGSITE: A reddish-brown mixture of silicates (of ferric iron, calcium, and magnesium) formed by the alteration of olivine. It forms rust-colored patches in basic igneous rocks.

INCIPIENT (ALTERATION): Process of alteration in its first stages of existence.

INTERGRANULAR (TEXTURE): Said of the texture of an igneous rock in which the pyroxene occurs as an aggregation of grains (rather than in large crystals) in the interstices of a network of feldspar laths.

INTERSERTAL (TEXTURE): Said of the groundmass texture of an igneous in which the material occupying the interstices of feldspar laths is composed of a glassy or partly crystalline material.

LATHS: Crystal habits which are long and thin, and of moderate to narrow width.

MAFIC: Said of an igneous rock composed chiefly one or more ferromagnesian, dark-colored minerals in its mode; also, said of those minerals.

OLIVINE: $(Mg, Fe)_2 SiO_4$, Olivine is a common rock-forming mineral of basic and low-silica igneous rocks (basalt); it crystallizes early from a magma.

PERMEABILITY: The property or capacity of a porous rock, sediment, or soil for transmitting fluid; it is a meausre of the relative ease of fluid flow under unequal pressure.

PHENOCRYSTS: A term for a relatively large, conspicuous crystal in a porphyritic rock.

PLAGIOCLASE: A solid-solution feldspar-mineral series from Ab($NaAlSi_3O_8$) to An($CaAl_2Si_2O_8$). Plagioclases are one of the commonest rock-forming minerals.

PORPHYRITIC: Said of the texture of an igneous rock in which larger crystals (phenocrysts) are set in a finer groundmass which may be crystalline or glassy or both.

PSEUDOMORPH: A mineral whose outward crystal form is that of another mineral species; it has developed by alteration, substitution or incrustation.

PYRITE: FeS_2, A common, pale-bronze or brass-yellow, isometric mineral.

PYROXENE: A group of dark, rock-forming silicate minerals closely related in crystal form and composition and having the general formula: $ABSi_2O_6$, where A = Ca, Na, Mg or Fe^{+2} and B = Mg, Fe^{+3} or Al.

QUARTZ: SiO_2, crystalline silica.

SAUSSURITE: A mineral aggregate consisting of a mixture of albite and zoisite or epidote. It is produced by alteration of calcic plagioclase.

SCORIACEOUS: Said of the texture of a coarsely vesicular basalt.

SLICKENSIDE: A polished and smoothly striated surface that results from friction along a fault plane.

SUBAERIAL: Occurring beneath the atmosphere or in the open air.

SUBHEDRAL: Said of a crystal which is partially bounded by crystal faces.

SUBMARINE: Occurring below water.

SUBSIDENCE: A local mass movement that involves principally the gradual downward settling or sinking of the Earth's surface.

THOLEIITIC BASALT: A group of olivine-free or olivine-poor basalts.

TRACHYTIC (TEXTURE): Said of igneous rocks in which the lath-shaped feldspar crystals of the groundmass have a subparallel orientation.

VESICLES: A cavity of variable shape in lava formed by the entrapment of a gas bubble during solidification of the lava.

VITROPHYRE: Any porphyritic igneous rock having a glassy groundmass.

ZEOLITE: A generic term for a large group of white, red, yellow or colorless hydrous aluminosilicites that are similar in composition to feldspars that occur as secondary minerals (derived by hydrothermal alteration of feldspar).

APPENDIX B

Temperature Surveys,

Ashida #1

Table 4.

TEMPERATURE SURVEYS

Ashida #1

No.	Date	Time	Comments
1	6/25/80	1300	Bailing hole. Fluid level at 803.5 feet (RKB).
2	7/1/80	0400	Survey from 500-1,264 feet at 2-1/2 hours after drilling.
3*	7/12/80	0800	Survey aborted when sensor became plugged with thick gel.
4*	7/13/80	1400-1545	Survey to 1,100 feet. Unreliable readings.
5*	7/14/80	0740	Survey to 920 feet. Unreliable readings.
6	7/19/80	?	Survey to 800 feet to check cement bond.
7	7/20/80	1000	Survey to 800 feet to check cement bond.
8	7/21/80	0800	Survey to 800 feet to check cement bond.
9	7/26/80	0720	Survey to 1,525 feet at 2-1/2 hours after drilling.
10	7/27/80	0800	Survey to 1,525 feet at 25 hours after drilling. Temperature readings unstable, but good bottom hole temperature.
11	7/28/80	0800	Bottom hole temperature at 1,500 feet at 50 hours after drilling.
12	7/29/80	1120-1255	Bottom hole temperature at 1,900 feet at 2-1/2 hours after drilling.
13	8/2/80	0730-0830	Survey from 1,000 feet to 2,810 feet. Circulated for 45 minutes prior to pulling out of hole. Survey at 3 hours after circulation.
14	8/4/80	0730-0930	Survey from 1,600-2,800 feet at 51 hours after circulating.
15	8/5/80	1240-1300	Bottom hole temperature at 3,020 feet at 2-1/2 hours after drilling.
16	8/7/80	0500-0800	Bottom hole temperature at 3,250 feet at 2-1/2 hours after drilling.
17	8/9/80	0800-0915	Survey from 2,000-3,564 feet at 3 hours after drilling.

Table 4 (continued)

No.	Date	Time	Comments
18	8/11/80	0730-0930	Surveyed 5 points from 3,562 to 3,162 feet at 50 hours after drilling.
19	8/13/80	1930-2200	Continuous survey run by Gearhart-Owens to 3,926 feet. Circulated for 4 hours prior to pulling out of hole. Survey at 3-1/2 hours after circulation.
20	8/14/80	0300-0400	Continuous survey run by Gearhart-Owens to 3,926 feet at 11 hours after circulation.
21	8/14/80	0700-0900	Survey 4 points from 3,925 to 3,625 feet at 15 hours after circulation.
22	8/14/80	1600-1800	Survey from 3,000 to 3,925 feet at 24 hours after circulation.
23	8/15/80	0330-0600	Survey from 3,000 to 3,925 feet at 35-1/2 hours after circulation.
24	8/15/80	1740-2030	Surveyed 8 points from 3,925 to 3,225 feet at 50 hours after circulation.
25	9/6/80	0800-0900	Survey from 3,000 to 4,300 feet at 3 hours after drilling.
26	9/8/80	0750-1000	Bottom hole temperature at 4,300 feet with maximum registering thermometer at 50 hours after drilling.
27	9/10/80	1600-1730	Bottom hole temperature at 4,550 feet at 3 hours after drilling.
28	9/13/80	0700-0845	Bottom hole temperature at 4,920 feet at 3 hours after drilling.
29	9/15/80	0800-0900	Bottom hole temperature at 4,920 feet at 50 hours after drilling.
30	9/18/80	1000-1130	Bottom hole temperature at 5,378 feet at 3 hours after drilling.
31	9/20/80	0800-1000	Bottom hole temperature at 5,685 feet at 3 hours after drilling.
32	9/22/80	0800-0900	Bottom hole temperature at 5,685 feet at 50 hours after drilling.
33*	9/27/80	0830-	Bottom hole temperature at 6,445 feet at 3 hours after drilling. Kuster bomb malfunctioned.

Table 4 (continued)

No.	Date	Time	Comments
34*	9/28/80	1100-1330	Bottom hole temperature at 6,445 feet at 30 hours after drilling. Unable to get bomb down the hole.
35	9/29/80	0800-1000	Bottom hole temperature at 6,445 feet at 50 hours after drilling.
36	10/4/80	0800-1130	Bottom hole temperature at 7,211 feet at 6 hours after drilling.
37	10/13/80	0300-0600	Continuous survey run by Gearhart-Owens from 4,000 feet to 7,900 feet at 4-1/2 hours after circulation. (Circulated for 6 hours prior to pulling out of hole.)
38	10/13/80	0815-1300	Bottom hole temperature at 7,927 feet at 15-1/2 hours prior to pulling out of hole.
39	10/16/80	1730-2230	Bottom hole temperature at 7,927 feet at 46 hours after circulating H_2O.
40	10/17/80	1000-2000	Bottom hole temperature with kuster bomb at 64 hours after circulation.
41	10/23/80	0930-1430	Survey from 2,200 to 3,980 feet at 208 hours after circulation.
42	10/24/80	0852-1400	12 point survey with kuster bomb at 232 hours after circulation.
43	10/24/80	1500-2000	16 point survey with kuster bomb at 239 hours after circulation.
44	10/31/80	1430-1800	6 point survey with kuster bomb at 25 hours after circulation. (Circulated for 3-1/2 hours prior to pulling out of hole.)

*indicates temperature data omitted from report.

TEMPERATURE LOG

Ashida #1

Survey #1 6/25/80 1:00 PM

Logged by GeothermEx, Inc.

Purpose: Establish fluid level.

Temperature at 830 feet (RKB) - 130°F

Fluid level = 803.5 feet (RKB)

TEMPERATURE LOG

Ashida #1

Survey #2 7/1/80 4:00 AM

Logged by Water Resources, Inc.

Purpose: Log the open hole 2-1/2 hours after drilling.

Depth, in feet	°F	
500	92.6	
600	94.8	
650	87.4	
700	87.2	
750	87.5	
800	88.6	
830	123.0	
840	128.0	
850	130.0	
860	132.9	
880	134.8	
900	118.0	
950	113.8	
1,000	113.7	
1,050	113.5	
1,110	112.3	
1,115	111.0	
1,170	111.4	
1,180	111.6	
1,190	111.6	
1,200	111.6	
1,230	111.5	
1,240	111.5	
1,264	111.0	T.D.

No change after 15 minutes.

TEMPERATURE LOG

Ashida #1

Survey #6 7/19/80

Logged by GeothermEx, Inc.

Purpose: To run cement bond survey in 13-3/8" casing to 800 feet.

Depth, in feet	°F
0	77.5
100	80.7
125	82.0
150	83.9
175	87.0
200	93.9 *
225	104.3 *
250	114.3 *
275	119.3
300	104.0
325	105.9
350	111.4
375	101.1
400	99.4
425	99.4
450	100.3
475	101.5
500	101.4
525	102.5
550	103.4
575	104.7
600	105.3
625	104.5
650	105.3
675	106.6
700	107.6
725	108.7
750	109.9
775	109.5
800	129.3
	130.8 - 5 min.
	131.0 - 8 min.

*unstable, rising

Run going up hole slowly without stopping at stations.

Depth, in feet	°F
625	105.4
600	105.0
575	105.4
550	104.7
525	103.4
500	102.4
475	101.7
450	101.3
425	100.3
400	99.6
375	101.1
350	111.4
325	108.5
300	105.6
275	106.3
250	116.8
225	111.5
200	101.2
175	92.6
150	87.2
125	84.2
100	82.1
75	80.9
50	80.1
25	79.0

TEMPERATURE LOG

Ashida #1

Survey #7 7/20/80 10:00 AM

Logged by GeothermEx, Inc.

Purpose: Cement bond log after cementing second stage to 800 feet.

Depth, in feet	°F
0	78.2
100	82.1
125	83.8
150	86.6
175	90.6
200	96.0
225	104.1
250	110.8
275	113.5
300	103.7
325	105.4
350	109.0
375	101.7
400	97.6
425	97.6
450	98.3
475	99.5
500	100.3
525	101.3
550	102.8
575	104.1
600	105.2
625	105.7
650	106.7
675	108.3
700	109.6
725	110.7
750	111.8
775	112.4
800	124.3

TEMPERATURE LOG

Ashida #1

Survey #8   7/21/80   8:00 AM

Logged by GeothermEx, Inc.

Purpose: Cement bond log within 13-3/8" casing to 800 feet.

Depth, in feet	°F
0	69.1
25	78.0
75	81.0
100	82.1
125	83.8
150	86.2
175	89.2
200	93.4
225	99.7
250	105.3
275	107.6
300	101.5
325	102.6
350	105.2
375	100.6
400	95.8
425	96.1
450	96.8
475	97.9
500	98.9
525	100.2
550	101.5
575	102.9
600	104.1
625	105.1
650	106.4
675	107.7
700	109.1
725	110.3
750	111.5
775	112.6
800	124.4

TEMPERATURE LOG

Ashida #1

Survey #9 7/26/80 7:20 AM

Logged by GeothermEx, Inc.

Purpose: Run temperature survey 2-1/2 hours after drilling.

Depth, in feet	°F	Depth, in feet	°F	
50	92.8	875	111.2	
100	96.7	900	111.7	
150	99.3	925	111.3	
175	103.2	950	112.0	
200	104.6	975	112.2	
225	102.8	1,000	112.1	
250	102.6	1,025	111.5	
275	102.3	1,050	110.9	
300	102.2	1,075	110.5	
325	101.8	1,100	109.9	
350	101.9	1,125	109.3	
375	102.1	1,150	108.9	
400	101.8	1,175	108.6	
425	101.5	1,200	107.5	
450	101.4	1,225	107.1	
475	101.4	1,250	106.7	
500	101.8	1,275	106.8	
525	101.9	1,300	106.9	
550	102.1	1,325	107.6	
575	102.3	1,350	107.8	
600	102.4	1,375	108.3	
625	102.6	1,400	108.0	
650	102.9	1,425	107.9	
675	102.9	1,450	107.8	
700	103.2	1,475	107.9	
725	103.5	1,500	108.1	
750	103.7	1,525	107.7	8:12 AM
775	104.0		108.0	8:14 AM
800	105.0		108.2	8:16 AM
825	107.1		108.3	8:21 AM
850	108.9		108.4	8:26 AM

TEMPERATURE LOG

Ashida #1

Survey #10   7/27/80   8:00 AM

Logged by GeothermEx, Inc.

Purpose: Temperature survey of hole ∿25 hours after drilling. Temperature probe plugged but got good bottom hole temperature.

Depth, in feet	°F
50	77.4
100	83.9
150	103.9
175	108.7
200	104.2
225	101.8
250	101.6
275	101.2
300	100.3
325	98.7
350	98.3
375	98.3
400	98.6
425	98.5
450	98.0
475	97.3
500	97.1
525	97.1
550	97.1
575	97.2
600	97.4
625	98.1
650	100.0
675	100.3
700	100.7
725	101.0
750	102.8
775	105.7*
800	107.1*

Depth, in feet	°F
825	122.2*
850	127.5*
875	136.2*
900	137.7*
925	136.8*
950	136.3
975	135.8
Went to bottom	
1,521	115.1
1,507	114.6
1,475	114.5
1,450	114.5
1,425	114.4
1,400	114.3
1,375	114.3
1,350	114.4
1,325	115.1
1,300	115.3
1,275	115.4
1,250	114.8*
1,225	114.6
1,200	114.4
1,175	114.3
1,150	114.4
1,125	116.5*
1,100	117.4*
1,075	118.0*
1,050	118.8*
1,025	119.8*

*unstable

TEMPERATURE LOG

Ashida #1

Survey #11   7/28/80   8:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom Hole Temperature - ∿50 hours after drilling.

Temperature @ 1,500 = 115.5°F

TEMPERATURE LOG

Ashida #1

Survey #12 7/29/80 11:20 AM

Logged by GeothermEx, Inc.

Purpose: Bottom Hole Temperature at 1,900 feet at 2-1/2 hours after drilling.

11:20 AM at 1,900 feet = 105.1°F

12:20 PM at 1,900 feet = 109.2°F

12:55 PM at 1,900 feet = 109.9°F

TEMPERATURE LOG

Ashida #1

Survey #13 8/2/80 7:30 AM

Logged by GeothermEx, Inc.

Purpose: To log the open hole, 3 hours after circulation.

Depth, in feet	°F	Depth, in feet	°F	
1,000	110.9	1,925	106.5	
1,025	110.5	1,950	106.5	
1,050	110.5	1,975	106.5	
1,075	110.1	2,000	106.5	
1,100	109.8	2,025	106.5	
1,125	109.4	2,050	106.4	
1,150	109.0	2,075	106.5	
1,175	109.2	2,100	106.6	
1,200	107.7	2,125	106.4	
1,225	107.3	2,150	106.6	
1,250	107.4	2,175	106.9	
1,275	107.7	2,200	106.9	
1,300	107.4	2,225	106.8	
1,325	107.3	2,250	107.1	
1,350	107.2	2,275	107.2	
1,375	107.2	2,300	107.4	
1,400	107.0	2,325	107.5	
1,425	106.7	2,350	107.4	
1,450	106.6	2,375	107.6	
1,475	106.6	2,400	107.1	
1,500	106.3	2,425	107.2	
1,525	106.3	2,450	107.8	
1,550	106.3	2,475	108.3	
1,575	106.2	2,500	108.4	
1,600	106.1	2,525	108.2	
1,625	106.1	2,550	108.3	
1,650	106.3	2,575	108.4	
1,675	106.2	2,600	108.8	
1,700	106.2	2,625	108.8	
1,725	106.1	2,650	109.3	
1,750	105.9	2,675	110.1	
1,775	106.1	2,700	110.5	
1,800	106.3	2,725	111.0	
1,825	106.4	2,750	111.5	
1,850	106.3	2,775	112.0	
1,875	106.3	2,800	113.1	
1,900	106.4	2,810	113.6	8:20 AM
		2,810	118.0	8:35 AM

TEMPERATURE LOG

Ashida #1

Survey #14   8/4/80   7:30 AM

Logged by GeothermEx, Inc.

Purpose: Temperature survey to 2,800 feet ∿51 hours after drilling.

Depth, in feet	°F	Depth, in feet	°F	
1,600	111.5	2,425	113.8	
1,700	110.9	2,450	114.0	
1,800	110.7	2,475	115.1*	
1,900	110.7	2,500	116.3	
2,000	110.9	2,525	116.7	
2,100	111.2	2,550	117.0	
2,200	112.5	2,575	117.2	
2,225	112.5	2,600	117.5	
2,250	112.8	2,625	119.2	
2,275	112.9	2,650	120.6	
2,300	113.3	2,675	121.6	
2,325	113.4	2,700	122.5	
2,350	113.6	2,725	123.3	
2,375	114.1	2,750	124.0	
2,400	114.0	2,800	126.4	9:30 AM

*unstable

TEMPERATURE LOG

Ashida #1

Survey #15   8/5/80   12:40 PM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature ~2-1/2 hours after drilling at 3,020 feet.

12:40 PM at 3,020 feet = 112°F

1:00 PM at 3,020 feet = 124°F

P.O.H.

TEMPERATURE LOG

Ashida #1

Survey #16   8/7/80   5:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at ~2-1/2 hours after drilling at 3,250 feet. Probe malfunctioned. Used 3 max-register thermometers.

At 3,250 = 137°F

At 3,250 = 137°F

At 3,250 = 138°F

TEMPERATURE LOG

Ashida #1

Survey #17 8/9/80 8:00 AM

Logged by GeothermEx, Inc.

Purpose: Survey hole ∿3 hours after drilling.

Depth in feet	°F	Depth, in feet	°F	
2,000	113.8	2,825	116.4	
2,025	113.8	2,850	116.6	
2,050	113.9	2,875	116.7	
2,075	113.9	2,900	116.9	
2,100	114.0	2,925	117.0	
2,125	114.0	2,950	117.1	
2,150	114.0	2,975	117.4	
2,175	114.1	3,000	117.4	
2,200	114.1	3,025	117.7	
2,225	114.2	3,050	118.0	
2,250	114.2	3,075	118.6	
2,275	114.3	3,100	118.6	
2,300	114.3	3,125	118.6	
2,325	114.4	3,150	119.3	
2,350	114.4	3,175	119.2	
2,375	114.5	3,200	119.0	
2,400	114.5	3,225	119.9	
2,425	114.6	3,250	120.3	
2,450	114.7	3,275	120.2	
2,475	114.8	3,300	119.8	
2,500	114.9	3,325	119.0	
2,525	114.9	3,350	118.4	
2,550	115.0	3,375	118.4	
2,575	115.1	3,400	118.9	
2,600	115.2	3,425	122.0	
2,625	115.4	3,450	122.8	
2,650	115.6	3,475	122.9	
2,675	115.7	3,500	123.1	
2,700	115.9	3,525	123.0	
2,725	116.0	3,550	122.4	
2,750	116.1	3,564	122.0	8:48 AM
2,775	116.2	3,564	141.0	9:13 AM
2,800	116.3			

Maximum Reading Thermometers = 143°F, 142°F

TEMPERATURE LOG

Ashida #1

Survey #18   8/11/80   7:30 AM

Logged by GeothermEx, Inc.

Purpose: Survey every 100 feet from 3,562 to 3,162 feet at 50 hours after drilling.

Depth, in feet	°F
3,562	161.5
3,462	147.4
3,362	145.2
3,262	140.1
3,162	135.2

Maximum Reading Thermometer = 171°F

TEMPERATURE LOG

Ashida #1

Survey #19   8/13/80   7:30 PM

Logged by Gearhart-Owen

Purpose: Continuous readout log from 100 to 3,926 feet.

Depth, in feet	°F	Depth, in feet	°F
100	105.0	2,550	116.5
200	109.3	2,600	116.7
300	110.4	2,650	117.2
400	110.4	2,700	117.5
500	111.2	2,750	117.6
600	112.0	2,800	117.9
700	113.2	2,850	118.3
800	114.8	2,900	118.6
900	122.0	2,950	119.0
1,000	119.9	3,000	118.9
1,100	118.8	3,050	119.4
1,200	117.2	3,100	120.6
1,300	116.3	3,150	120.8
1,400	115.7	3,200	120.2
1,500	115.1	3,250	119.9
1,600	114.8	3,300	118.6
1,700	114.8	3,350	121.5
1,800	114.8	3,400	121.8
1,900	114.8	3,450	123.5
2,000	115.0	3,500	124.6
2,050	115.2	3,550	121.8
2,100	115.2	3,600	120.6
2,150	115.3	3,650	121.5
2,200	115.4	3,700	122.1
2,250	115.4	3,750	122.4
2,300	115.6	3,800	125.2
2,350	115.8	3,850	125.9
2,400	115.8	3,900	124.6
2,450	116.0	3,926	125.8
2,500	116.2	3,926	143.6 after 30 minutes

Maximum Reading Thermometer = 146°F

TEMPERATURE LOG

Ashida #1

Survey #20 8/14/80 4:00 AM

Logged by Gearhart-Owen

Purpose: To run continuous log from 2,500 to 3,926 feet at 11 hours after circulation.

Depth, in feet	°F	Depth, in feet	°F
2,500	120.0	3,375	125.2
2,550	120.2	3,400	125.0
2,600	120.4	3,425	124.8
2,650	120.8	3,450	125.1
2,700	121.2	3,475	125.7
2,750	121.5	3,500	126.4
2,800	121.8	3,525	127.2
2,850	122.2	3,550	127.8
2,900	122.5	3,575	127.8
2,950	122.8	3,600	128.0
3,000	123.2	3,625	128.0
3,025	123.4	3,650	128.1
3,050	123.8	3,675	128.5
3,075	124.1	3,700	129.2
3,100	124.5	3,725	129.6
3,125	124.8	3,750	129.8
3,150	125.1	3,775	132.4
3,175	125.3	3,800	134.3
3,200	125.5	3,825	135.4
3,225	125.5	3,850	135.8
3,250	125.9	3,875	137.0
3,275	126.4	3,900	138.2
3,300	126.3	3,925	143.2
3,325	126.0	3,925	146.9 after 30 minutes
3,350	125.6		

TEMPERATURE LOG

Ashida #1

Survey #21 8/14/80 7:00 AM

Logged by GeothermEx, Inc.

Purpose: Survey hole at 100-foot intervals from 3,925 to 3,625 feet 15 hours after circulating.

Depth, in feet	°F	Time
3,925	158.4	7:35 AM
	164.5	7:58 AM
3,825	146.7	8:00 AM
	146.4	8:10 AM
3,725	143.0	8:12 AM
	141.7	8:18 AM
3,625	136.5	8:20 AM
	136.9	8:25 AM

Maximum Reading Thermometers = 167°F, 164°F

TEMPERATURE LOG

Ashida #1

Survey #22   8/14/80   4:00 PM

Logged by GeothermEx, Inc.

Purpose: Survey from 3,000 to 3,925 feet 24 hours after circulating.

Depth, in feet	°F	Depth, in feet	°F
3,000	121.7	3,500	131.9
3,025	122.1	3,525	132.8
3,050	122.6	3,550	133.8
3,075	123.3	3,575	135.3
3,100	123.9	3,600	137.4
3,125	124.3	3,625	139.4
3,150	124.9	3,650	141.0
3,175	125.4	3,675	142.8
3,200	125.7	3,700	144.1
3,225	126.1	3,725	145.7
3,250	126.7	3,750	147.1
3,275	127.3	3.775	148.6
3,300	127.8	3,800	150.3
3,325	128.1	3,825	152.5
3,350	128.5	3,850	154.3
3,375	129.2	3,875	156.4
3,400	129.7	3,900	159.4
3,425	130.1	3,925	162.1
3,450	130.6	3,925	170.5 after 45 minutes
3,475	131.2		

Maximum Reading Thermometer = 184°F, 186°F

TEMPERATURE LOG

Ashida #1

Survey #23 8/15/80 3:30 AM

Logged by GeothermEx, Inc.

Purpose: Survey from 3,000 to 3,925 feet 35-1/2 hours after circulating.

Depth, in feet	°F	Depth, in feet	°F	
3,000	124.6	3,500	138.2	
3,025	125.6	3,525	139.9	
3,050	126.3	3,550	140.9	
3,075	127.4	3,575	143.2	
3,100	127.6	3,600	145.8	
3,125	128.3	3,625	147.4	
3,150	129.0	3,650	148.5	
3,175	129.4	3,675	149.8	
3,200	129.4	3,700	151.5	
3,225	130.5	3,725	152.9	
3,250	131.5	3,750	154.8	
3,275	132.1	3,775	156.4	
3,300	132.4	3,800	158.4	
3,325	132.4	3,825	160.5	
3,350	133.2	3,850	163.1	
3,375	134.3	3,875	165.3	
3,400	134.1	3,900	169.2	
3,425	136.0	3,925	171.3	4:25 AM
3,450	137.3	3,925	171.6	4:35 AM
3,475	137.6	3,925	172.3	4:55 AM

Maximum Reading Thermometer = 190°F, 190°F

TEMPERATURE LOG

Ashida #1

Survey #24 8/15/80 5:40 PM

Logged by GeothermEx, Inc.

Purpose: Survey at 100-foot intervals from 3,925 to 3,225 feet 50 hours after circulating.

Depth, in feet	°F	Time
3,925	146.7	6:10 PM
	181.5	6:46 PM
3,825	178.5	6:49 PM
	169.2	7:00 PM
3,725	168.6	7:01 PM
	160.9	7:11 PM
3,625	160.3	7:12 PM
	154.3	7:22 PM
3,525	153.9	7:23 PM
	148.0	7:33 PM
3,425	147.5	7:34 PM
	142.2	7:44 PM
3,325	141.8	7:45 PM
	138.2	7:55 PM
3,225	138.0	7:56 PM
	135.7	8:06 PM

TEMPERATURE LOG

Ashida #1

Survey #25 9/6/80 8:00 AM

Logged by GeothermEx, Inc.

Purpose: Log the open hole to ∿4,300 feet 3 hours after drilling.

Depth in feet	°F	Depth, in feet	°F	
3,000	125.8	4,100	146.7	
3,100	126.7	4,125	147.8	
3,200	127.5	4,150	150.7	
3,300	128.5	4,175	151.4	
3,400	129.3	4,200	153.3	
3,500	130.6	4,225	156.0	
3,600	132.0	4,250	157.7	
3,700	133.1	4,275	162.0	
3,800	134.2	4,300	161.9	8:48 AM
3,900	136.7	4,300	182.8	8:57 AM
3,925	136.9	4,300	183.5	8:57:30 AM
3,950	139.3	4,300	183.9	8:58 AM
3,975	140.6	4,300	184.1	8:58:30 AM
4,000	140.3	4,300	184.5	8:59 AM
4,025	140.8	4,300	184.7	8:59:30 AM
4,050	143.3	4,300	185.2	9:00 AM
4,075	146.6			

TEMPERATURE LOG

Ashida #1

Survey #26 9/8/80 7:50 AM

Logged by GeothermEx, Inc.

Purpose: To log the open hole from 3,920 to 4,303 feet 50 hours after drilling. Temperature probe malfunctioned.

Maximum Reading Thermometers = 230°F, 230°F

TEMPERATURE LOG

Ashida #1

Survey #27   9/10/80   4:00 PM

Logged by GeothermEx, Inc.

Purpose: Pull out of hole to change bit. Run maximum thermometer to bottom at 4,550 feet.

Maximum Reading Thermometers - 178°F, <200°F

TEMPERATURE LOG

Ashida #1

Survey #28   9/13/80   7:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature 3 hours after drilling at 4,920 feet.

#1 at 4,920 feet = 230°F

#2 at 4,920 feet = 230°F

TEMPERATURE LOG

Ashida #1

Survey #29   9/15/80   8:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature ∿50 hours after drilling at 4,920 feet.

#1 at 4,920 feet = 293°F

#2 at 4,920 feet = 294°F

#3 at 4,920 feet = 295°F

TEMPERATURE LOG

Ashida #1

Survey #30 9/18/80 10:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at 5,378 feet at 3 hours after drilling.

Gearhart-Owens temperature probe - 230°F

Maximum Reading Thermometers = 256°F, 256°F

TEMPERATURE LOG

Ashida #1

Survey #31   9/20/80   8:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at 5,685 feet at 3 hours after drilling.

Gearhart-Owens temperature probe = 291.8°F after 30 minutes on bottom

Maximum Reading Thermometer = 292°F

TEMPERATURE LOG

Ashida #1

Survey #32 9/22/80 8:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at 5,685 feet at 50 hours after drilling.

Gearhart-Owens temperature probe = 321.3°F

Maximum Reading Thermometer = 348°F, 355°F

TEMPERATURE LOG

Ashida #1

Survey #35   9/29/80   8:00 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at 6,445 feet 50 hours after drilling

Ran 3 maximum thermometers on Gearhart-Owens line. Gearhart-Owens digital readout burned out.

Maximum Reading Thermometer #1 = 405°F

Maximum Reading Thermometer #2 = 405°F

Maximum Reading Thermometer #3 = 405°F

TEMPERATURE LOG

Ashida #1

Survey #36   10/4/80   8:00 AM

Logged by GeothermEx, Inc.

ose: Bottom hole temperature at 7,211 feet at 6 hours after drilling.

Maximum Reading Thermometer #1 = 400°F

Maximum Reading Thermometer #2 - 395°F

Maximum Reading Thermometer #3 = 375°F (at 7,200 feet)

TEMPERATURE LOG

Ashida #1

Survey #37 10/13/80 3:00 AM

Logged by Gearhart-Owen

Purpose: Continuous survey from 4,000 to 7,927 feet at 4-1/2 hours after circulation (circulated for 6 hours prior to pulling out of hole).

Depth, in feet	°F	Depth, in feet	°F
4,000	174.6	4,680	184.3
4,020	174.0	4,700	191.2
4,040	173.6	4,720	191.3
4,060	176.1	4,740	190.5
4,080	176.0	4,760	193.2
4,100	176.2	4,780	193.9
4,120	176.5	4,800	193.5
4,140	177.0	4,820	191.9
4,160	178.5	4,840	195.2
4,180	177.6	4,860	194.5
4,200	178.8	4,880	194.5
4,220	180.0	4,900	196.7
4,240	179.0	4,920	197.3
4,260	179.9	4,940	195.5
4,280	181.1	4,960	198.9
4,300	181.2	4,980	198.9
4,320	180.8	5,000	199.6
4,340	181.0	5,020	199.5
4,360	182.5	5,040	199.7
4,380	183.0	5,060	201.6
4,400	182.6	5,080	202.5
4,420	181.5	5,100	203.0
4,440	185.0	5,120	202.5
4,460	183.4	5,140	202.5
4,480	183.0	5,160	205.0
4,500	186.3	5,180	204.8
4,520	186.3	5,200	204.7
4,540	185.0	5,220	205.7
4,560	184.0	5,240	206.0
4,580	188.1	5,260	205.7
4,600	188.3	5,280	205.7
4,620	184.6	5,300	207.7
4,640	189.5	5,320	208.6
4,660	188.0	5,340	209.0

TEMPERATURE LOG

Ashida #1

Survey #37 (continued)

Depth, in feet	°F	Depth, in feet	°F
5,360	209.0	6,180	226.7
5,380	211.0	6,200	222.7
5,400	214.0	6,220	227.9
5,420	214.5	6,240	230.2
5,440	212.5	6,260	231.2
5,460	210.0	6,280	231.0
5,480	212.4	6,300	230.6
5,500	213.0	6,320	225.2
5,520	213.0	6,340	231.5
5,540	210.9	6,360	232.9
5,560	212.6	6,380	232.9
5,580	214.0	6,400	231.5
5,600	214.6	6,420	222.0
5,620	214.3	6,440	228.0
5,640	214.5	6,460	230.0
5,660	215.6	6,480	229.6
5,680	217.0	6,500	225.0
5,700	215.8	6,520	220.5
5,720	214.0	6,540	233.0
5,740	218.0	6,560	225.0
5,760	218.0	6,580	220.5
5,780	217.2	6,600	233.5
5,800	218.9	6,620	237.0
5,820	218.8	6,640	235.5
5,840	213.0	6,660	234.5
5,860	220.5	6,680	236.8
5,880	219.5	6,700	237.2
5,900	219.0	6,720	233.5
5,920	223.1	6,740	220.0
5,940	224.5	6,760	231.0
5,960	224.7	6,780	238.0
5,980	225.0	6,800	238.5
6,000	224.4	6,820	236.2
6,020	224.0	6,840	238.4
6,040	221.0	6,860	242.0
6,060	226.2	6,880	243.0
6,080	227.0	6,900	245.0
6,100	225.0	6,920	245.3
6,120	221.7	6,940	246.0
6,140	220.4	6,960	249.0
6,160	229.0	6,980	248.5

TEMPERATURE LOG

Ashida #1

Survey #37 (continued)

Depth, in feet	°F	Depth, in feet	°F
7,000	251.0	7,460	-
7,020	246.5	7,480	-
7,040	232.2	7,500	-
7,060	251.0	7,520	274.0
7,080	258.0	7,540	276.0
7,100	245.4	7,560	278.2
7,120	259.0	7,580	280.9
7,140	241.0	7,600	283.0
7,160	241.3	7,620	285.0
7,180	253.0	7,640	287.2
7,200	246.0	7,660	289.5
7,220	247.0	7,680	291.0
7,240	265.0	7,700	293.2
7,260	263.0	7,720	295.0
7,280	269.6	7,740	296.8
7,300	275.0	7,760	299.0
7,320	276.0	7,780	301.5
7,340	277.2	7,800	304.2
7,360	260.5	7,820	306.2
7,380	280.0	7,840	308.0
7,400	275.0	7,860	309.0
7,420	283.0	7,880	310.5
7,440	286.0	7,900	313.0 → 324.0

TEMPERATURE LOG

Ashida #1

Survey #38   10/13/80   8:15 AM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at 7,927 feet at 15-1/2 hours after circulating.

Kuster Bomb = 465°F

Maximum Reading Thermometers = 495°F, 495°F

TEMPERATURE LOG

Ashida #1

Survey #39 10/16/80 5:30 PM

Logged by GeothermEx, Inc.

Purpose: Bottom hole temperature at 7,927 feet at 46 hours after circulating.

Fluid level at 3,589 feet

Temperature at 3,589 feet = 162°F, 160°F

Kuster Bomb at 7,927 feet = 507.5°F

TEMPERATURE LOG

Ashida #1

Survey #40   10/17/79   10:00 AM

Logged by GeothermEx, Inc.

Purpose: 9 point survey with Kuster Bomb at 64 hours after circulating.

Fluid level = 3,342 feet at 10:40 AM

Maximum Reading Thermometers at 3,352 feet = 157°F

at 3,502 feet = 163°F

at 3,652 feet = 167°F

Fluid level = 3,326 feet at 11:54 AM

Bottom hole temperature = 514°F

Fluid level = 3,207 feet at 9:30 PM

TEMPERATURE LOG

Ashida #1

Survey #41   10/23/80   9:30 AM

Logged by GeothermEx, Inc.

Purpose: Survey from 2,200 to 3,980 feet at 208 hours after circulating.

Phase I: Fluid level = 2,224 feet at 9:38 AM

Maximum Reading Thermometer at 4,102 feet = 207°F

Phase II: 10:30 AM; Gearhart-Owens temperature gear every 20 feet.

Depth, in feet	°F	Depth, in feet	°F
2,200	127.5	2,780	139.5
2,220	127.8	2,800	140.1
2,240	128.7	2,820	140.7
2,260	128.8	2,840	141.5
2,280	128.9	2,860	142.1
2,300	129.2	2,880	142.6
2,320	129.4	2,900	143.3
2,340	129.7	2,920	143.9
2,360	130.1	2,940	144.5
2,380	130.4	2,960	145.1
2,400	130.7	2,980	145.8
2,420	131.1	3,000	146.3
2,440	131.4	3,020	146.9
2,460	131.8	3,040	147.5
2,480	132.3	3,060	148.3
2,500	132.7	3,080	148.8
2,520	133.3	3,100	149.3
2,540	134.6	3,120	150.0
2,560	134.5*	3,140	150.7
2,580	134.8	3,160	151.2
2,600	134.9	3,180	152.0
2,620	135.3	3,200	152.7
2,640	135.6*	3,220	153.5
2,660	136.0	3,240	154.2
2,680	136.5	3,260	155.0/160.1
2,700	137.1	3,280	155.7/160.9
2,720	137.7	3,300	157.3/161.6
2,740	138.3	P.O.H. - Tool went berserk	
2,760	138.9	3,320	162.4

*unstable

TEMPERATURE LOG

Ashida #1

Survey #41 (continued)

Depth, in feet	°F
3,340	163.2
3,360	164.1
3,380	164.9
3,400	165.7
3,420	166.7
3,440	167.4
3,460	168.3
3,480	169.2
3,500	170.1
3,520	171.0
3,540	171.9
3,560	172.9
3,580	174.0
3,600	175.1
3,620	176.1
3,640	177.2
3,660	178.3
3,680	179.4
3,700	180.5
3,720	181.6
3,740	182.7
3,760	183.9
3,780	185.1
3,800	186.5
3,820	187.7
3,840	189.1
3,860	190.3
3,880	191.6
3,900	193.0
3,920	194.4
3,940	195.7
3,960	197.1
3,980	198.3

TEMPERATURE LOG

Ashida #1

Survey #42   10/24/80   8:52 AM

Logged by GeothermEx, Inc.

Purpose: 12 point survey with Kuster Bomb at 232 hours after circulating.

Depth, in feet	°F
4,114	206.0
5,637	317.4
7,000	411.3
7,100	422.1
7,200	435.0
7,300	448.3
7,400	460.2
7,500	472.4
7,600	482.1
7,700	493.2
7,800	510.4
7,927	527.6

TEMPERATURE LOG

Ashida #1

Survey #43 10/24/80 3:00 PM

Logged by GeothermEx, Inc.

Purpose: 16 point survey with Kuster Bomb at 239 hours after circulating.

Depth in feet	°F
4,114	206.0
4,598	242.4
5,082	274.5
5,566	308.5
5,808	327.0
6,000	337.1
6,100	343.9
6,200	349.8
6,300	356.6
6,400	363.1
6,500	372.1
6,600	376.6
6,700	383.4
6,800	390.5
6,900	400.1
7,000	410.8

TEMPERATURE LOG

Ashida #1

Survey #44 10/31/80 2:30 PM

Purpose: 6 point survey with Kuster Bomb at 25 hours after circulating (circulated for 3-1/2 hours prior to pulling out of hole).

Depth in feet	°F
7,800	453.8
7,900	463.2
8,000	475.1
8,100	502.4
8,200	521.1
8,300	549.1

APPENDIX C

Drill bits, Ashida #1

Table 5

DRILL BITS

Ashida #1

Bit No.	Size (inches)	Serial No.	Make	Type	Depth In (feet)	Depth Out (feet)	Footage	Hours	Grade G	Grade B	Grade T	Comments
1	12-1/4	33368	Reed	Button FP535	25	478	453	49-1/2	-	-	-	-
2	12-1/4	740205	Security	Button 5:4F	478	1,085	607	61-1/2	I	8	2	Bearings = 8; Teeth = 1; Gauge = I. Cones cut rings on each other. Probably due to drilling with no returns, i.e., bad lubrication and cooling of bit.
3	12-1/4	V2094	Smith	Button F-2	1,085	1,268	183	18	-	-	-	-
H.O.#1	17-1/2	-	Security	Mill Tooth	70	517	447	61	-	-	-	-
H.O.#2	17-1/2	R.R.	Security	Mill Tooth	517	870	353	27-1/2	-	-	-	-
H.O.#3	17-1/2	-	Security	Button	870	924	54	14	-	-	-	Bushings shot.
H.O.#4	17-1/2	-	Security	Button	924	1,086	162	24	-	-	-	-
#5 (used to ream)	17-1/2	126357	Reed	Button	1,086	1,225	139	17-1/2	-	-	-	Reamed 12-1/4" hole.
4	12-1/4	919549	Security	Button/ S83	1,268	1,901	633	33-1/2	-	-	-	Not sealed bearings.
5	12-1/4	541799	Security	Button/ S88	1,901	2,635	734	55-1/2	I	6	4	Sealed bearings.
6	12-1/4	926808	Security	Button/ S8J	2,635	3,022	387	36-1/2	I	8	4	No bearings.
7	12-1/4	919883	Security	Button/ S85	3,022	3,259	237	32-1/2	I	8	4	Cones frozen.

Table 5 (continued)

Bit No.	Size (inches)	Serial No.	Make	Type	Depth In (feet)	Depth Out (feet)	Footage	Hours	Grade G	Grade B	Grade T	Comments
8	12-1/4	DA442	H.T.C.	Button X44	3,259	3,925	666	85	-	-	-	-
9	8-1/2	472302	Security	Button S88	3,925	4,303	378	48-1/2	-	-	-	Sealed bearings; Jets = 9/16, 9/16, 9/16
10	8-1/2	469885	Security	Button S88	4,303	4,572	269	37-1/2	I	1	8	Sealed bearings; Jets = 1/2, 1/2, 1/2, P.O.H. without inserts.
11	8-1/2	924683	Security	Mill Tooth M4NJ	4,572	4,595	23	6-1/2	Out	1	2	Mill tooth bit; Jets = 1/2"
12	8-1/2	587512	Security	Button M88	4,595	4,920	325	43-1/2	I	1	1	Button - Jets = 1/2" Excellent shape.
13	8-1/2	823917	Security	Button M88	4,920	5,387	467	64	I	8	8	Bearings shot. Teeth gone. Jets = 1/2"
14	8-1/2	823902	Security	Button M88	5,387	5,685	298	34-1/2	I	6	6	One cone loose; Jets = 1/2"
15	8-1/2	TK 239	H.T.C.	Button J44	5,685	6,445	760	107-1/2	2	2	2	Sealed journals; Jets = 1/2"; Bit in good condition
16	8-1/2	TK 453	H.T.C.	Button J44	6,445	7,211	766	115	2	2	2	Sealed Journals; Jets = 9/16"; Bit in good condition.
17	8-1/2	TK 459	H.T.C.	Button J44	7,211	7,211	-	-	I	8	1	Jets = 9/16"; Bearings burned up.
18	8-1/2	VR 583	H.T.C.	Button J44	7,211	7,927	716	90	I	7	6	Jets = 9/16"; Bearings bad, 1 cone loose.
19	8-1/2	NZ 309	H.T.C.	Button J44	7,927	8,300	373	42-1/2	I	8	8	No jets; no teeth, no bearings.

LABORATORY NO: 0670-80
DATE OF REPORT: August 20, 1980
IDENTIFICATION: ASHIDA #1

GEOTHERMEX, INC.
5221 Central Avenue
Richmond, CA 94804

Sample collected by A.Campbell 6/25/80

SPECIES		mg/L	eq/L
Ca	Ra	113.	5.64-3
Mg	Ra	145.	1.19-2
Na	Ra	432.	1.88-2
K	Ra	20.5	5.24-4
OH	Ru	10.6	6.23-4
CO_3	Ru	305.	1.02-2
CO_2(FREE)			
SO_4	Ru	185.	3.85-3
Cl	Ru	174.	4.91-3
TDS			
pH	Ru	10.04	
Ec μmhos/cm @25°		1906(1:20)	
Ec μmhos/CALC		3270	
Ec OBS/CALC		.583	
CATIONS Σ+		3587	
ANIONS Σ-		1893	

SPECIES		mg/L	eq/L
B	Ru	12.3	1.14-3 (a)
SiO_2	Ru	8770.	1.46-1 (a)
NH_4			
F		1.22	6.42-5
S^{2-}			
Fe^{2+}			
Mn^{2+}			
Rb			
Li	Ra	0.450	6.48-5
Sr			
Cs			
Ba			
Hg			
As		28.3	3.78-4
SiO_2	Ra	12700.	2.11-1 (a)
SiO_2	Rd	661. (1:10)	1.10-2 (a)
SiO_2 D.I. H_2O		27.8	4.61-4 (a)
Ca on	Ru	92.7	4.63-3

(a) MOLES/L

Repeated analyses of this sample failed to yield an ionic or Ec. balance. Samples with excessively basic pH's cannot be balanced according to Standard Methods for the Examination of Water and Wastewater, 14th Ed., Pg. 35

Note: extremely high SiO2 levels are probably due to the very high pH.

SiO_2 in diluted aliquot: $x = \frac{661 - .9(27.8)}{.1} = 6360$ mg/l

A.Campbell reports sample collected with bailer run down inside drillpipe. Temperature at fluid level reported as 138°F, temperature in bailer when sample recovered was 114°F.

Analysis by:
AMTECH American Technical Laboratories, Inc.
8909 Complex Drive — Suite F San Diego, California 92123 (714) 560-7717

LABORATORY NO: 0670-80
DATE OF REPORT: August 20, 1980
IDENTIFICATION: ASHIDA #1
Drilling Water

GEOTHERMEX, INC.
5221 Central Avenue
Richmond, CA 94804

SPECIES	mg/L	eq/L
Ca	1.53	7.63-5
Mg	0.557	4.58-5
Na	10.6	4.61-4
K	1.48	3.78-5
HCO_3	18.1	2.97-4
CO_3	-	
CO_2(FREE)		
SO_4	12.0	2.50-4
Cl	2.84	8.01-5
TDS		
pH	7.24	
Ec µmhos/cm @25°	79.5	
Ec µmhos/CALC	68.9	
Ec OBS/CALC	1.024	
CATIONS Σ+	6.20-4	
ANIONS Σ-	6.26-4	

SPECIES	mg/L	eq/L
B	0.093	8.6-6 (a)
SiO_2	24.4	4.05-4 (a)
NH_4		
F	<0.10	5.3-6
S^{2-}		
Fe^{3+}		
Mn^{2+}		
Rb		
Li	0.0017	2.5-7
Sr		
Cs		
Ba		
Hg		

(a) MOLES/L

Analysis by:
AMTECH American Technical Laboratories, Inc.
8008 Complex Drive — Suite F San Diego, California 92123 (714) 560-7717

APPENDIX F

Casing detail

APPENDIX F

Phase II: Cementing 13-3/8-inch surface casing at 1,200 feet.

1. A 12-1/4-inch pilot hole was completed to a depth of 1,268 feet at 2:00 AM, Tuesday, July 1 with mud/gel drilling fluid.

2. The hole was opened to 17-1/2-inch to a depth of 1,225 feet. Hole opening was completed at 7:00 AM, Tuesday, July 15.

3. The hole was conditioned in the following manner:

   7/15, 8:00 AM - Pump 65 barrels mud down hole and trip out 17-1/2-inch assembly.
   1:30 PM - Pump 180 barrels mud and LCM at 1,185 feet through open pipe.
   8:00 PM - Spot 150 barrels mud and LCM at 800 feet. Monitor fluid level.

   7/16, 1:30 AM - Pump 50 barrels mud and LCM at 300 feet. Monitor fluid level.
   8:00 AM - Pump 50 barrels mud and LCM at 300 feet. Monitor fluid level.
   10:30 AM - Pump 180 barrels mud and LCM at 252 feet.
   3:00 PM to 5:30 PM - Spot mud and LCM at 60 foot intervals from a depth of 980 feet to 480 feet.
   8:30 PM - Pump 50 barrels mud and LCM at 480 feet and monitor fluid level.
   10:30 PM - Pump 50 barrels mud and LCM down annulus and monitor fluid level.

   7/17, 2:30 AM - Spot 50 barrels mud and LCM at 480 feet and monitor fluid level.
   2:30 AM - 8:00 AM - Clean fill to 1,225 feet.

   Fluid level at 205 feet RKB

4. Running 13-3/8-inch casing.

   7/17, 4:00 PM - Begin running J-55 buttress 13-3/8-inch 54.5#/foot.

   7/18, 1:00 AM - Finish running casing to 1,200 feet with float guide shoe on bottom, baffle on top joint, D.V. tool on top #10 joint, cement basket on top #11 joint, with centralizers on bottom joint, 10 joints from surface, 5 joints from surface. Bottom 5 joints welded and 5 joints above d.v. tool welded.

5. Cementing 13-3/8-inch casing.

   7/18, 1:00 AM - 6:30 AM - Pump 100 barrels mud/gel through casing to clean hole for cement.

6:30 AM - 8:00 AM - Cement Stage I

a. Pump 4 sacks CaCl and 20 barrels H_2O
b. Pump 20 barrels H_2O as spacer
c. Pump 13 drums FloCheck (NaSiO) and 20 barrels H_2O.
d. Pump 20 barrels H_2O as spacer
e. Pump 310 sacks class G mix
   Lead = 210 sacks 1:1 perlite, 40% SSAI, 2% gel
   Tail = 100 sacks, 40% SSAI.
f. Displacement
   (1) Drop shut off plug
   (2) Pump 180 barrels H_2O to chase plug to baffle but did not see pump build up pressure.
   (3) Drop bomb to open d.v. tool
   (4) Circulate mud through d.v. tool
      (i) 150 barrels mud on first run
      (ii) Intermittantly throughout day

7/18, 5:30 PM - 8:00 PM - Cement Stage II

a. Pump 4 sacks CaCl and 20 barrels H_2O
b. Pump 20 barrels H_2O as spacer
c. Pump 12 drums FloCheck and 20 barrels H_2O
d. Pump 20 barrels H_2O as spacer
e. Pumped approximately 300 sacks class G 1:1, 2% gel cement and plugged surge bin.
f. Dropped closing plug and displaced with 141 barrels H_2O (gauge reading): Should have taken 124 barrels; therefore, gauge off 13%.

7/19, 7/20, 7/21 Run temperature surveys to detect cement bond. Indicate bond at 200 to 250 feet depth.

7/21, 8:30 AM - 11:30 AM - Run 1.6-inch tubing down outside 13-3/8-inch casing. Tag cement at 211 feet.

4:00 PM - 12:00 AM - Cement with Redimix Stage III

7/22, 12:00 AM - 8:00 AM

a. Pour 34 yards and 2% CaCl Redimix down outside of casing in stages. Bring cement level to ∿128 foot RKB.
b. Pump 134 cubic feet geothermal 1:1 cement = 50 sacks. Bring level to ∿80 feet.

7/22, 8:00 AM - 11:30 AM - Pour 1-1/2 yards Redimix down outside casing and bring cement to ∿65 foot depth inside 22-inch casing. Pump 25 cubic feet Class G, 1:1 cement and bring cement to cellar floor.

7/23, 6:30 AM - Drill bottom plug at 1,100 feet. Run CBL - Good bond throughout.

CASING DETAIL

Float Guide Shoe
1 - Joint 13-3/8-inch J-55 Buttress casing

Baffle
9 - Joints 13-3/8-inch J-55 Buttress casing

DV Tool
1 - Joint 13-3/8-inch J-55 Buttress casing

Cement Basket
19 - Joints 13-3/8-inch J-55 Buttress casing

APPENDIX F

Phase III: Cementing 9-5/8-inch Production Casing.

Wednesday, August 13

12:00 PM -	Drilling operations ceased at a depth of 3,925 feet.
12:00 PM - 4:00 PM -	The hole was conditioned for logging by circulation of mud/gel.
4:00 PM - 7:00 PM -	Pulled out of hole.
7:00 PM - 7:30 PM -	Rig to log.

Thursday, August 14

7:00 AM -	Run Gearhart-Owen logs, 2 temperature logs, electric log, gamma ray-neutron log, 4-arm caliper log
7:00 AM - 9:00 AM -	Temperature log by GeothermEx.
9:00 AM - 9:30 AM -	Rig down
9:30 AM - 12:00 PM -	Lay down 3 11-inch D.C., 1 8-inch D.C.
12:00 PM - 4:00 PM -	Rig up to run casing and cement
4:00 PM - 6:00 PM -	Temperature log by GeothermEx, 3,000-3,925 feet.
6:00 PM - 12:00 AM -	Rig up to run casing and cement.

Friday, August 15

12:00 AM - 3:30 AM -	Rig up to run casing and cement
3:30 AM - 6:00 AM -	Temperature survey by GeothermEx, 3,000-3,925 feet.
6:00 AM - 8:00 AM -	Rig up to run casing and cement
8:00 AM - 4:00 PM -	Blend cement
4:00 PM - 6:00 PM -	Rig up to run casing and cement
6:00 PM - 9:00 PM -	Temperature survey by GeothermEx.
9:00 PM - 12:00 AM -	Check fluid level = 400 feet (RKB)

Saturday, August 16

12:00 AM-12:30 AM -	Run in hole.
12:30 AM - 4:30 AM -	Condition mud and build volume
4:30 AM - 5:00 AM -	Spot 150 barrels mud with LCM on bottom.
5:00 AM - 8:00 AM -	Pull out of hole. Rig to log hole.
8:00 AM - 12:00 AM -	Rig idle.

Sunday, August 17

12:00 AM - 6:00 PM -	Rig idle.
6:00 PM - 9:00 PM -	Rerun electric log because opportunity permitted.
9:00 PM - 12:00 AM -	Rig idle.

Monday, August 18

12:00 AM - 8:00 AM -	Rig idle.
8:00 AM - 9:30 AM -	Start rig. Remove bolts from BOP and install 7-inch flow line.

9:30 AM - 12:30 PM - Trip in hole.
12:30 PM - 3:30 PM - Condition hole for casing. Mud viscosity = 41.
3:30 PM - 8:00 PM - Lay down 5-inch D.P. and 8-inch D.C. (run double shift from 4 p.m.)
8:00 PM - 12:00 AM - Rig to run 9-5/8-inch casing.

Tuesday, August 19

12:00 AM - 4:30 AM - Unload 4-inch D.P. from trailer. Nipple up BOP.
4:30 AM - 8:30 AM - Pick up 4-inch D.P.
8:30 AM - 9:00 AM - Rig to run casing.
9:00 AM - 11:00 PM - Run 9-5/8-inch casing Stage I. Hang liner at 11:00 p.m.
11:00 PM -12:00 AM - Rig to cement.

Wednesday, August 20

12:30 AM - 2:15 AM - Circulate hole
2:15 AM - 3:15 AM - Pumped CaCl, H_2O and flo-check
3:15 AM - 3:50 AM - Mix and pump 817 cubic feet of cement
3:50 AM - 5:15 AM - Displace cement (maximum pressure - 250 psi); pressure built up to 1,500 psi at completion of displacement.
5:15 AM - 5:40 AM - Drop ball to open d.v. tool.
5:40 AM - 6:00 AM - Pressured up to open d.v. Pressure built up to 1,500 psi then dropped to 0. Pumped 1 barrel (H_2O?) with no returns. Pumped 4 barrels at 900 psi with no returns.
6:00 AM - 6:15 AM - Disconnect liner hanger. Pull up 60 feet and circulate with 450 psi for 10 minutes.
6:15 AM - 7:00 AM - Re-enter liner. Unable to circulate at 1,000 psi.
7:00 AM - 7:20 AM - Pull up to 1,015 (RKB). Circulate to clear 13-3/8-inch casing. After 15 minutes some returns of semi-hardened cement through rotary table. Pumped out cement, CaCl, mud and flo-check for 5 minutes.
7:20 AM - 9:00 AM - Pull out of hole.
9:00 AM - 12:00 AM - Cleaned out BOP's, flow lines, and cellar of cement.

Thursday, August 21

12:00 AM - 6:00 AM - Pick up 4-inch kelly and 6 7-inch d.c.
6:00 AM - 8:00 AM - Wait on sub.
8:00 AM - 11:00 AM - Trip in hole with 12-1/4-inch bit. Pipe stopped at 1,022 feet (10 feet above liner top). Worked easily through cement and tagged top of liner at 1,032 feet. Dumped mud and circulated with clear water.
11:00 AM-12:00 PM - Pull out of hole.
12:00 PM - 4:00 PM - Trip in hole with 8-1/2-inch bit, and clear liner hanger out with clear water.
4:00 PM - 6:30 PM - Pick up drill pipe. Drill out d.v. tool.
6:30 PM - 10:00 PM - Pick up drill pipe.
10:00 PM-11:00 PM - Wash down 5 singles (150 feet)

11:00 PM-12:00 AM - Drill out float collar and clean to 3,903 feet.

Friday, August 22

12:00 AM-12:30 AM - Circulate
12:30 AM - 2:30 AM - Pull out of hole.
2:30 AM - 3:30 AM - Rig to run cement bond log.
3:30 AM - 6:30 AM - Run CBL from 3,904 feet to 1,032 feet. Cement must have channeled all the way up 9-5/8-inch liner resulting in a partial bond along entire length of pipe. Bond log indicated 50-70% bonding, sufficient to produce the well.
6:30 AM - 9:45 AM - Pick up 13-3/8-inch RTTS tool to test the lap area. Ran in hole and set tool at 900 feet between d.v. in 13-3/8-inch casing and the top of the lap area. Pressured up and held 1,000 psi for 10 minutes, then pressure dropped to 600 psi. Unable to get well to hold pressure.
9:45 AM - 11:30 AM - Chain out of hole.
11:30 AM - 3:00 PM - Pick up 9-5/8-inch RTTS with 409.65 feet tail and trip in hole to 1,060 feet. Test 9-5/8-inch casing with 1,200 psi for 30 minutes - O.K.
3:00 PM - 4:30 PM - Pull out of hole and lay down 9-5/8-inch packer.
4:30 PM - 12:00 AM - Pick up 13-3/8-inch RTTS packer and trip in hole. Set packer at 1,028 feet. Pressured up repeatedly to 600 psi and 750 psi, but always bled back to 400 psi within 5 minutes.

Attempt to break down lap area failed. Established injection rate of 1.3 barrels/minute at 1,000 psi. Injected 16 barrels--enough to clear the lap. Started out of hole.

Saturday, August 23

12:00 AM - 1:00 AM - Pull out of hole and lay down packer.
1:00 AM - 8:00 AM - Decided to perform squeeze job with a Halliburton easy drill packer. The procedure would be to set the packer at ∿150 feet above the lap and then squeeze cement below the tool until an adequate squeeze pressure was reached.

At 8:00 AM the rig was shut down for the weekend.

Sunday, August 24

12:00 AM - Rig idle.

Monday, August 25

12:00 AM - Rig idle.
12:00 AM - 8:00 AM - Rig idle.
8:00 AM - 9:00 AM - Service rig. Try to fill hole with water unsuccessfully.
9:00 AM - 11:00 AM - Trip in hole with 12-1/4-inch bit. Clean 13-3/8-inch casing from 877 to 917 feet. Pull out of hole.

11:00 AM-12:30 PM - Pick up EZ drill packer and start in hole. Tool set itself at 68 feet. It was decided to perform a squeeze job from this depth.

12:30 PM - 4:30 PM - Set drill collars on packer to compress rubber elements and establish a good seal. Stabbed into packer and established an injection rate.

New plan was to pump enough cement to fill the 13-3/8-inch casing from the top of the 9-5/8-inch liner to the bottom of the easy drill packer (68 feet) and also to fill the lap area.

4:30 PM - 12:00 AM - Wait on bulk cement delivery.

Tuesday, August 26

12:00 AM - 8:00 AM - Wait on bulk cement delivery.

8:00 AM - 12:00 PM - Blend cement and prepare to squeeze.

12:00 PM - 1:00 PM - Began pumping with no table pump pressure. After injecting ~80% of cement on location, the pressure increased to 1,500 psi, indicating a good squeeze in the lap area. After holding the pressure for 15 minutes the drill collars began to hydraulic out of the hole. Several cement lines were broken.

1:00 PM - 4:00 PM - Lay down tools and pick up 11-inch d.c.

4:00 PM - 6:00 PM - Pick up 12-1/4-inch bit and 11-inch d.c.

6:00 PM - 12:00 AM - Drilling on EZ drill.

Wednesday, August 27

12:00 AM - 2:00 AM - Drilling on EZ drill.

2:00 AM - 2:30 AM - Push EZ drill to 342 feet (top of cement?).

2:30 AM - 8:00 AM - Drilling on EZ drill.

8:00 AM - 10:00 AM Trip for bit and 6 7-inch d.c.

10:00 AM - 4:00 PM - Drilling cement.

4:00 PM - 4:30 PM - Closed rams and pressure tested the 13-3/8-inch d.v. tool with 500 psi for 30 minutes.

4:30 PM - 7:00 PM - Drilling cement. Pumpted down without rotary from 974 to 1,006 feet. Shut off pump and lowered pipe to 1,032 feet--no cement.

7:00 PM - 8:30 PM - Clean hole and displace fluid in hole with clean water.

8:30 PM - 9:30 PM - Pressure test liner lap with 500 psi--lost 110 psi in one hour.

9:30 PM - 10:00 PM - Ream from 974 to 1,006 feet in packer squeezing area.

10:00 PM-12:00 AM - Pull out of hole.

Thursday, August 28

12:00 AM - 2:00 AM - Lay down 11-inch d.c. Pick up 13-3/8-inch RTTS and go in hole.

2:00 AM - 5:30 AM - Set RTTS at 1,002 feet. Pressure test liner lap. Exact pressure and length of test were not recorded. The absence of cement just above the top of the liner lap indicates that cement was not squeezed into the lap area. However, the successful pressure test demonstrates that a sufficient amount of cement dropped into the lap area.

5:30 AM - 6:30 AM - Pull out of hole and lay down tools.

6:30 AM - 8:00 AM - Make up 9-7/8-inch bit and start in hole (run 2 crews for casing).

8:00 AM - 9:00 AM - Trip in with 9-7/8-inch bit to the top of the liner and trip out.

9:00 AM - 1:00 PM - Strip BOP and rig to run 9-5/8-inch casing.

1:00 PM - 5:00 PM - Run 9-5/8-inch casing.

5:00 PM - 8:00 PM - Rig to cement casing.

8:00 PM - 9:00 PM - Cement with 150 sacks of 1:1 perlite and 100 sacks of tail cement without perlite. Displace with 76 barrels of mud. Cement in place at 9:00 PM.

9:00 PM - 10:00 PM - Clean out wellhead and center casing. Wait on cement.

Subsequent pressure tests proved successful. Drilling the 8-1/2-inch production hole began at 3:00 AM on Thursday, September 4.

CASING DETAILS

Float Shoe	(1.75')	1451.99'
1 jt Casing	(39' ±)	
Float Collar	(1.75')	
37 jts Casing	(1409.49')	
D.V. Tool		3.25'
37 jts Casing		1425.19'
Liner Hanger		7.00'
	TOTAL	2887.43'

Bottom of Shoe	3920.00'
D.V. Tool (Bottom)	2468.01'
D.V. Tool (Top)	2464.76'
Liner Hanger (Bottom)	1039.57'
Liner Hanger (Top)	1032.57'

CEMENT DETAILS

Volume Calculations

Theoretical:

Total	3920 - 1200	(Shoe to 13-3/8" Shoe)
	2720 x .3132	= 852 Ft^3
Stage 1	3920 - 2468	(Shoe to D.V. Tool)
Shoe Joint	40 x .4257	= 17 Ft^3
	1452 x .3132	= 454.77 Ft^3
Stage 2	2468 - 1200	(D.V. to 13-3/8" Shoe)
	1268 x .3132	= 397 Ft^3
	1200 - 1032	(13-3/8" Shoe to Top of Liner)
	168 x .3627	= 61 Ft^3

CEMENT ON LOCATION

Surge Bin	55 sx of Mix 1	≈	146 Ft^3
Bin No. 1	235 sx of Mix 2	≈	381 Ft^3
Bin No. 2	162 sx of Mix 1	≈	429 Ft^3
Bin No. 3	162 sx of Mix 1	≈	429 Ft^3
	TOTAL		1385 Ft^3

NOTE * Mix 1 - Class G Cement w/ 1:1 perlite and 40% SSA-1
Yield - 2.65 Ft^3/sx

Mix 2 - Class G Cement w/ 40% SSA-1
Yield - 1.62 Ft^3/sx

STAGE 2 CASING DETAIL

Tie Back Sleeve		5.00'
27 jts of 9-5/8" Casing		1036.67'
	TOTAL	1041.67'
Tie-Back Sleeve will go in		4.00'
		1037.67'
Need Casing		1032.57'
		5.00'

Casing will be above Rotary 5'.

Volumes calculated from Caliper Log
3920' to 1200' = 1085 Ft^3
Which is 233 Ft^3 over theoretical or 27%

Stage 1
3920' to 2464' = 663 Ft^3
Which is 208 Ft3 over theoretical or 46%

Stage 2
2464' to 1200' = 442 Ft^3
Which is 25 Ft^3 over theoretical or 6.3%

Stage 1

Calculated volume 3920' - 2464'		663 Ft^3
Shoe Joint		17 Ft^3
	Sub Total	680 Ft^3
	30% excess	137 Ft^3
	TOTAL	817 Ft^3

817' - 471' = 346'/471' = 73%

73% overall excess in Stage 1

Stage 2

Calculated volume 2464' - 1200'	422 Ft^3
9-5/8" x 13-3/8" annulus in lap	61 Ft^3
	483 Ft^3

% excess decided from the amount of cement on location. Which is 1385 Ft^3 less Stage 1 817 Ft^3. 568 Ft3 left. Which is 85 Ft^3 more than needed or 18.6% excess over caliper calculated volume + 24% (110) over theoretical.

Source Inc.
Santa Rosa, CA 95402

CEMENTING DETAIL

Stage 1

20 BBLs	$CaCl_2$ Water	
20 BBLs	H_2O Spacer	
36 BBLs	Flo-chek	
20 BBLs	H_2O Spacer	
817 Ft^3	Cement Slurry ~	145 BBLs
6 BBLs	H_2O Spacer	
220 BBLs	Displacement to 3860' w/Mud 60' from Bottom	

Displacement to	1032' 4" D.P.	
D.P. ---------------->	1032' x .0117	12 BBLs
9-5/8" Casing ------->	2828' x .0728	214 BBLs
		226 BBLs

Stage 2

10 BBLs	$CaCl_2$ Water	
20 BBLs	Water Spacer	
10 BBLs	Flo-chek	
20 BBLs	Water Spacer	
568 Ft^3	Cement ~	101 BBLs
6 BBLs	Water Spacer	
115 BBLs	Displacement to 2464' w/Mud	

Displacement to	2464'	
D.P. ---------------->	1032' x .0117	12 BBLs
9-5/8" Casing ------->	1432' x .0758	109 BBLs
		121 BBLs