GL02067

GeothermEx, Inc.

SUITE 201
5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804

(415) 527-9876
CABLE ADDRESS: GEOTHERMEX

TEMPERATURE-GRADIENT AND HEAT-FLOW DATA, PANTHER CANYON, NEVADA

for

SUNOCO ENERGY DEVELOPMENT COMPANY

DALLAS, TEXAS

by

Marci A. Fisher
Murray C. Gardner

GeothermEx, Inc.
Berkeley, California

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CONCLUSIONS

1. The temperature gradient data collected in Grass Valley in 1979 indicated that there were 2 anomalies in the area of the survey; one was roughly circular about Leach Hot Springs,with a 3-mile diameter for the 100°C/km contour. The center of the other anomaly was about 5 miles southward. The 100°C/km contour had a diameter of about 1.5 miles.

2. Both anomalies found in 1979 were centered about 1 mile from the break in slope that marked the Sonoma and Tobin Ranges front. An unnamed canyon separated the 2 anomalies. Panther Canyon was at the northeastern margin of the southerly anomaly. The anomalies suggested the effect of range front faults but did not clearly associate the heat flow with structures.

3. Temperature gradient data from the Panther Canyon project more clearly define the southerly thermal anomaly recognized in the earlier Grass Valley data. The shallow depth gradient contours strike parallel to the range front fault bordering the western Tobin Range.

4. The configuration of the thermal anomaly suggests it may be controlled by the principal NNW-trending range-bordering faults as well as structural trends in the bedrock geology.

5. The southern and southeastern boundaries of the Panther Canyon anomaly are not well defined below 50 m depth.

6. Temperature gradients from several holes within the Panther Canyon project were below the regional average of 45°C/km. The holes may not have penetrated below convective effects of shallow cool groundwater flowing from the Tobin Range.

7. Heat flow values were generally less than the regional average, but the highest value, 3.3 HFU, was within the range normally associated with the Battle Mountain High.

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RECOMMENDATIONS

1. Drill an intermediate depth hole (2,000+) at the western end of Panther Canyon about 1 mile southwest of hole 81-85. This hole would determine the effects that the Panther Canyon-Tobin Range structural intersection has on the thermal anomaly.

2. Alternatively drill a deep (7,000+) test 1.5 miles southwest of hole 81-85 to test the validity of the Panther Canyon anomaly.

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INTRODUCTION

A series of six shallow temperature-gradient holes were drilled for Sunoco Energy Development Company in Panther Canyon, Pershing County, Nevada during the period March 24 through June 15, 1981. A proposed intermediate-depth gradient hole was spud but abandoned after encountering unresolvable drilling problems. The locations of these holes are shown on figure 1. This report summarizes the results of the Panther Canyon project.

The drilling contractor was Fred Anderson & Son Exploration Drilling, Inc. Anderson supplied a Gardner-Denver 15W drill rig, a 3-man crew and supporting equipment. Shallow holes were limited to three days for drilling and completion to 152 meters. Drilling histories for each hole are summarized in table 1.

GeothermEx provided lithologic descriptions of drill cuttings as well as several temperature profiles for the shallow holes. Temperature surveys were run on each shallow hole at intervals of approximately one day, one week and three months after completion. Equilibrium profiles for these holes are represented by the final surveys in September 1981. There was negligible change between the second surveys and the final surveys.

Holes 80, 83, 84, 85 and 86 are located along Panther Canyon which extends easterly from Grass Valley separating the Sonoma and Tobin Ranges. Hole 88 lies on the western edge of the Tobin Range while hole 90 was drilled on the eastern flank of the Goldbank Hills. Exposed bedrock ranges from Lower Paleozoic sediments and metasediments to Tertiary basaltic and rhyolitic volcanics. Most holes penetrated unconsolidated sand, clay and gravels; however, some encountered silicified sediments, basalt, limestone and chert. In these, the gradients decreased below the contact.

Lithologic logs for each hole drilled in this project are in Appendix B. The regional and areal geology, hydrology and geophysics are described by GeothermEx, Inc. (1979).

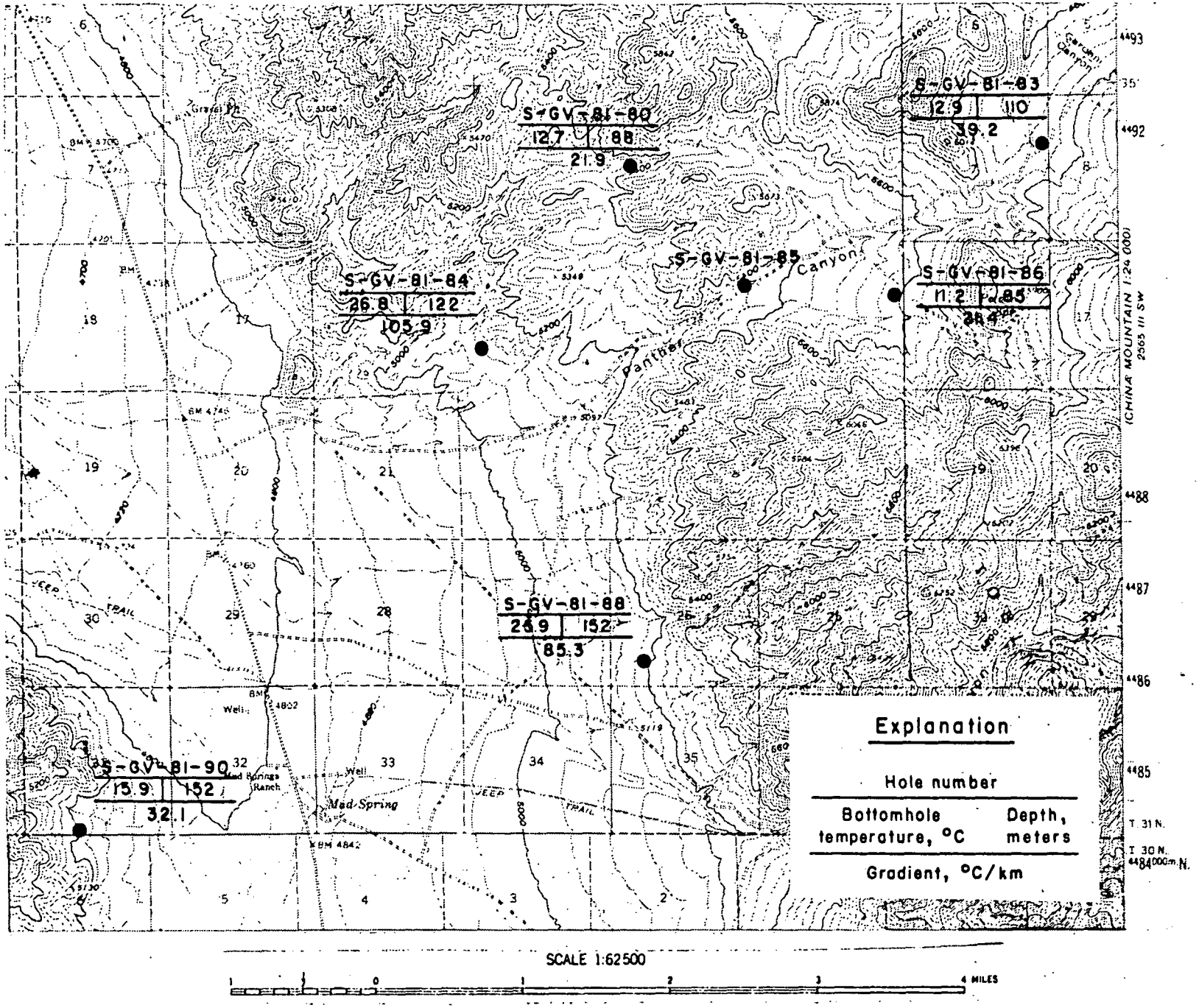

Figure 1: Locations, depths, bottom-hole temperatures, and gradients of temperature-gradient holes, Panther Canyon Project, Nevada

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Table 1. Drilling histories of temperature-gradient holes, Panther Canyon, Nevada, Sunoco Energy Development Company

Gradient Holes	Summary
S-GV-81-80	Spud: 05/02/81 Complete: 05/06/81 T.D.: 290 feet First 200 feet of hole drilled with air and foam.
S-GV-81-83	Spud: 05/16/81 Complete: 05/19/81 T.D.: 360 feet Hole made minor amounts of water at 120 feet (approximately 100 gal/hr). Spudded hole with foam but switched to mud after encountering caving problems at 200 feet.
S-GV-81-84	Spud: 05/07/81 Complete: 05/09/81 T.D.: 400 feet
S-GV-81-85	Spud: 05/28/81 Abandoned: 06/16/81 Hole drilled with air hammer after encountering extremely hard formation (greenstone) at 78 feet. Drilled to 300 feet with persistent caving and bridging problems around 200-220 feet where water was encountered. Hole abandoned after cementing drill pipe in hole while trying to plug off water zone.
S-GV-81-86	Spud: 03/24/81 Complete: 03/28/81 T.D.: 280 feet Some difficulty with caving reported for upper 80 feet of hole. Lost circulation at 258 and 278 feet. Both losses sealed with LCM.

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Gradient Holes	Summary
S-GV-81-88	Spud: 03/27/81 Complete: 05/01/81 T.D.: 500 feet Hole was suspended from 03/28/81 through 04/29/81 while rig drilled a water well in Dixie Valley.
S-GV-81-90	Spud: 05/14/81 Complete: 05/16/81 T.D.: 500 feet Entire hole drilled with foam. Hole made water (approximately 300 gal/hr) starting at 370 feet.

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HOLE DESCRIPTIONS

S-GV-81-80

T. 31 N., R. 39 E., SW1/4, NW1/4, section 11

This hole is located in Paleozoic sediments in the southern Sonoma Range at an elevation of 1,536 meters. The site is positioned very close to a NNW-trending fault which extends from Panther Canyon. Consolidated sediments were penetrated at a depth of 3 meters. The cuttings consisted of alternating siliceous shale, sandstone and siltstone with interbedded chert between 3 and 70 meters. At 70 meters a basalt flow was encountered which continued until 88 meters (T.D.). Alteration and mineralization of the basalt increased with depth. Abundant mineralization and crypotcrystalline silica suggest the hole may have penetrated a fault zone.

Temperatures ranged from 10.4°C at 9 meters to 12.7°C at 88 meters with an average gradient of 21.9°C/km between 15 and 88 meters. The temperature profile is straight and indicates heat flow by conduction. However, the presence of shallow groundwater, evidenced by several cool springs issuing in the immediate area, may have a cooling influence on this hole. A low gradient would be expected if the borehole passed into the footwall (or cool) side of the fault.

S-GV-81-83

T. 31 N., R. 40 E., SE1/4, NE1/4, section 7

This hole is located in Quaternary alluvium at the southern tip of Pumpernickel Valley at an elevation of 1,786 meters. The section consists of unconsolidated clay, sand and gravel from the surface to 30 meters depth with clasts of chert and quartz. Below 30 meters and extending to 110 meters, the gravels change composition to a mixed assemblage of limestone, sandstone, chert and silicified conglomerate.

Temperatures ranged from 7.9°C at 3 meters to 12.9°C at 110 meters with an average gradient of 39.2°C/km. The profile was straight and indicative of conductive heat flow. The high elevation may be partially responsible for this low observed gradient.

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S-GV-81-84

T. 31 N., R. 39 E., NW1/4, SW1/4, section 15

This hole is located in Quaternary-Tertiary gravels at the southernmost end of the Sonoma Range at an elevation of 1,536 meters. Hole 80 is approximately 1-1/2 miles to the NE. The upper portion of this hole from surface to 82 meters depth was drilled in unconsolidated siliceous sediments with minor volcanic and limestone clasts. Below 82 meters the cuttings were dominantly light-grey, fine-grained limestone with minor chert and silt. This limestone may represent the Triassic Augusta Mountain formation which is exposed in the Panther Canyon area.

Temperatures ranged from 13.6°C at 9 meters to 26.9°C at 122 meters. An average gradient of 105.9°C/km is observed between 15 and 122 meters; however, below 85 meters, coincident with the change from siliceous sediments to limestone, the gradient decreases to 54.7°C/km. This can be explained by the thermal conductivity difference between the limestone in the lower portion of the hole which has a higher *in situ* thermal conductivity than unconsolidated sediment in the upper portion.

S-GV-81-85

T. 31 N., R. 39 E., SE1/4, NE1/4, section 14

Hole 85 was located approximately 1 mile SE of hole 80 along the Panther Canyon Road at an elevation of 1,634 meters. Outcrops of silicified conglomerate are exposed 15 meters north of the drill site. The hole was spudded in unconsolidated sediments consisting predominantly of quartz and clasts of silicified conglomerate. Below 24 meters depth a hard formation was encountered. The section between 24 and 52 meters consisted entirely of greenstone whose hardness warranted drilling with an air hammer. Below 52 meters greenstone decreases and pale green chert increases. Between 61 meters and 73 meters the cuttings were entirely chert and water was encountered. The remainder of the hole from 73 to 91 meters consisted of greenstone and chert in approximately equal amounts.

It was determined to deepen the shallow hole to 500 ± meters and no temperature profiles were taken of hole 85. The hole was abandoned after an attempt to stabilize the hole at a water entry zone which resulted in cementing the drill string in the hole.

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S-GV-81-86

T. 31 N., R. 39 E., SE1/4, NE1/4, section 13

This hole is located 1 mile east of hole 85 at the eastern edge of Panther Canyon. Hole 86 lies at an elevation of 1,704 meters in Quaternary alluvium. The upper section from surface to 30 meters depth is composed of unconsolidated sediments and clasts of dark-grey limestone and pastel-colored cherts. Below 30 meters a 9-meter thick andesitic flow occurred. Cuttings from 39 to 85 meters are predominantly rhyolite which grade to a silicic tuff with increasing depth.

Temperatures range from 8.4°C at 6 meters to 11.2°C at 85 meters, with an average gradient of 21.4°C/km between 15 and 85 meters. The temperature profile reflects the frequent change in conductivities encountered in the first 40 meters of the hole. Below 40 meters it is straight and indicative of conductive heat flow, however the high elevation may attribute to the low gradient.

S-GV-81-88

T. 31 N., R. 39 E., SW1/4, SW1/4, section 26

This hole is located on the western flank of the northern Tobin Range in Quaternary alluvium at an elevation of 1,579 meters. Cuttings consisted entirely of unconsolidated sand, silt, clay and gravel of predominantly chert with lesser metavolcanics and metasediments.

Temperatures ranged from 11.7°C to 26.0°C with an average gradient of 85.3°C/km between 15 and 152 meters. The profile is straight and represents heat flow by conduction. This high gradient could be partly attributed to the high portion of clay observed in the returns. However, hole 88 lies within an area where similarly high gradients have been observed in other holes.

S-GV-81-90

T. 31 N., R. 39 E., SE1/4, SW1/4, section 31

This hole is located in Paleozoic sediments on the western side of Grass Valley. Hole 90 lies in the eastern flank of the northern Gold Bank Hills at an elevation of 1,524 meters. The cuttings consist almost entirely of highly fractured and weathered quartzite between 2 to 152 meters depth. Several intervals between 91 to

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107 meters and 143 to 152 meters contain as much as 75% of meta-andesite and probably represent Triassic flows.

Temperatures ranged from 11.3°C at 9 meters to 15.9°C at 152 meters with an average gradient of 32.1°C/km between 15 and 152 meters. The profile is straight and represents heat flow by conduction. The low gradient may be partly attributed to the high thermal conductivity of quartzite which effectively decreases the gradient. Groundwater encountered at 113 meters may also have a cooling effect on the gradient.

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TEMPERATURE DATA

Temperature logs for each hole are given in Appendix A; bottomhole temperatures and average gradients are displayed on figure 1. For this report the results of the Panther Canyon temperature-gradient program have been integrated with Grass Valley temperature data obtained in 1979.

Temperatures observed at 30 and 50 meter depths are shown on plate 1, and those observed at 100 meter depths and greater are summarized on plate 2. Temperature gradients in the interval 30-50 meters are shown on plate 3. Gradients computed for the interval 130-150 meters are shown on plate 4.

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HEAT FLOW

Heat flow computed for the Panther Canyon holes are summarized on table 2 and are shown on plate 5. Plate 5 also contains computed values for the 1979 Grass Valley gradient holes and published values. Thermal conductivities and porosities were estimated for the Panther Canyon holes since no samples were sent for laboratory measurement. Estimated thermal conductivities are shown on table 3.

Heat flow calculations in table 2 were made using the formula

$$Q = K_{is} \frac{dt}{dx} \text{ and } K_{is}^{1-\phi} = K_b^{\phi}$$

where Q = heat flow in HFU (cal/cm^2-sec), K_{is} = in situ thermal conductivity, dt/dx = temperature gradient in °C/km, K_b = bulk thermal conductivity, K_p = conductivity of material in pores, assumed to be water with K_p value of 1.43, and ϕ = porosity.

Terrain corrections were estimated from the topographic setting of each hole; they have relatively little effect on computed heat flows, because all holes were located on gently sloping terrain.

Heat flow ranges from a high of 3.3 HFU in the lower part of S-GV-81-84, consistent with the Battle Mountain High, to values of about 2.1 HFU in S-GV-81-88 and S-GV-81-90 and values of about 1.0 HFU in S-GV-81-83 and S-GV-81-86.

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Table 2. Bottomhole temperatures, temperature gradients and estimated heat flow, Panther Canyon, Nevada

Hole #	Total Depth (m)	Bottomhole Temperature (°C)	Depth Interval, (m)	Temperature Gradient (°C/km)	Terrain Correction (%)	Heat Flow, HFU[1]
S-GV-81-80	88	12.7	70-88	21.8	+5	0.77
S-GV-81-83	110	12.9	61-110	43.1	-5	1.07
S-GV-81-84	122	26.8	82-122	54.7	-5	3.30
S-GV-81-86	85	11.2	61-85	24.6	0	0.98
S-GV-81-88	152	25.9	100-152	75.3	0	2.16
S-GV-81-90	152	15.9	100-152	32.8	0	2.13

[1] HFU = heat flow units, 10^{-6} cal/cm^2 - sec

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Table 3. Summary of K_{is} values used to estimate thermal conductivities for Panther Canyon project, Nevada

Hole #	Depth Interval, (m)	K_b [1]	Ø, %	K_{is} [2]	Lithology
S-GV-81-80	70-88	3.70	10	3.36	90% BASALT 10% SAND (chert, shale, argillite)
S-GV-81-83	61-110	3.45	30	2.65	80% GRAVELS and SANDS (chert, limestone, sandstone); 20% CLAY
S-GV-81-84	82-122	7.50	10	6.35	100% LIMESTONE
S-GV-81-86	61-85	4.45	10	3.97	90% RHYOLITE 10% CLAY and SILT
S-GV-81-88	100-152	3.86	30	2.87	70% GRAVELS and SAND (chert, metavolcanics) 30% CLAY and SILT
S-GV-81-90	100-152	7.67	10	6.48	80% QUARTZITE 20% ANDESITE

[1] K_b = bulk thermal conductivity

[2] K_{is} = *in situ* thermal conductivity

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APPENDIX A

Lithologic logs of temperature-gradient holes

LITHOLOGIC LOG

S-GV-81-80

Depth intervals, feet		Completion Date: 5/6/81
0-10	100%	CLAY, SILT and SAND, poorly-sorted.
10-20	100%	CHERT, gray to greenish-gray, cryptocrystalline to slightly grainy, very hard, abundant planar, brown-stained fracture surfaces.
20-80	100%	SHALE, siliceous, greenish-gray, hard, brittle, dull, grainy texture, abundantly fractured, grading to minor chert.
80-90	100%	SHALE, siliceous, gray to greenish and brownish-gray, with dull grainy texture; hard, brittle, occasionally with discolored fracture surfaces.
90-100	100%	SHALE, as above, grading to minor cryptocrystalline chert and minor fine-grained sandstone, abundant fracture surfaces.
100-110	100%	SHALE, as above, grading to minor greenish chert, abundant fracture surfaces.
110-120	50%	CHERT, brownish-green to gray-green, resinous to slightly grainy luster, occasionally contains thin quartz veins, abundant planar, slightly oxidized fracture surfaces.
	50%	SHALE, siliceous, as above.
120-130	80%	SANDSTONE, light greenish-gray, fine-grained, poorly-sorted, "dirty" appearance, angular and irregularly shaped grains, including quartz, feldspar and black lithic fragments, common intergranular calcite, common planar, discolored fracture surfaces.
	20%	CHERT, as above.
130-140	80%	SILTSTONE, siliceous and ARGILLITE, greenish-gray to dark gray, well indurated, abundant planar fracture surfaces.
	20%	CHERT, gray to greenish-gray.
140-170	90%	SILTSTONE, ARGILLITE and SANDSTONE, siliceous, greenish-gray to dark gray, well indurated, abundantly fractured.
	10%	CHERT, green to greenish gray.

LITHOLOGIC LOG

S-GV-81-80 (continued)

170-180	90% SILTSTONE and ARGILLITE, as above, no sandstone. 10% CHERT, as above.
180-190	80% ARGILLITE, SILTSTONE and SANDSTONE, greenish and brownish gray to dark gray, well indurated (slightly metamorphosed) and abundantly fractured, common calcite veins. 20% CHERT, predominantly dark gray, fractured, veined with calcite.
190-200	100% ARGILLITE and SILTSTONE, gray to greenish and brownish, occasionally with slight phyllitic sheen, siliceous, well indurated, brittle, veined with calcite; trace chert and limestone.
200-210	60% CHERT, pale blue and green to white. 30% SHALE, predominantly yellow-brown, occasionally bluish, bladed fragments. 10% ARGILLITE, dark gray.
210-230	100% SHALE, SILTSTONE, and ARGILLITE, bluish, greenish, brown, and gray, well indurated, brittle, veined with calcite, trace chert.
230-250	90% BASALT, dark greenish-gray, hard, brittle, non-porphyritic, veined with calcite. 10% CHERT, SHALE and ARGILLITE.
250-260	90% BASALT, altered, light to dark green-gray, abundant kaolinization, and disseminated pyrite, abundant veins of calcite (sometimes with epidote) and some of cryptocrystalline silica, possible fault zone. 10% CHERT, SHALE, etc.
260-280	90% BASALT, as above, less severely altered. 10% CHERT, SHALE, as above.
280-310	100% BASALT as in 230-250, but slightly altered, some disseminated pyrite, some kaolinization, veins of calcite (± epidote), quartz, cryptocrystalline silica, minor slickensides.

LITHOLOGIC LOG

S-GV-81-83

Depth intervals, feet		Completion Date: 5/19/81
0-10	70% SILT, buff to tan, unconsolidated. 30% SAND, predominantly fine-grained with minor gravels composed of chert and quartz.	
10-30	60% CLAY, generally as above, but taking on slightly darker brown color. 20% SAND, fine to coarse-grained. 20% GRAVELS, predominantly composed of chert.	
30-40	50% CLAY, orangish-brown. 30% GRAVELS, composed predominantly of chert. 20% SAND, also composed predominantly of chert.	
40-50	60% SANDS, predominantly coarse-grained. 20% CLAY, as above. 20% GRAVELS, as above.	
50-60	60% SANDS, as above. 20% CLAY, as above. 20% GRAVELS, as above, with frequent cinnabar crusts.	
60-80	50% GRAVELS, composed of chert, 3-6 mm diameter. 30% SANDS, as above. 20% CLAY, as above.	
80-90	70% GRAVELS, trace of limestone. 30% SANDS, as above.	
90-120	70% GRAVELS, with composition changing to predominantly gray limestone, with lesser pale-colored very fine-grained sandstone and minor chert. 30% SANDS, as above.	
120-130	70% GRAVELS, with increase in chert and quartz, trace cinnabar coatings. 30% SANDS, as above.	
130-140	60% SANDS, predominantly coarse-grained. 30% GRAVELS, composed as above, with trace of volcanic material. 10% CLAY, orangish-brown.	

LITHOLOGIC LOG

S-GV-81-83 (continued)

140-150	90% GRAVELS, as above. 10% SAND, coarse-grained.
150-190	70% GRAVELS, angular, 2-6 mm in diameter, composed chert, limestone, sandstone/siltstone, and minor volcanic material. 30% SAND, coarse-grained, composed as above.
190-200	90% GRAVELS, as above. 10% SAND, as above.
200-210	100% GRAVELS, predominantly angular, 2-4 mm in diameter, composed as described in 150-190.
210-220	100% GRAVELS, as above, with minor clay.
220-230	90% GRAVELS, as above. 10% CLAY, tan, sticky.
230-250	75% GRAVELS, as above, with minor coarse sands. 25% CLAY, orangish-tan.
250-260	85% GRAVELS, as above. 15% CLAY, as above.
260-290	75% GRAVELS, as above. 25% CLAY, as above.
290-300	70% GRAVELS, with minor coarse sands. 30% CLAY, orangish-brown.
300-310	50% CLAY, as above. 50% GRAVELS, as above.
310-320	60% GRAVELS, as above. 40% CLAY, as above.
320-360	65% GRAVELS, as above. 25% CLAYS, as above. 10% SAND, as above.

LITHOLOGIC LOG

S-GV-81-84

Depth intervals, feet		Completion Date: 5/9/81
0-20	90% SAND and GRAVEL, coarse, sub-round to angular fragments predominantly of fine-grained multicolored siliceous sediments and chert with lesser purplish and gray volcanic rocks. 10% CLAY and SILT, tan.	
20-60	80% SAND and GRAVEL, coarse, lithologies as above. 20% CLAY and SILT, tan.	
60-70	60% SAND and GRAVEL, coarse, lithologies as above. 40% CLAY and SILT, tan.	
70-80	70% SAND and GRAVEL, lithologies as above. 30% CLAY and SILT, tan.	
80-90	50% SAND and GRAVEL, coarse, lithologies as above; sugary calcite coating on some grains. 50% CLAY and SILT, tan.	
90-100	50% SAND and GRAVEL, pea, multicolored white, green, gray, yellow, red; predominantly chert and fine-grained siliceous sediments with lesser purplish, gray and white volcanic rocks, including silicia tuffs, common sugary volcanics grain coating. 50% CLAY and SILT, tan.	
100-110	80% SAND and GRAVEL, pea, lithologies as above. 20% CLAY and SILT, tan.	
110-120	50% SAND and GRAVEL, pea, lithologies as above. 50% CLAY AND SILT, tan.	
120-130	60% SAND and GRAVEL, pea, lithologies as above. 40% CLAY and SILT, tan.	
130-140	90% SAND and GRAVEL, lithologies as above. 10% CLAY and SILT, tan.	

LITHOLOGIC LOG

S-GV-81-84 (continued)

140-150	60% SAND and GRAVEL, lithologies as above. 40% CLAY and SILT, tan.
150-160	60% CLAY and SILT, tan. 40% SAND and GRAVEL, lithologies as above.
160-170	60% SAND and GRAVEL, pea, lithologies as above, but volcanic fragments predominant. 40% CLAY and SILT.
170-190	50% CLAY and SILT. 50% SAND and GRAVEL, pea, sub-round to angular, predominantly gray, reddish and whitish volcanic fragments, including silicic tuffs, lesser pastel-colored chert, fine-grained siliceous sediments, and limestone.
190-200	60% CLAY and SILT, tan, becoming slightly reddish. 40% SAND and GRAVEL, pea, lithologies as above.
200-210	60% CLAY and SILT, lithologies as above, increase purplish porphyritic volcanic fragments (andesite?). 40% SAND and GRAVEL, pea, lithologies as above.
210-220	80% CLAY and SILT, tan to reddish-brown. 20% SAND, fine to coarse, sub-round to angular, lithologies as above.
220-230	60% CLAY and SILT, red-brown. 40% SAND and GRAVEL, pea, lithologies as above.
230-240	60% LIMESTONE, light gray to yellow-brown, very fine-grained, angular chips. 30% CLAY and SILT, red-brown. 10% Miscellaneous volcanic and siliceous sedimentary fragments.
240-250	40% CHERT, pastel hues, angular to sub-round fragments. 30% CLAY and SILT, red-brown. 20% LIMESTONE, as above. 10% Miscellaneous gray and reddish volcanic fragments, resinous to grainy texture.
250-260	60% CLAY and SILT, red-brown. 40% SAND and GRAVEL, pea, predominantly chert, with lesser limestone and volcanic fragments.
260-270	70% LIMESTONE, gray, very fine-grained, brittle. 30% CLAY and SILT, red-brown.

LITHOLOGIC LOG

S-GV-81-84 (continued)

270-280	100% LIMESTONE, as above, locally slightly recrystallized; minor chert and volcanic fragments.
280-320	100% LIMESTONE, gray, very fine-grained, slightly recrystallized in part.
320-330	100% LIMESTONE, as above, stained yellow-brown in part, especially on fracture surfaces.
330-340	100% LIMESTONE, as above, decrease staining.
340-370	100% LIMESTONE, as above, continue minor staining.
370-390	100% LIMESTONE, yellow-brown to brown, veined with calcite, less well indurated than above, possibly stained from original gray.
390-400	90% CHERT, brown, with grainy texture, very hard, possibly recrystallized. 10% LIMESTONE, yellow-brown.

LITHOLOGIC LOG

S-GV-81-85

Depth intervals, feet		Abandoned Date: 6/16/81
0-10	50% GRAVEL, 2 to 4 mm in diameter, composed of fragments of chert and quartz with minor volcanic material. 30% SAND, predominantly coarse-grained, composed of quartz and chert. 20% SILT, buff in color.	
10-30	80% GRAVELS, 2 to 6 mm in diameter, composed predominantly of chert fragments with less common volcanic material. 10% SAND, coarse-grained. 10% SILT, buff in color.	
30-40	50% GRAVELS, 2 to 5 mm, composed of chert, volcanic material. 35% SAND, predominantly coarse-grained. 15% SILT, buff in color.	
40-50	50% SAND, predominantly coarse-grained, composed of highly weathered quartz and quartzite. 30% GRAVELS, 2 to 3 mm in diameter, composed of quartzite, quartz and lesser chert and volcanic material. 20% SILT, buff with very slight pinkish cast.	
50-60	40% SAND, as above. 40% GRAVELS, as above. 20% SILT, as above.	
60-80	80% GRAVELS, 2 to 5 mm in diameter, composed of chert, fragments of silicified conglomerate, and minor quartzite and volcanic material. 10% SILT, as above. 10% SAND, as above.	
80-90	100% GREENSTONE, greenish-gray, aphanitic, with disseminated black opaque minerals, rare calcite vein and minor hydrothermal alteration, minor iron oxide stain on weathered surfaces, trace chert.	
90-110	100% GREENSTONE, as above, composition close to a basalt.	
110-120	100% GREENSTONE, as above, sample contains abundant cement.	

LITHOLOGIC LOG

S-GV-81-85 (continued)

120-130	100% GREENSTONE, as above,with only minor cement.
130-140	100% GREENSTONE, dark greenish-gray, dense, aphanitic, composition probably basaltic, contains scattered disseminated sulphides (?), very rare calcite, rare weathered or oxidized surfaces, trace chert.
140-150	100% GREENSTONE, as above,with dark green chert 10% as microveinlets and mottled with greenstone.
150-160	100% GREENSTONE, as above, continue with dark green chert.
160-170	70% GREENSTONE, as described in 130-140-foot interval. 30% CHERT, pale green and buff.
170-180	80% CHERT, appears to grade to siliceous tuff. 20% GREENSTONE, as above.
180-190	70% CHERT, as above. 30% GREENSTONE, as above.
190-200	90% CHERT, multi-colored, but predominantly light gray, grainy, frequently dissected by microveinlets of chert, occasionally takes on appearance and texture of a siliceous tuff. 10% GREENSTONE, as above.
200-210	100% CHERT, as above.
210-220	100% CHERT, as above, with minor slough.
220-230	100% CHERT, as above, continue grading to siliceous tuff.
230-240	100% CHERT, pale gray, grades to siliceous tuff, frequent grainy appearance, minor fragments of greenstone.
240-270	75% CHERT, pale gray, grades to siliceous tuff. 25% GREENSTONE, gray to greenish-gray, aphanitic, mottled with chert, very dense, scattered disseminated opaques.
270-280	50% CHERT, predominantly light gray, but frequently pale green. 50% GREENSTONE, as above.
280-300	80% GREENSTONE, as above. 20% CHERT, as above.

LITHOLOGIC LOG

S-GV-81-86

Depth Interval, Feet		Completion Date: 03/28/81
0-10	90% CLAY, silty, tan. 10% SAND and GRAVEL, angular chips to 8 mm, average 3.4 mm, predominantly dark gray limestone and pastel-colored chert.	
10-20	90% CLAY, as above. 10% SAND and GRAVEL, as above, more finely-grained, angular, 1-2 mm.	
20-30	90% CLAY, as above. 10% SAND and GRAVEL, as above, 0-10' interval.	
30-40	90% CLAY, as above. 10% SAND and GRAVEL, as above, nearly all coarse angular chips to 12 mm, 8 mm average.	
40-50	90% SAND and GRAVEL, poorly-sorted angular chips 5-10 mm, predominantly dark gray limestone and pastel-colored chert. 10% CLAY, silty.	
50-60	50% CLAY, silty, dark gray-brown. 50% SAND and GRAVEL, fine-grained to 10 mm chips, angular, nearly all purplish-gray porphyritic andesite, with minor metashale and chert.	
60-70	70% CLAY, silty, dark gray-brown. 30% SAND and GRAVEL, coarse, mostly purplish-gray andesite chips as above, same chert and metashale.	
70-100	80% ANDESITE, purplish-gray to dark gray, microporphyritic or amygdaloidal, altered in part to yellowish-brown. 20% CLAY, silty, dark gray-brown.	
100-110	70% ANDESITE, reddish-brown to greenish, slightly altered. 30% CLAY, silty, dark gray-brown, silghtly reddish.	

LITHOLOGIC LOG

S-GV-81-86 (continued)

110-120	60% ANDESITE, as above. 30% CLAY and SILT, light reddish-tan. 10% CHERT, multicolored fragments and aggregates of chert grains.
120-140	60% RHYOLITE, white to greenish-white, mottled with other colors, aphanitic texture, biotite phenocrysts; possibly a tuff. 30% CLAY and SILT, light tan. 10% CHERT, as above.
140-150	60% RHYOLITE, as above, gradation to darker colors, including tan, brown, gray; grainier texture; probable tuff, silicic to intermediate composition. 30% CLAY and SILT, as above. 10% CHERT, as above.
150-160	60% RHYOLITE, as above, 120-140' interval. 30% CLAY and SILT, as above. 10% CHERT, as above.
160-170	60% RHYOLITE, as above, 120-140' interval, gradation to gray and brown. 30% CLAY and SILT, as above. 10% CHERT, as above.
170-180	60% RHYOLITE, as above, 120-140' interval. 30% CLAY and SILT, as above. 10% CHERT, as above.
180-190	50% CHERT, pale brown to yellowish, resinous luster, locally vitreous. 30% RHYOLITE, white to greenish-white, as above. 20% CLAY and SILT, very light tan.
190-200	70% CHERT, predominantly brownish, gradational to red brown and pale greens and yellows. 20% RHYOLITE, white to greenish-white, as above. 10% CLAY and SILT, very light tan.

LITHOLOGIC LOG

S-GV-81-86 (continued)

200-220	80% RHYOLITE, predominantly yellowish cream-colored, grainy to slightly chalky texture, finely-banded in part, mottled in part; possible tuff. 20% CLAY and SILT, very light tan.
220-230	90% RHYOLITE, predominantly pale green, gradational to other pastel colors; uneven, irregular texture, very mottled. 10% CLAY and SILT, light tan.
230-240	90% RHYOLITE, as above, with more even texture. 10% CLAY and SILT, as above.
240-250	90% RHYOLITE, as above, 220-230' interval; texture more variable; banding common. 10% CLAY and SILT, as above.
250-260	90% RHYOLITE, as above, 220-230' interval. 10% CLAY and SILT, as above.
260-280	100% RHYOLITE, predominantly white, gradational to pale yellow and pale green and occasionally dark brown or red-brown, sugary to resinous luster, variable appearance; minor limestone and chert fragments; limonite-coated fracture(?) surfaces.

LITHOLOGIC LOG

S-GV-81-88

Depth Interval, feet	Completion Date: 5/1/80
0-80	90% COARSE SAND and GRAVEL, angular chips, multicolored in pastel hues; predominantly chert, with lesser metavolcanic and metasedimentary fragments. 10% CLAY and SILT, tan.
80-120	80% SAND and GRAVEL, as above. 20% SILT and CLAY.
120-140	50% CLAY and SILT, tan. 50% SAND and GRAVEL, multicolored angular chips, mostly gray or greenish metavolcanic fragments and pastel pastel colored chert.
140-150	50% CLAY and SILT, tan. 50% SAND, very fine to very coarse, lithologies as above.
150-160	60% CLAY and SILT, tan. 40% SAND, very find to medium, lithologies as above.
160-170	50% CLAY and SILT, tan. 50% SAND, very fine to medium, lithologies as above.
170-180	70% CLAY and SILT, tan. 30% SAND, very fine to coarse, lithologies as above.
180-190	50% CLAY and SILT, tan. 50% SAND, very fine to coarse, lithologies as above.
190-210	60% CLAY and SILT, tan. 40% SAND, very fine to very coarse, lithologies as above.
210-230	70% CLAY and SILT, tan. 30% SAND, very fine to coarse, lithologies as above.
230-240	50% CLAY and SILT, tan. 50% SAND, very fine to coarse, lithologies as above.
240-250	No sample.

LITHOLOGIC LOG

S-GV-81-88 (continued)

250-260	70% CLAY and SILT, tan. 30% SAND, very fine to coarse, lithologies as above.
260-280	50% CLAY and SILT, tan. 50% SAND, very fine to medium, lithologies as above.
280-300	60% CLAY and SILT, tan. 40% SAND and GRAVEL, lithologies as above.
300-310	60% SAND and GRAVEL, angular chips, predominantly pastel-colored chert and gray metavolcanic; minor metasiltstone. 40% CLAY and SILT, tan.
310-400	70% SAND and GRAVEL, lithologies as above. 30% CLAY and SILT, tan.
400-410	60% SAND and GRAVEL, lithologies as above. 40% CLAY and SILT, tan.
420-430	60% SAND and GRAVEL, lithologies as above, predominantly chert. 40% CLAY and SILT, tan.
430-440	70% SAND and GRAVEL, lithologies as above. 30% CLAY and SILT, tan.
440-500	80% SAND and GRAVEL, lithologies as above. 20% CLAY and SILT, tan.

LITHOLOGIC LOG

S-GV-81-90

Depth Interval, feet		Completion Date: 5/16/81
0-10	60% SAND and minor GRAVEL, fine-to coarse-grained, angular, composed of white to buff quartzite. 40% CLAY and SILT, tan to buff.	
10-20	90% QUARTZITE, predominantly white, less buff and pink, fine-grained, well-sorted to poorly sorted with mottled appearance. 10% CLAY and SILT, tan to buff.	
20-30	80% QUARTZITE, as above. 20% ANDESITE, gray to greenish-gray, mottled to micro-porphyritiz texture, slightly altered, trace epidote.	
30-40	70% QUARTZITE, as above. 30% ANDESITE, as above.	
40-50	80% ANDESITE, as above. 20% QUARTZITE, as above.	
50-60	70% QUARTZITE. 30% ANDESITE, as above, predominantly gray in color.	
60-100	100% QUARTZITE, predominantly tan to grayish-tan, poorly-sorted with mottled texture, frequent alteration and oxidation.	
100-140	100% QUARTZITE, as above, with trace of gray andesite.	
140-150	100% QUARTZITE, as above, with trace of greenish-gray andesite.	
150-180	100% QUARTZITE, as 60-70'.	
180-200	100% QUARTZITE, generally pink to tan, poorly sorted, occasional sugary appearance, minor white clayey alteration, occasional orangish oxidation stains.	
200-210	100% QUARTZITE, pale yellowish-orange and pinkish tan, very poorly-sorted, mottled texture, grades to silicified breccia composed almost entirely of silica, abundant alteration to clays and iron oxide staining, trace of grayish-green meta-andesite.	

LITHOLOGIC LOG

S-GV-81-90 (continued)

210-240	100% QUARTZITE, as above, meta-andesite absent.
240-280	100% QUARTZITE, as above, relict texture generally obscured.
280-290	100% QUARTZITE, as above, with trace of silicic volcanics.
290-300	100% QUARTZITE, as above (200-210).
300-320	80% QUARTZITE, pinkish-tan and yellowish-orange, very poorly-sorted, mottled texture, relict texture obscured by metamorphism and alteration, frequent iron oxide staining, highly weathered. 20% META-ANDESITE, pale green, with large feldspar phenocrysts, frequently mottled with quartzite.
320-330	50% QUARTZITE, pale orange, poorly-sorted, with abundant alteration to clays, frequent iron oxide staining. 50% ANDESITE, grayish-brown, aphanitic texture, abundant pale brown feldspar laths(?), highly weathered.
330-340	75% ANDESITE, as above. 25% QUARTZITE, as above.
340-350	75% ANDESITE, as above, taking on reddish-brown color. 25% QUARTZITE, as above.
350-360	90% QUARTZITE, as above. 10% ANDESITE, as above.
360-380	100% QUARTZITE, predominantly white to pinkish-white, poorly-sorted, relict texture obscured, scattered iron oxide stains, frequent incipient alteration to clays, highly weathered.
380-410	100% QUARTZITE, as above, with trace of andesite.
410-420	80% QUARTZITE, as above. 20% ANDESITE, as above
420-430	100% QUARTZITE, continue trace of andesite.
430-450	100% QUARTZITE, pale pink to white.
450-460	100% QUARTZITE, as above, with frequent incipient alteration to clays.

LITHOLOGIC LOG

S-GV-81-90 (continued)

460-470	100%	QUARTZITE, pale pink to tan, poorly-sorted with relict texture generally obscured, frequent incipient alteration to clays, occasionally iron oxide staining, trace of andesite.
470-490	75%	ANDESITE
	25%	QUARTZITE
490-500	70%	ANDESITE
	30%	QUARTZITE

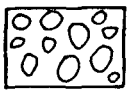
GeothermEx, Inc.
SUITE 201
5221 CENTRAL AVENUE
RICHMOND, CALIFORNIA 94804

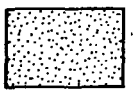
(415) 527-9876
CABLE ADDRESS: GEOTHERMEX

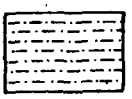
APPENDIX B

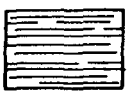
Temperature logs of temperature-gradient holes

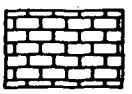
EXPLANATION OF SYMBOLS USED ON LITHOLOGIC LOGS


GRAVEL

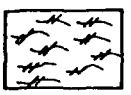

SAND


SILT


SHALE

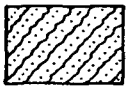

LIMESTONE


GREENSTONE
BASALT


ANDESITE


RHYOLITE


CHERT


QUARTZITE

N.S. NO SAMPLE

TEMPERATURE LOG

S-GV-81-80

T. 31 N., R. 39 E., SW 1/4 of NW 1/4, Sec. 11

Hole completed 05/06/81

Survey #1 05/08/81

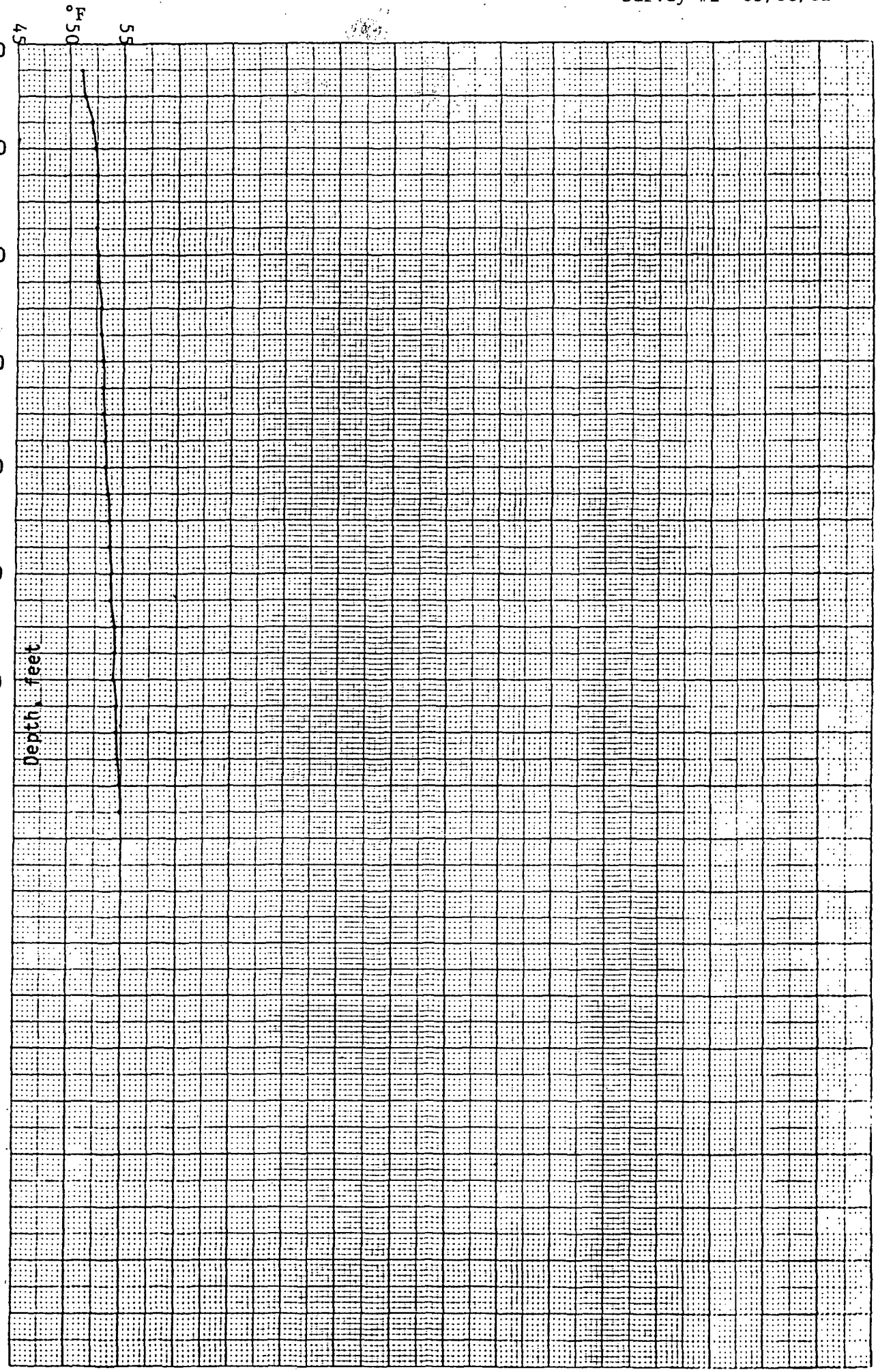
Elevation 5,040 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	10.6	51.1	160	11.9	53.4
20	10.7	51.3	170	12.0	53.6
30	11.1	52.0	180	12.1	53.8
40	11.3	52.3	190	12.1	53.8
50	11.4	52.5	200	12.2	54.0
60	11.4	52.5	210	12.2	54.0
70	11.4	52.5	220	12.4	54.3
80	11.5	52.7	230	12.4	54.3
90	11.5	52.7	240	12.4	54.3
100	11.6	52.9	250	12.5	54.5
110	11.6	52.9	260	12.5	54.5
120	11.7	53.1	270	12.6	54.7
130	11.8	53.2	280	12.7	54.9
140	11.8	53.2	290	12.7	54.9
150	11.9	53.4			

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-80
Survey #1 05/08/81



TEMPERATURE LOG

S-GV-81-80

T. 31 N., R. 39 E., SW 1/4 of NW 1/4, Sec. 11

Hole completed 05/06/81

Survey #2 05/14/81

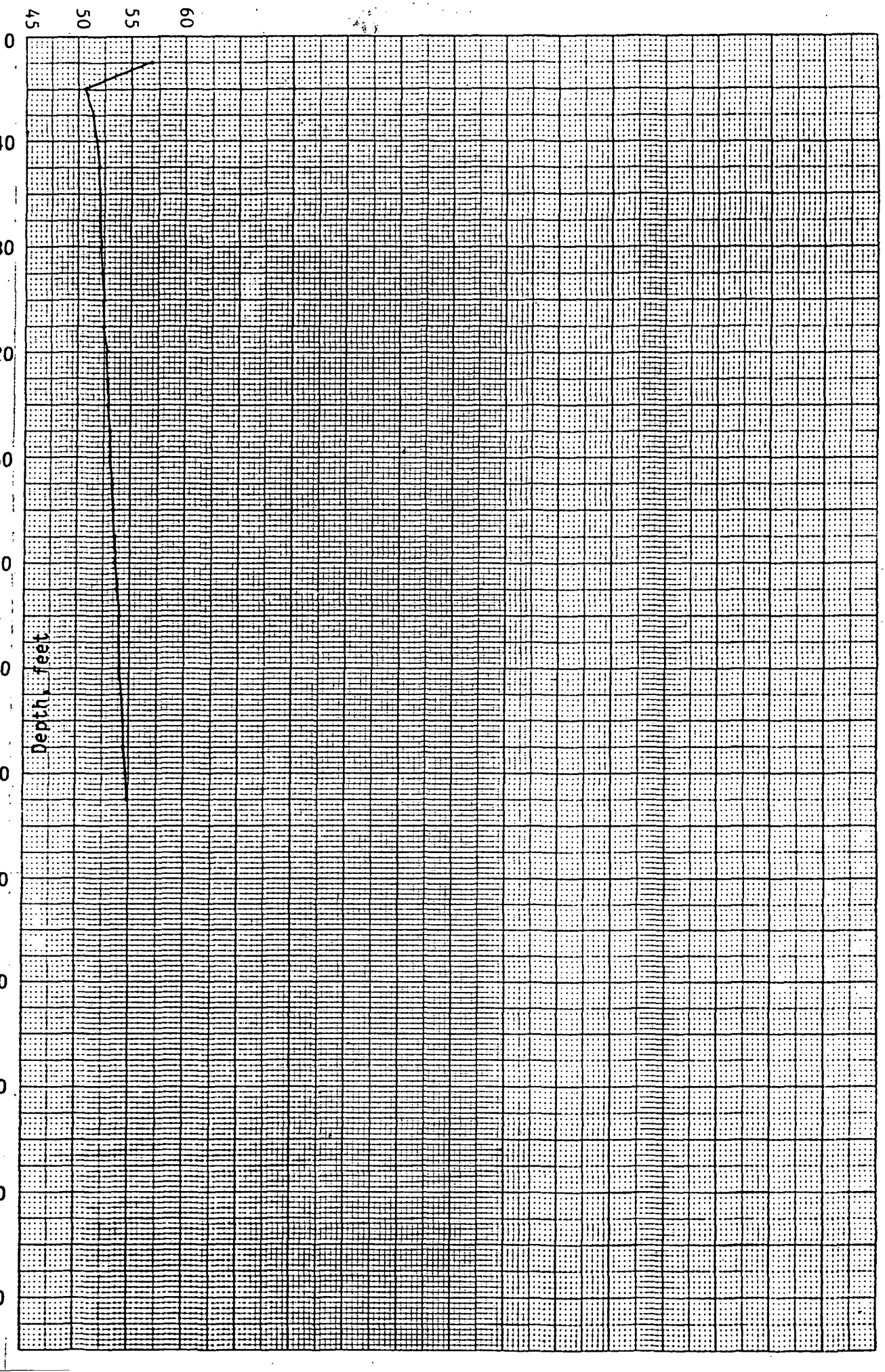
Elevation 5,040 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	13.8	56.8	160	11.8	53.2
20	10.4	50.7	170	11.9	53.4
30	10.8	51.4	180	11.9	53.4
40	11.0	51.8	190	12.0	53.6
50	11.1	52.0	200	12.0	53.6
60	11.1	52.0	210	12.1	53.8
70	11.2	52.2	220	12.2	54.0
80	11.2	52.2	230	12.3	54.1
90	11.3	52.3	240	12.3	54.1
100	11.4	52.5	250	12.4	54.3
110	11.4	52.5	260	12.5	54.5
120	11.5	52.7	270	12.5	54.5
130	11.6	52.9	280	12.6	54.7
140	11.6	52.9	290	12.7	54.9
150	11.7	53.1			

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-80
Survey #2 05/14/81



TEMPERATURE LOG

S-GV-81-80

T. 31 N., R. 39 E., SW 1/4 of NW 1/4, Sec. 11

Hole completed 5/06/81

Survey #3 9/03/81 12:00 PM

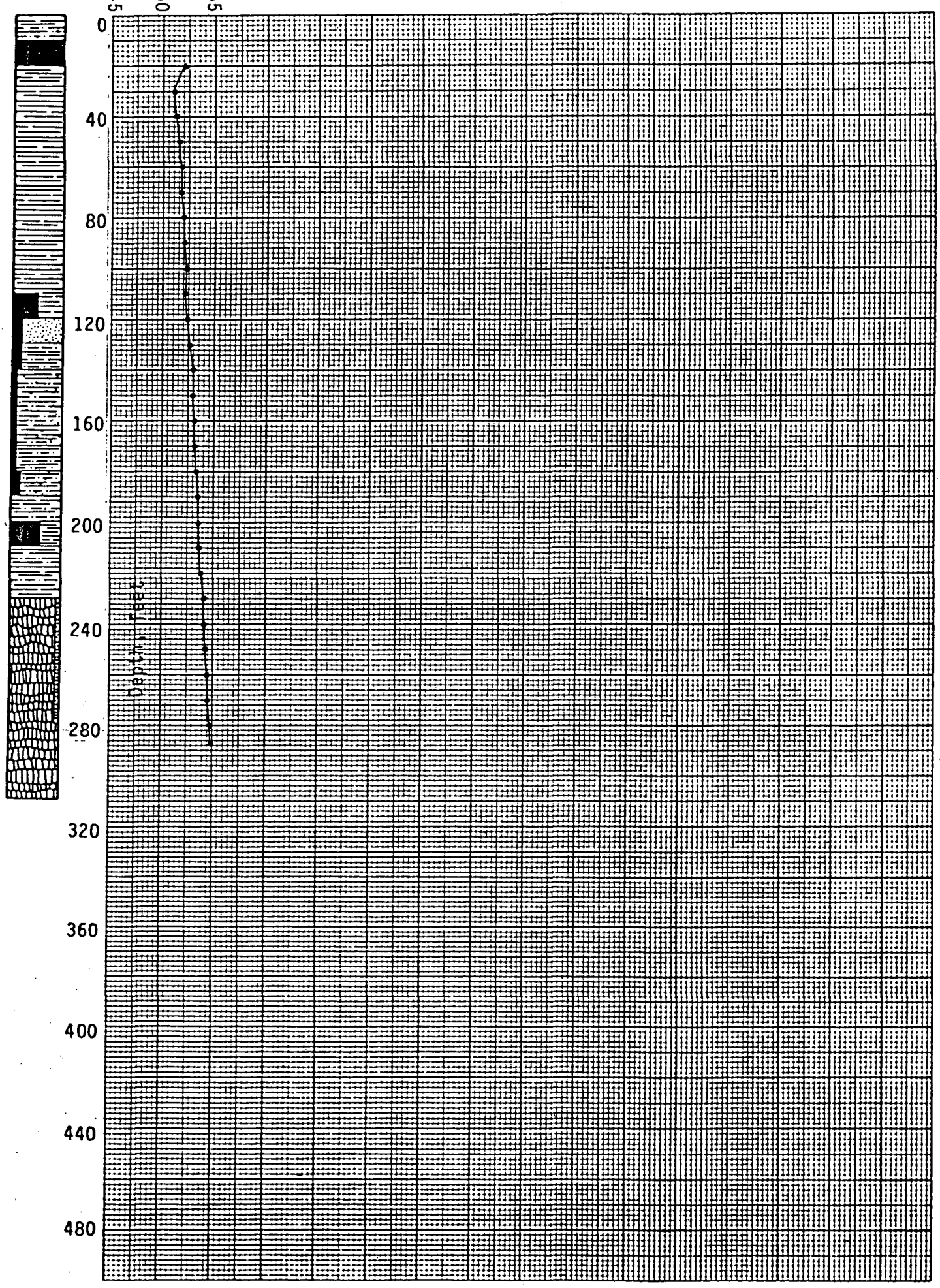
Elevation 5,040 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	--	--	160	11.7	53.1
20	11.1	52.0	170	11.8	53.2
30	10.6	51.1	180	11.8	53.2
40	10.7	51.3	190	11.9	53.4
50	10.9	51.6	200	12.0	53.6
60	11.0	51.8	210	12.0	53.6
70	11.0	51.8	220	12.1	53.8
80	11.1	52.0	230	12.2	54.0
90	11.2	52.2	240	12.3	54.1
100	11.3	52.3	250	12.4	54.3
110	11.3	52.3	260	12.5	54.5
120	11.4	52.5	270	12.5	54.5
130	11.5	52.7	280	12.6	54.7
140	11.6	52.9	287	12.7	54.9
150	11.6	52.9			

TEMPERATURE LOG - SUN, Panther Canyon

S-GV-81-80
Survey #3 9/3/81



TEMPERATURE LOG

S-GV-81-83

T. 31 N., R. 40 E., SE 1/4 of NE 1/4, Sec. 7

Hole completed 05/19/81

Survey #1 05/20/81

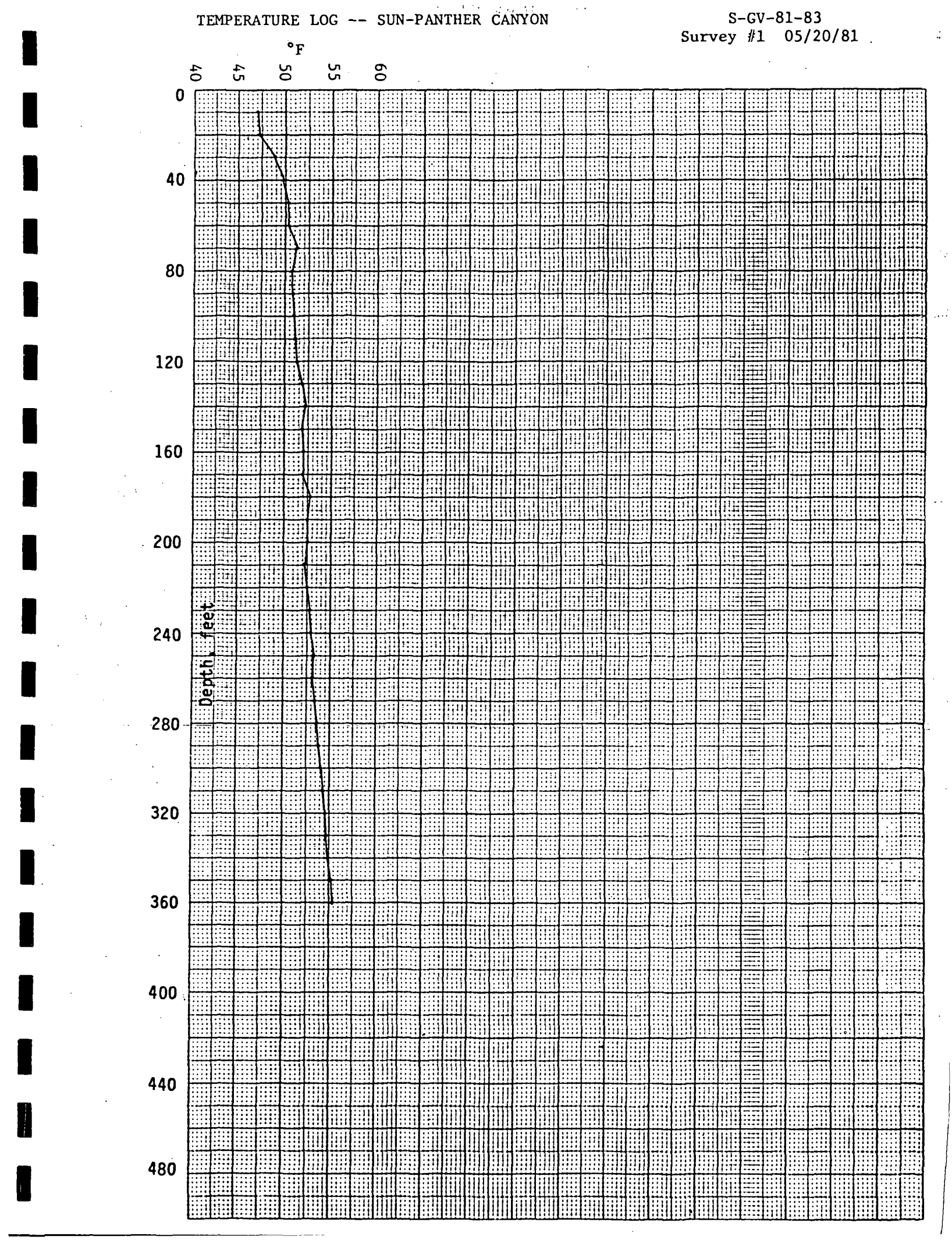
Elevation 5,860 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	8.4	47.1	190	11.4	52.5
20	9.0	48.2	200	11.4	52.5
30	9.4	48.9	210	11.3	52.3
40	9.9	49.8	220	11.4	52.5
50	10.1	50.2	230	11.5	52.7
60	10.2	50.4	240	11.6	52.9
70	10.7	51.3	250	11.7	53.1
80	10.4	50.7	260	11.7	53.1
90	10.5	50.9	270	11.9	53.4
100	10.5	50.9	280	12.0	53.6
110	10.6	51.1	290	12.1	53.8
120	10.7	51.3	300	12.2	54.0
130	11.0	51.8	310	12.3	54.3
140	11.2	52.2	320	12.5	54.5
150	11.0	51.8	330	12.6	54.7
160	11.1	52.0	340	12.7	54.9
170	11.1	52.0	350	12.9	55.2
180	11.5	52.7	360	13.0	55.4

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-83
Survey #1 05/20/81



TEMPERATURE LOG

S-GV-81-83

T. 31 N., R. 40 E., SE 1/4 of NE 1/4, Sec. 7

Hole completed 05/19/81

Survey #2 05/31/81

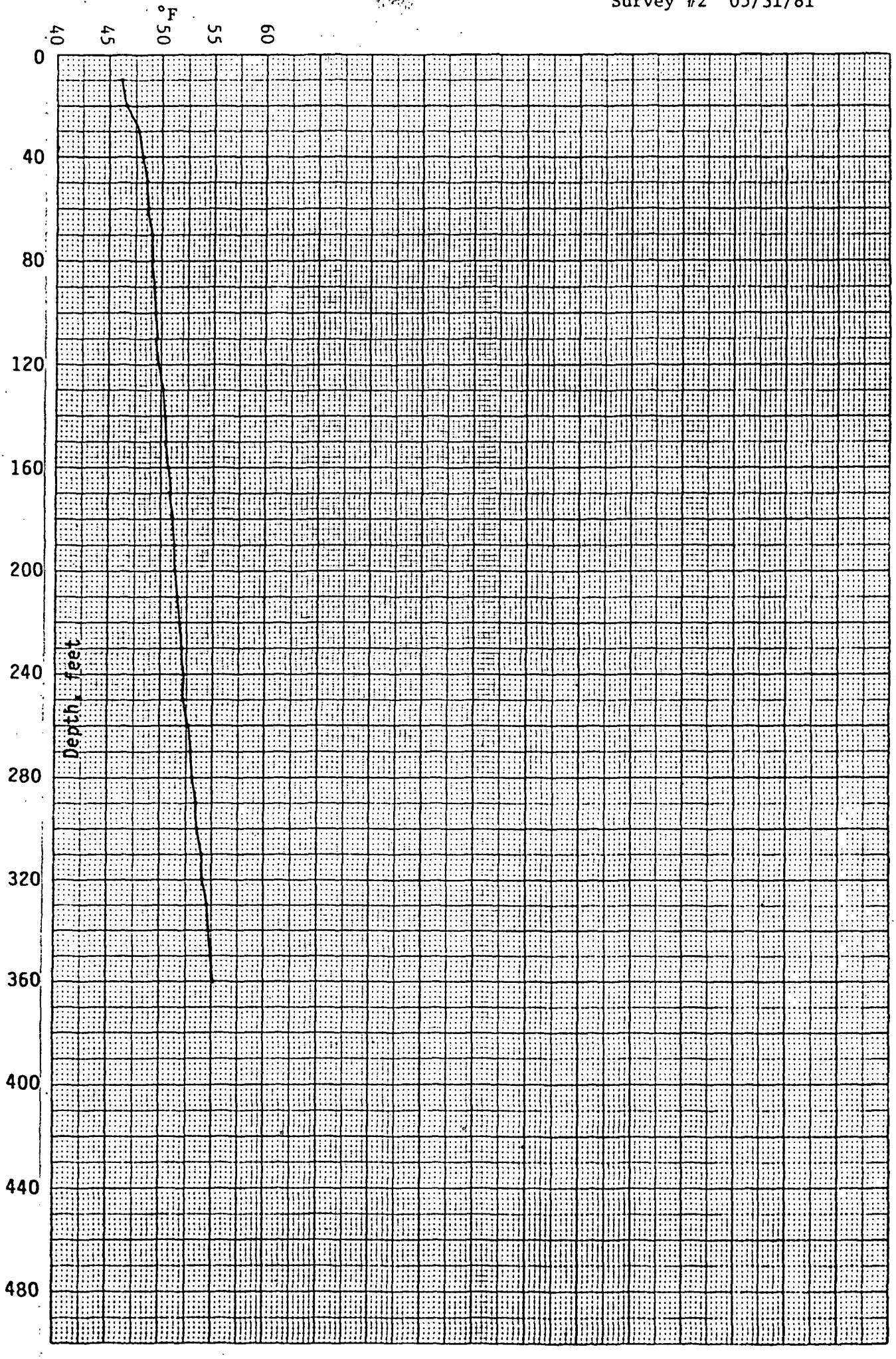
Elevation 5,860 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	7.9	46.2	190	10.7	51.3
20	8.1	46.6	200	10.8	51.4
30	8.7	47.7	210	10.9	51.6
40	9.0	48.2	220	11.0	51.8
50	9.2	48.6	230	11.1	52.0
60	9.3	48.7	240	11.2	52.2
70	9.5	49.1	250	11.3	52.3
80	9.5	49.1	260	11.5	52.7
90	9.6	49.3	270	11.6	52.9
100	9.7	49.5	280	11.7	53.1
110	9.8	49.6	290	11.9	53.4
120	9.9	49.8	300	12.0	53.6
130	10.1	50.2	310	12.2	54.0
140	10.2	50.4	320	12.3	54.1
150	10.3	50.5	330	12.5	54.5
160	10.4	50.7	340	12.6	54.7
170	10.5	50.9	350	12.7	54.9
180	10.6	51.1	360	12.9	55.2

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-83
Survey #2 05/31/81



TEMPERATURE LOG

S-GV-81-83

T. 31 N., R. 40 E., SE 1/4 of NE 1/4, Sec. 7

Hole completed 5/19/81

Survey #3 9/03/81 3:00 PM

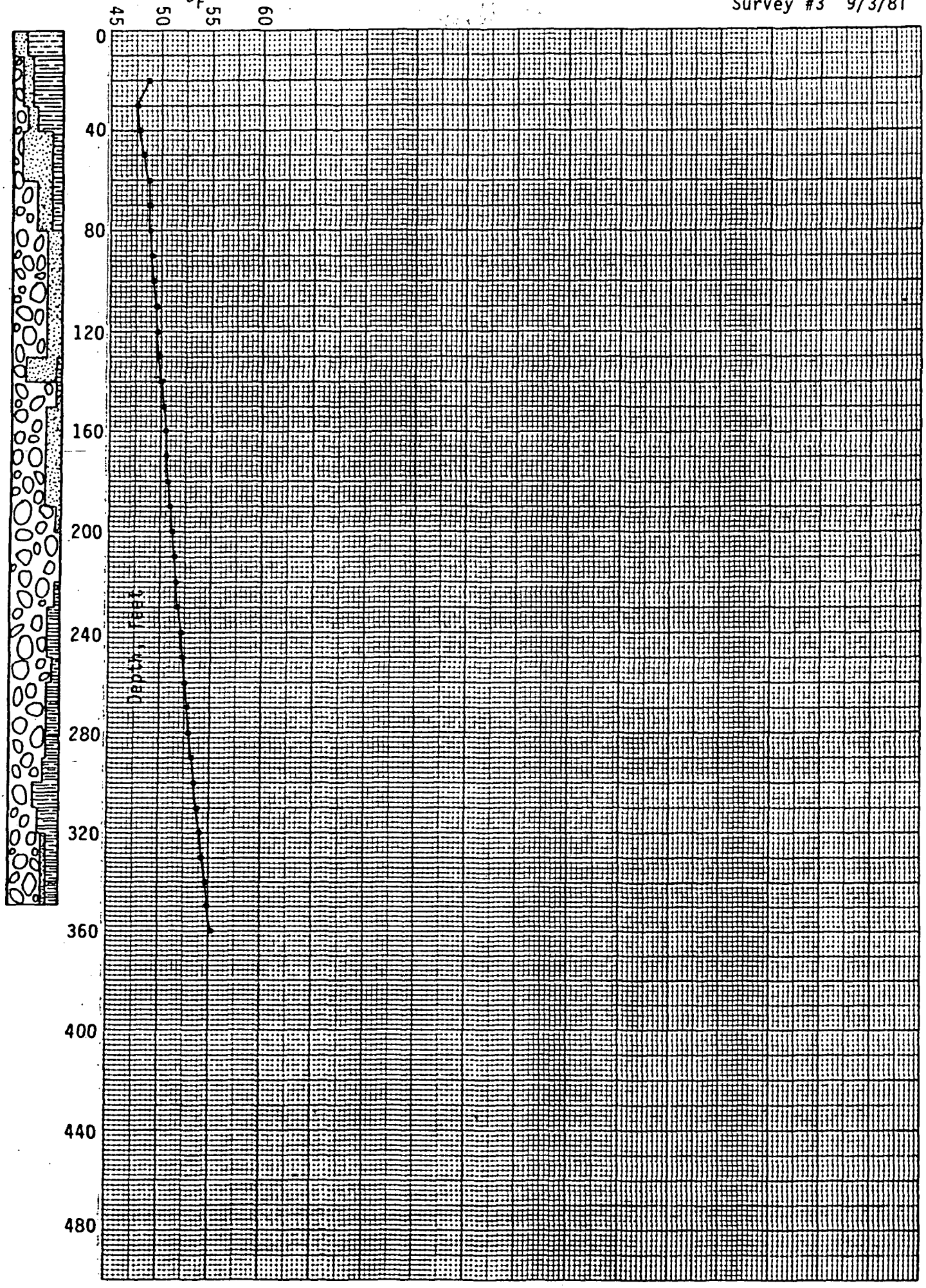
Elevation 5,860 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	--	--	190	10.5	50.9
20	9.2	48.6	200	10.6	51.1
30	8.6	47.5	210	10.8	51.4
40	8.8	47.8	220	10.9	51.6
50	9.0	48.2	230	11.0	51.8
60	9.2	48.6	240	11.1	52.0
70	9.3	48.7	250	11.3	52.3
80	9.4	48.9	260	11.4	52.5
90	9.5	49.1	270	11.5	52.7
100	9.6	49.3	280	11.6	52.9
110	9.7	49.5	290	11.8	53.2
120	9.8	49.6	300	11.9	53.4
130	9.9	49.8	310	12.1	53.8
140	10.0	50.0	320	12.3	54.1
150	10.1	50.2	330	12.4	54.3
160	10.2	50.4	340	12.6	54.7
170	10.3	50.5	350	12.7	54.9
180	10.4	50.7	360	12.9	55.2

TEMPERATURE LOG - SUN, Panther Canyon

S-GV-81-83
Survey #3 9/3/81



TEMPERATURE LOG

S-GV-81-84

T. 31 N., R. 39 E., NW 1/4 of SW 1/4, Sec. 15

Hole completed 05/09/81

Survey #1 05/10/81

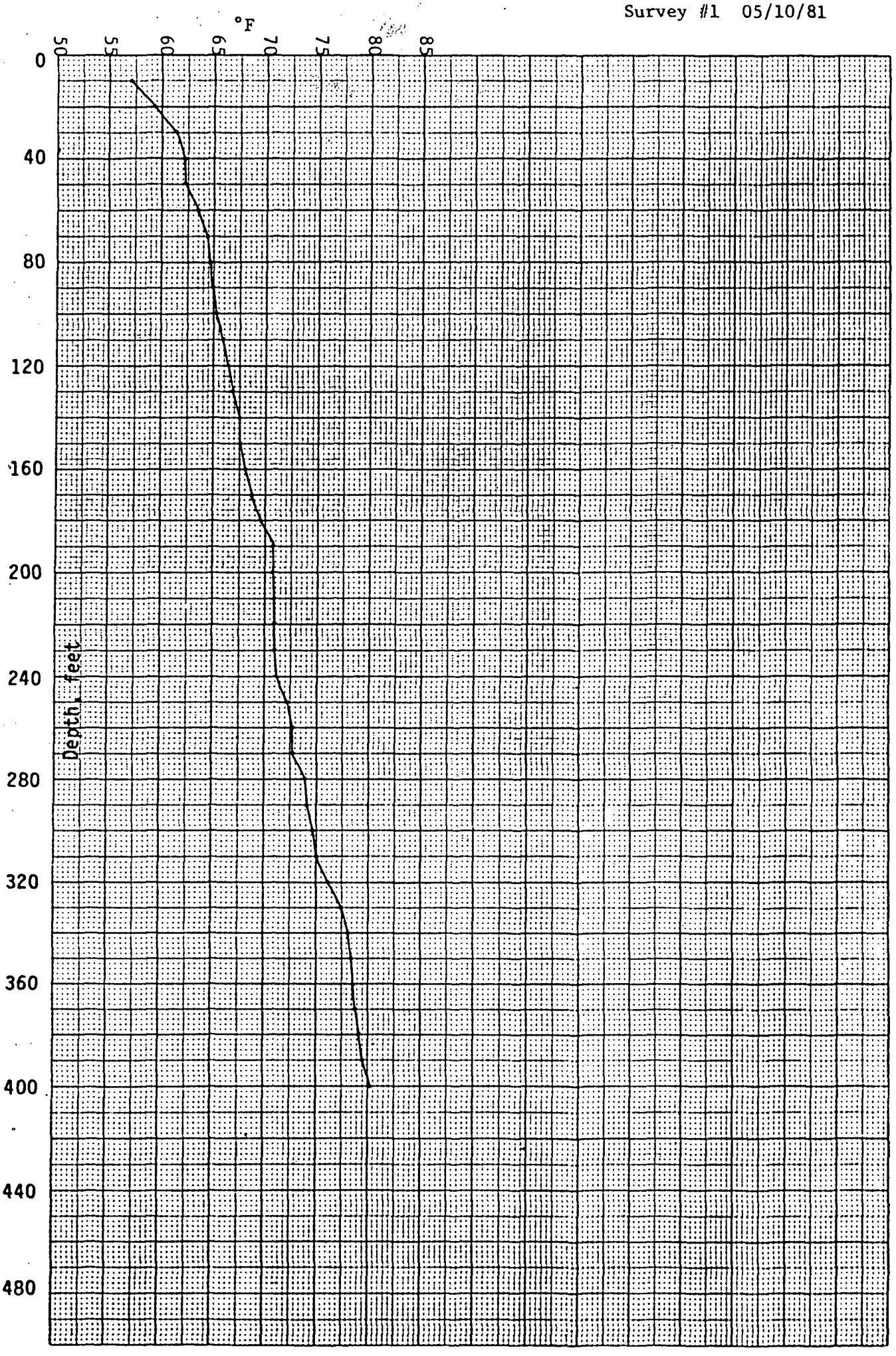
Elevation 5,040 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	13.9	57.0	210	21.6	70.9
20	15.2	59.4	220	21.6	70.9
30	16.5	61.7	230	21.5	70.9
40	16.8	62.2	240	21.7	71.1
50	16.8	62.2	250	22.4	72.3
60	17.5	63.5	260	22.6	72.7
70	18.0	64.4	270	22.6	72.7
80	18.2	64.7	280	23.2	73.8
90	18.3	64.9	290	23.4	74.1
100	18.5	65.3	300	23.7	74.7
110	18.9	66.0	310	23.9	75.0
120	19.1	66.4	320	24.5	76.1
130	19.3	66.7	330	25.2	77.4
140	19.7	67.5	340	25.6	78.1
150	19.8	67.6	350	25.8	78.4
160	20.0	68.0	360	25.9	78.6
170	20.4	68.7	370	26.0	78.8
180	20.9	69.6	380	26.2	79.2
190	21.5	70.7	390	26.4	79.5
200	21.5	70.7	400	26.7	80.1

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-84
Survey #1 05/10/81



TEMPERATURE LOG

S-GV-81-84

T. 31 N., R. 39 E., NW 1/4 of SW 1/4, Sec. 15

Hole completed 05/09/81

Survey #2 05/14/81

Elevation 5,040 feet

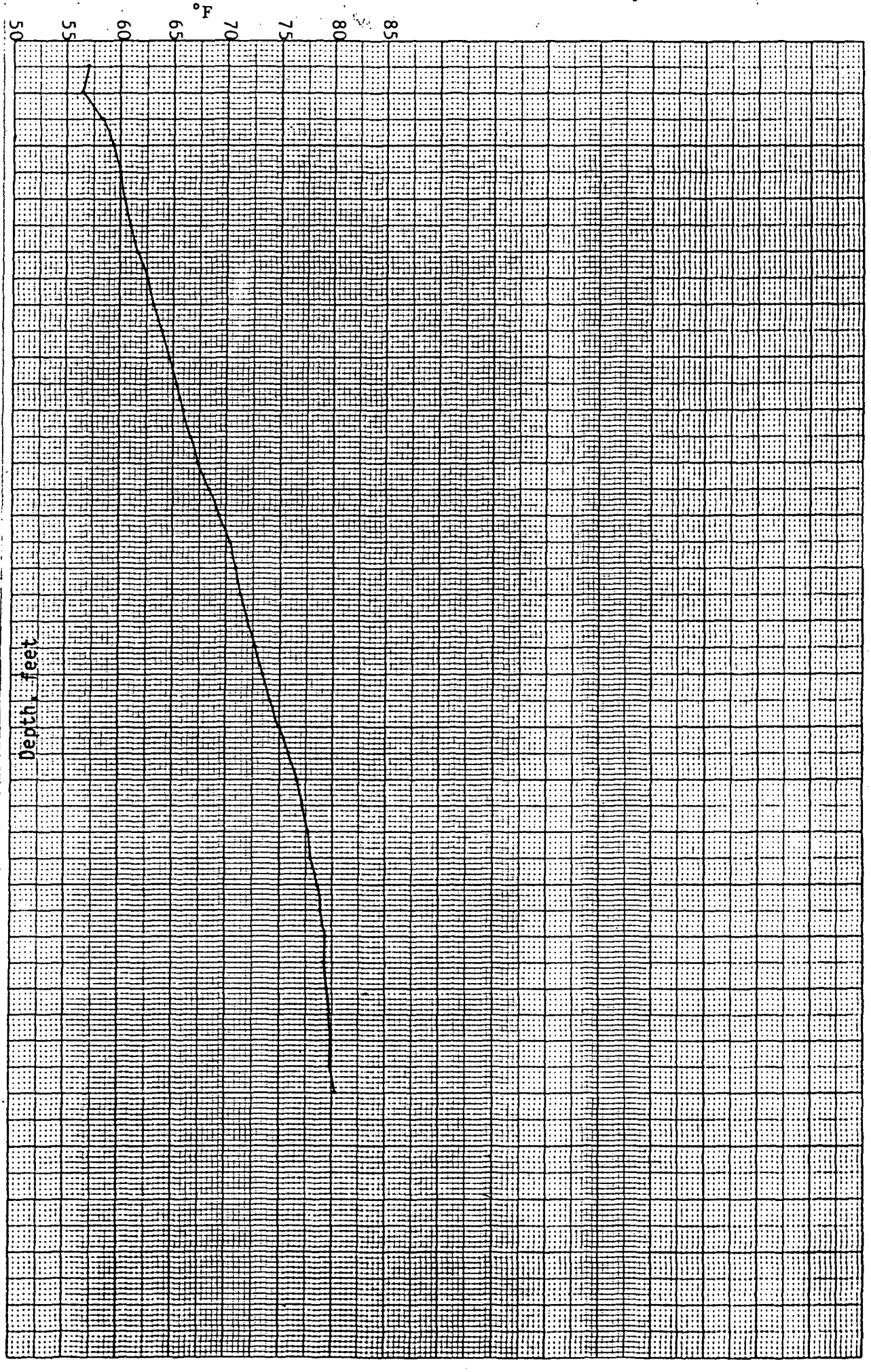
Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	13.9	57.0	210	21.9	71.4
20	13.6	56.5	220	22.2	72.0
30	14.6	58.3	230	22.6	72.7
40	15.2	59.4	240	23.0	73.4
50	15.5	60.0	250	23.4	74.1
60	15.8	60.4	260	23.9	75.0
70	16.1	61.0	270	24.4	75.9
80	16.5	61.7	280	24.8	76.6
90	17.0	62.6	290	25.1	77.2
100	17.3	63.1	300	25.4	77.7
110	17.7	63.9	310	25.5	77.9
120	18.1	64.6	320	25.9	78.6
130	18.5	65.3	330	26.0	78.8
140	18.9	66.0	340	26.3	79.3
150	19.2	66.6	350	26.3	79.3
160	19.6	67.3	360	26.4	79.5
170	20.2	68.4	370	26.5	79.7
180	20.8	69.4	380	26.6	79.9
190	21.2	70.2	390	26.6	79.9
200	21.6	70.9	400	26.8	80.2

Maximum reading thermometer: 83°F

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-84
Survey #2 05/14/81



TEMPERATURE LOG

S-GV-81-84

T. 31 N., R. 39 E., NW 1/4 of SW 1/4, Sec. 15

Hole completed 5/09/81

Survey #3 9/03/81 10:00 PM

Elevation 5,040 feet

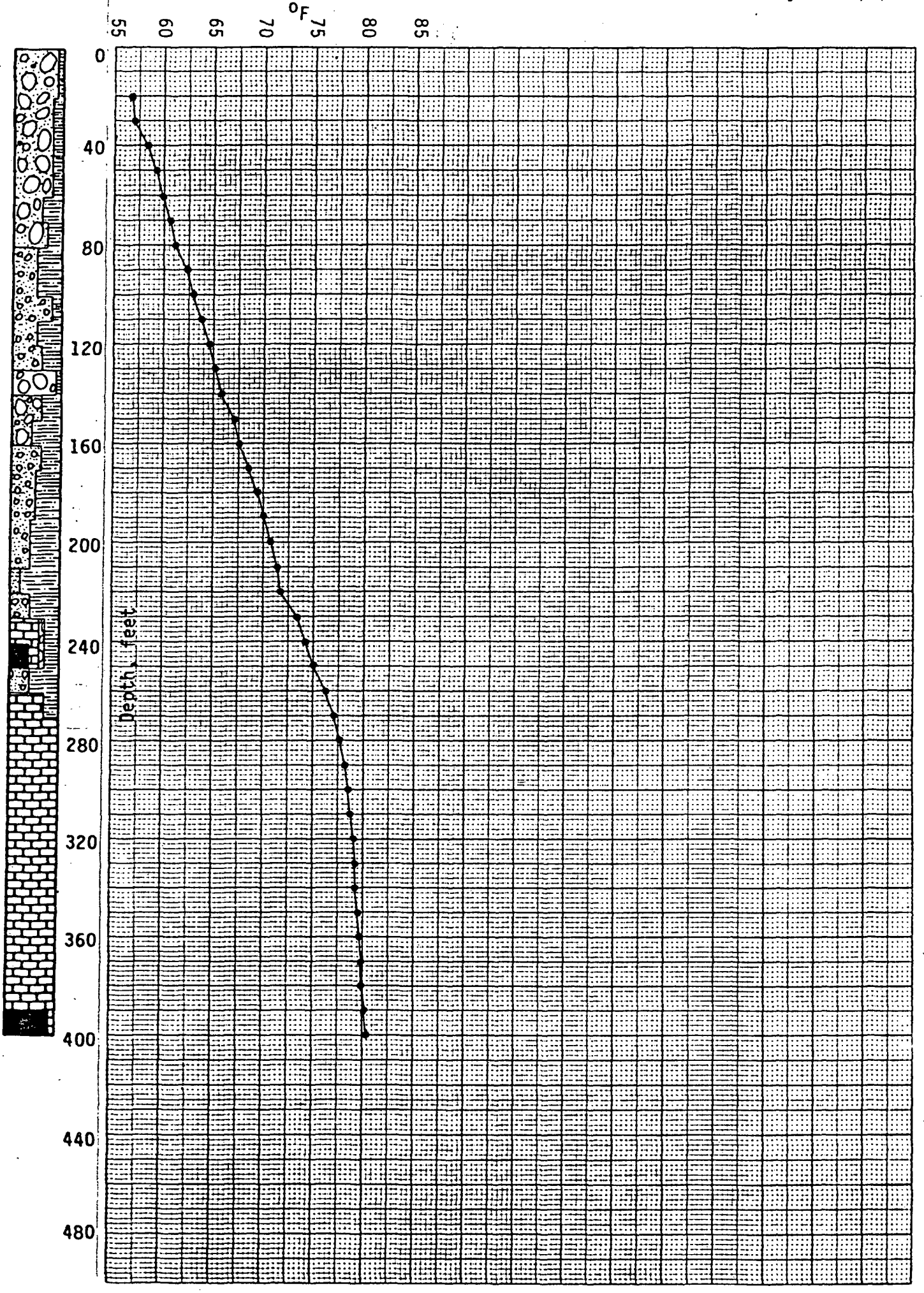
Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	--	--	210	21.9	71.4
20	13.7	56.7	220	22.1	71.8
30	13.9	57.0	230	23.0	73.4
40	14.6	58.3	240	23.5	74.3
50	15.1	59.2	250	23.9	75.0
60	15.5	59.9	260	24.6	76.3
70	15.9	60.6	270	25.0	77.0
80	16.3	61.3	280	25.3	77.5
90	16.8	62.2	290	25.6	78.1
100	17.2	63.0	300	25.8	78.4
110	17.6	63.7	310	26.0	78.8
120	18.0	64.4	320	26.1	79.0
130	18.4	65.1	330	26.2	79.2
140	18.8	65.8	340	26.3	79.3
150	19.5	67.1	350	26.4	79.5
160	19.8	67.6	360	26.5	79.7
170	20.2	68.4	370	26.6	79.9
180	20.7	69.3	380	26.6	79.9
190	21.1	70.0	390	26.7	80.1
200	21.5	70.7	400	26.9	80.4

Maximum reading thermometer: 81°F (27.2°C)

TEMPERATURE LOG - SUN, Panther Canyon

S-GV-81-84
Survey #3 9/3/81



TEMPERATURE LOG

S-GV-81-86

T. 31 N., R. 39 E., SE 1/4 of NE 1/4, Sec. 13

Hole completed 03/28/81

Survey #1 03/29/81

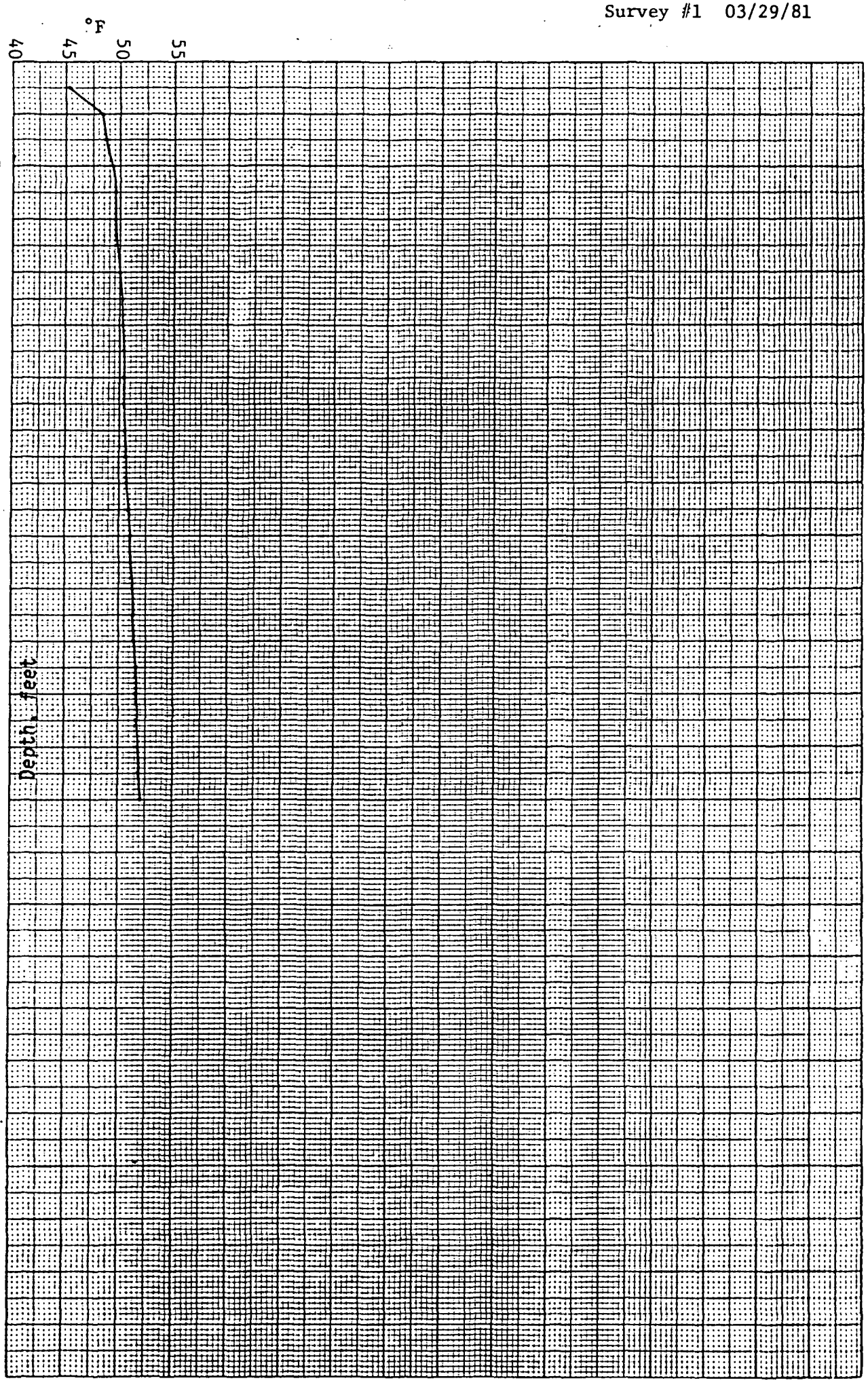
Elevation 5,590 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	7.4	45.3	150	10.4	50.7
20	9.1	48.4	160	10.4	50.7
30	9.3	48.7	170	10.5	50.9
40	9.6	49.3	180	10.6	51.1
50	9.8	49.6	190	10.6	51.1
60	9.8	49.6	200	10.7	51.3
70	9.9	49.8	210	10.7	51.3
80	10.0	50.0	220	10.8	51.4
90	10.1	50.2	230	10.9	51.6
100	10.2	50.4	240	10.9	51.6
110	10.2	50.4	250	10.9	51.6
120	10.2	50.4	260	11.0	51.8
130	10.2	50.4	270	11.0	51.8
140	10.3	50.5	280	11.1	52.0

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-86
Survey #1 03/29/81



TEMPERATURE LOG

S-GV-81-86

T. 31 N., R. 39 E., SE 1/4 of NE 1/4, Sec. 13

Hole completed 03/28/81

Survey #2 04/29/81

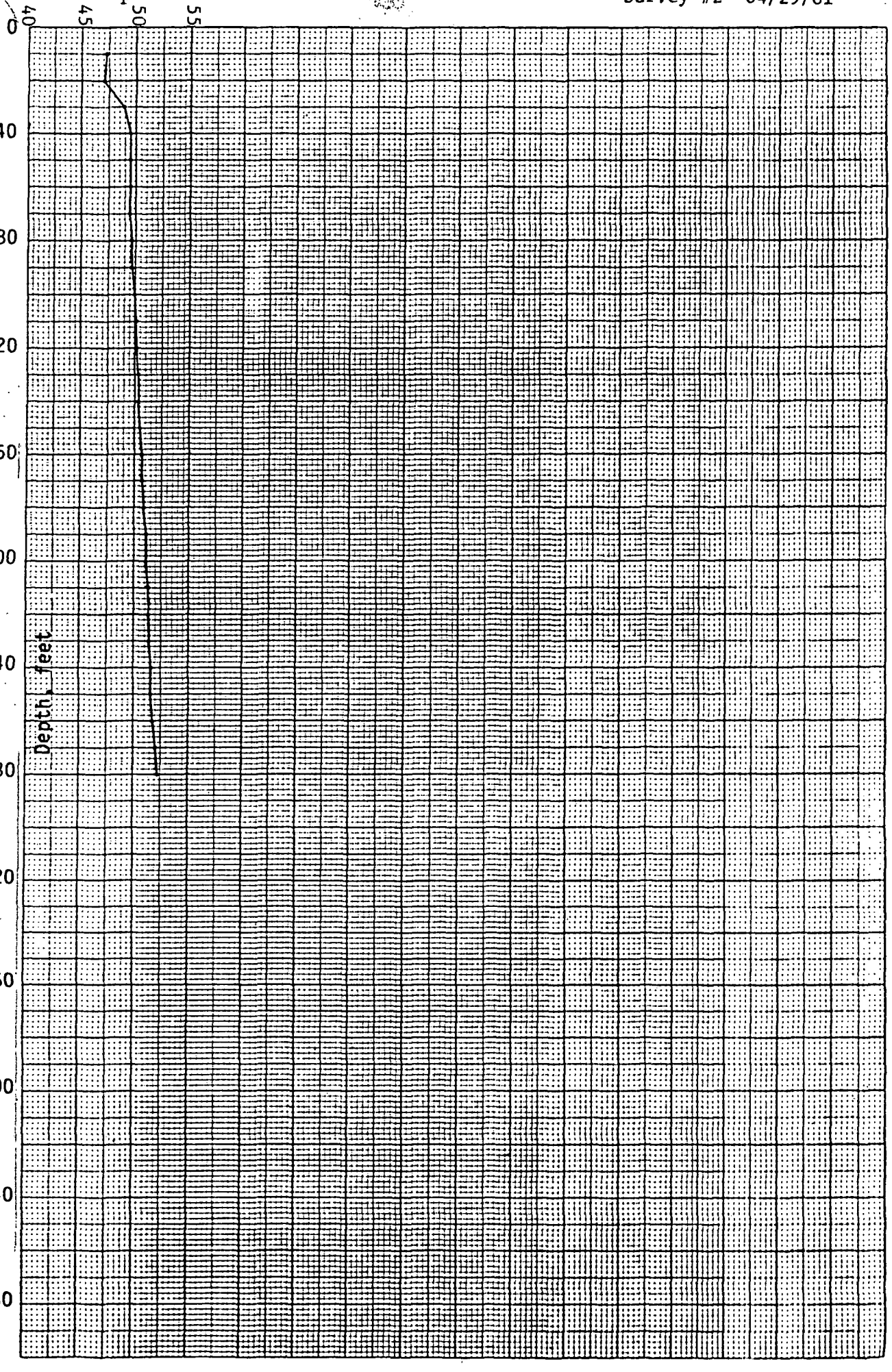
Elevation 5,590 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	8.5	47.3	150	10.3	50.5
20	8.4	47.1	160	10.4	50.7
30	9.4	48.9	170	10.4	50.7
40	9.7	49.5	180	10.5	50.9
50	9.7	49.5	190	10.6	51.1
60	9.7	48.5	200	10.6	51.1
70	9.7	49.5	210	10.7	51.3
80	9.8	49.6	220	10.8	51.4
90	9.9	49.8	230	10.8	51.4
100	10.0	50.0	240	10.9	51.6
110	10.1	50.2	250	10.9	51.6
120	10.1	50.2	260	11.0	51.8
130	10.2	50.4	270	11.1	52.0
140	10.2	50.4	280	11.2	52.2

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-86
Survey #2 04/29/81



TEMPERATURE LOG

S-GV-81-86

T. 31 N., R. 39 E., SE 1/4 of NE 1/4, Sec. 13

Hole completed 03/28/81

Survey #3 9/03/81 1:30 PM

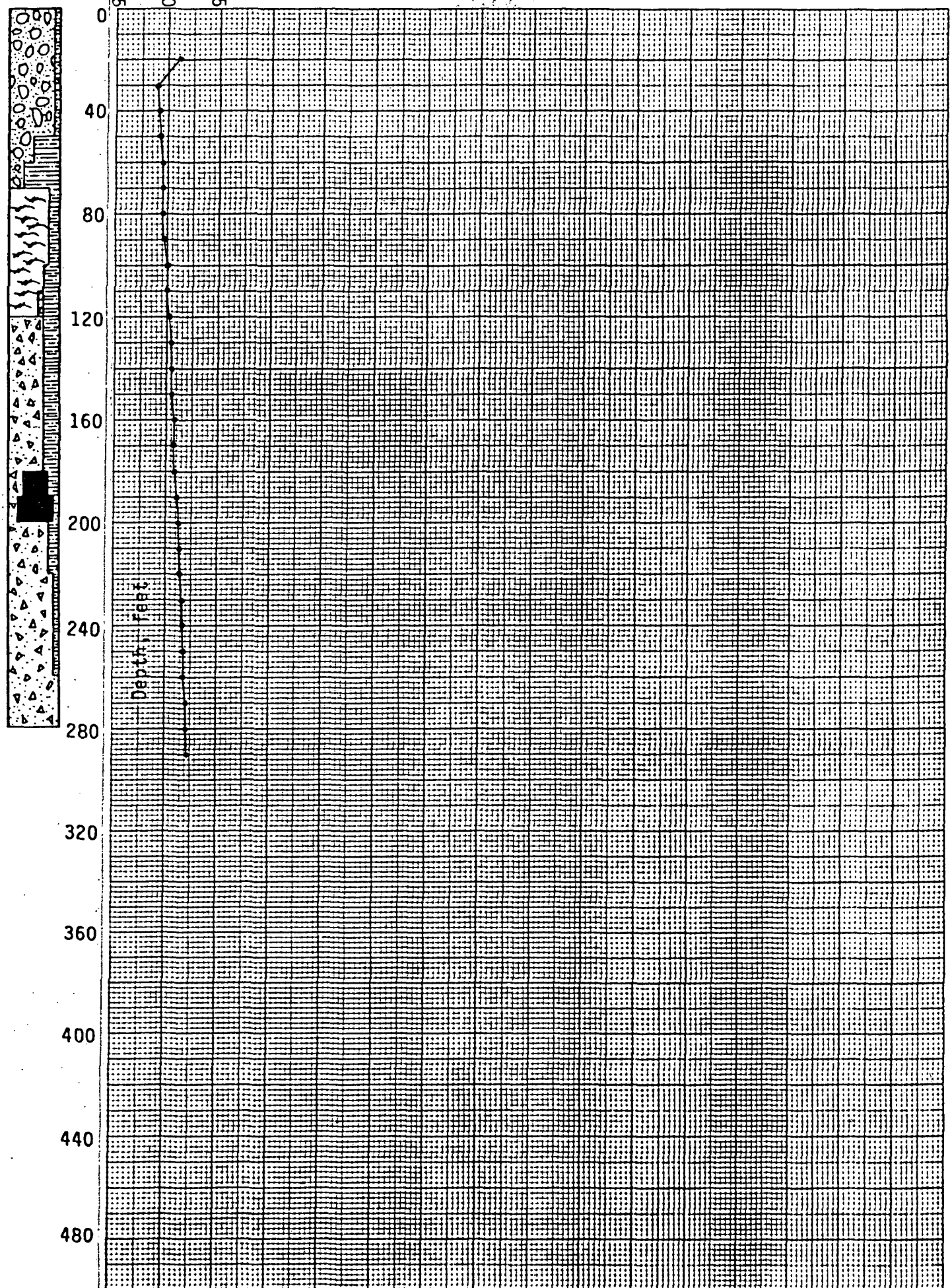
Elevation 5,590 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	--	--	150	10.3	50.5
20	10.6	51.1	160	10.4	50.7
30	9.4	48.9	170	10.4	50.7
40	9.5	49.1	180	10.5	50.9
50	9.6	49.3	190	10.6	51.1
60	9.7	49.5	200	10.7	51.3
70	9.8	49.6	210	10.8	51.4
80	9.8	49.6	220	10.8	51.4
90	9.9	49.8	230	10.9	51.6
100	10.0	50.0	240	10.9	51.6
110	10.0	50.0	250	11.0	51.8
120	10.1	50.2	260	11.0	51.8
130	10.2	50.4	270	11.1	52.0
140	10.3	50.5	280	11.1	52.0
			290	11.2	52.2

TEMPERATURE LOG - SUN, Panther Canyon

S-GV-81-86
Survey #3 9/3/81



TEMPERATURE LOG

S-GV-81-88

T. 31 N., R. 39 E., SW 1/4 of SW 1/4, Sec. 26

Hole completed 05/01/81

Survey #1 05/02/81

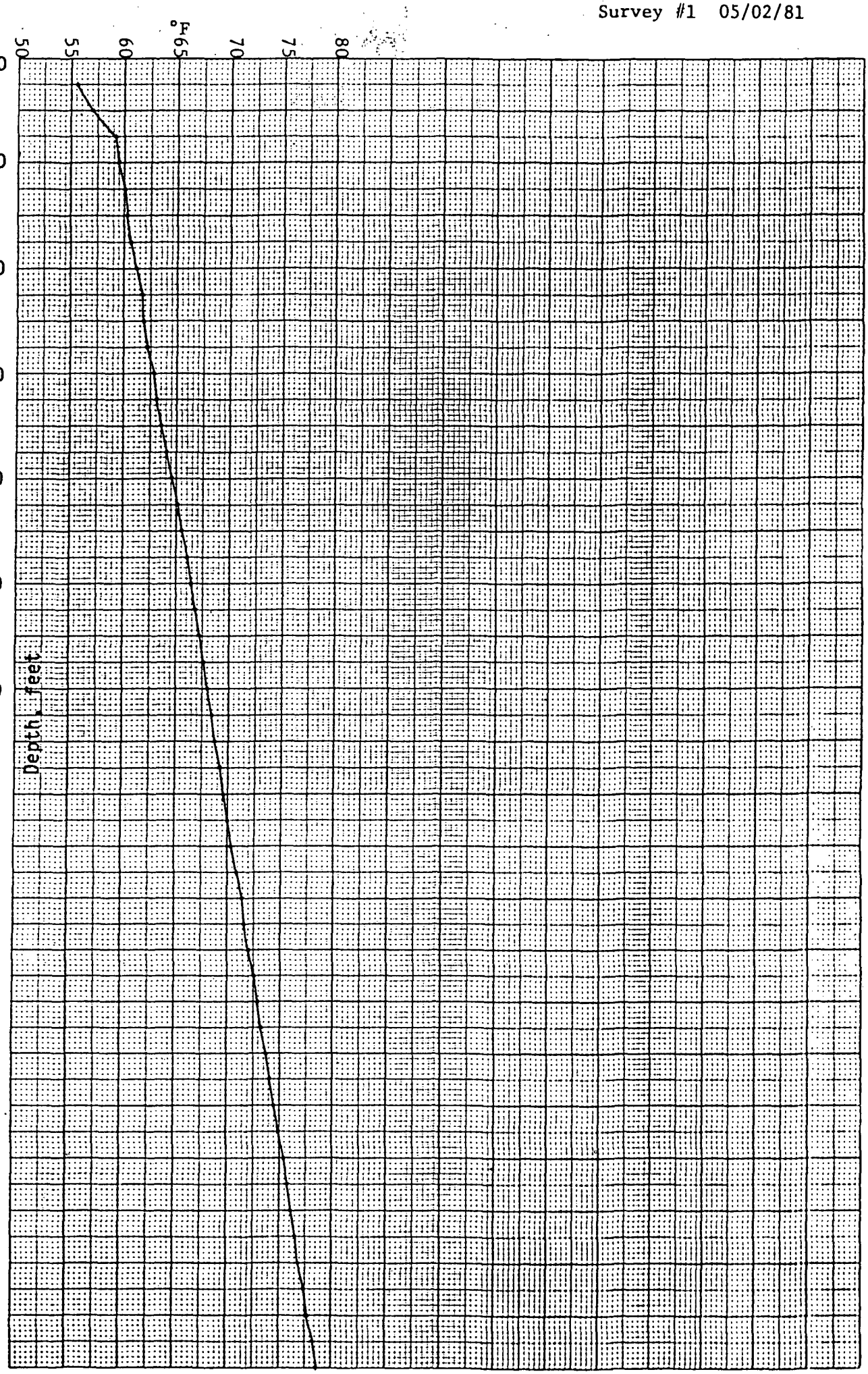
Elevation 5,180 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	13.1	55.6	260	20.4	68.7
20	13.9	57.0	270	20.7	69.3
30	15.1	59.2	280	20.9	69.6
40	15.3	59.5	290	21.1	70.0
50	15.6	60.1	300	21.3	70.3
60	15.7	60.3	310	21.6	70.9
70	15.9	60.6	320	21.8	71.4
80	16.2	61.2	330	22.0	71.6
90	16.5	61.7	340	22.3	72.1
100	16.6	61.9	350	22.5	72.5
110	16.8	62.2	360	22.7	72.9
120	17.1	62.8	370	22.9	73.2
130	17.3	63.1	380	23.2	73.8
140	17.5	63.5	390	23.4	74.1
150	17.8	64.0	400	23.6	74.5
160	18.1	64.6	410	23.9	75.0
170	18.4	65.1	420	24.1	75.4
180	18.6	65.5	430	24.3	75.7
190	18.9	66.0	440	24.5	76.1
200	19.1	66.4	450	24.7	76.5
210	19.3	66.7	460	24.9	76.8
220	19.6	67.3	470	25.2	77.4
230	19.8	67.6	480	25.4	77.7
240	20.0	68.0	490	25.7	78.3
250	20.2	68.4	500	25.9	78.6

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-88
Survey #1 05/02/81



TEMPERATURE LOG

S-GV-81-88

T. 31 N., R. 39 E., SW 1/4 of SW 1/4, Sec. 26

Hole completed 05/01/81

Survey #2 05/05/81

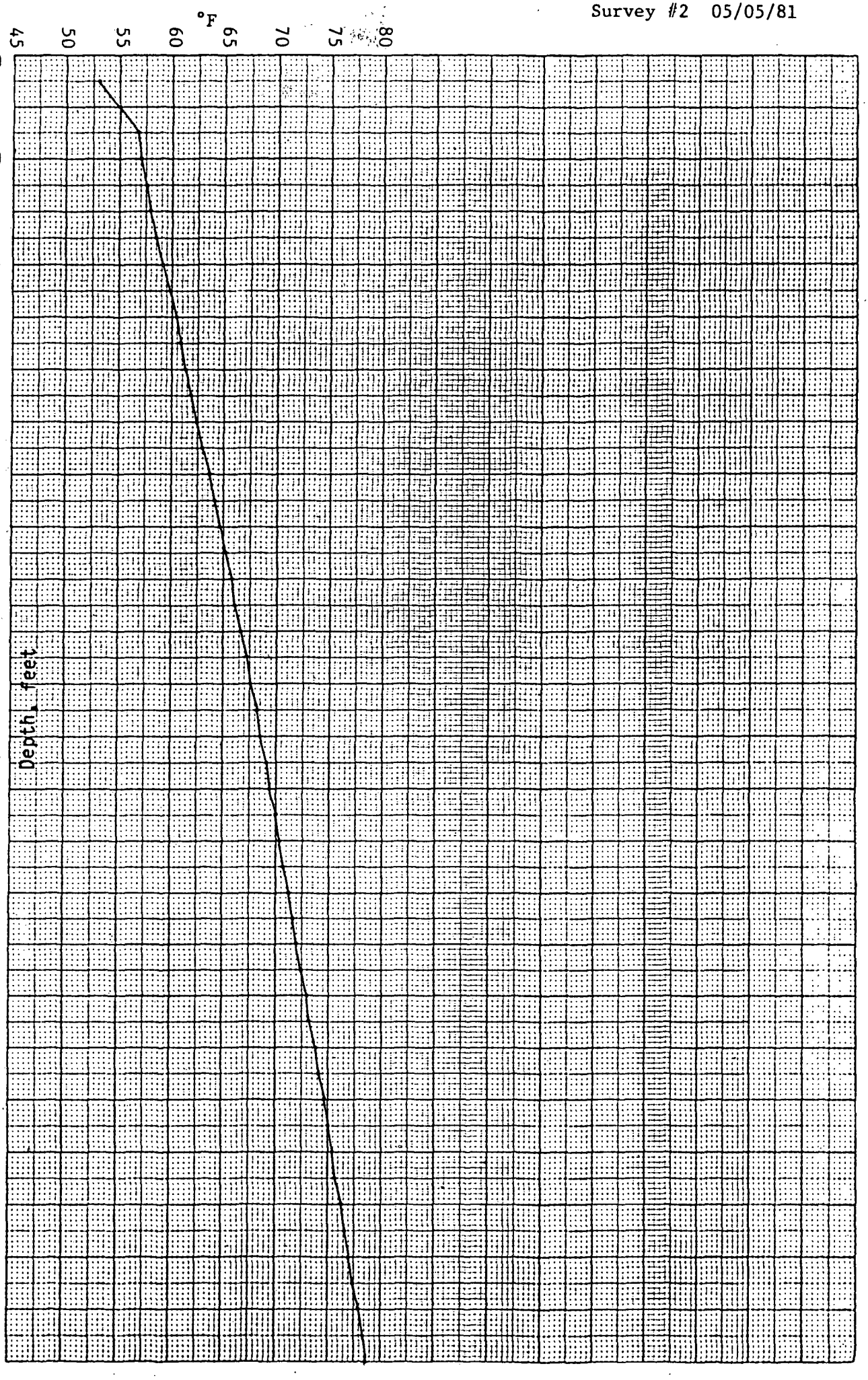
Elevation 5,180 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	11.7	53.1	260	20.3	68.5
20	12.8	55.0	270	20.6	69.1
30	13.7	56.7	280	20.8	69.4
40	13.9	57.0	290	21.1	70.0
50	14.2	57.6	300	21.3	70.3
60	14.4	57.9	310	21.5	70.7
70	14.7	58.5	320	21.8	71.2
80	15.1	59.1	330	22.0	71.6
90	15.5	59.9	340	22.2	72.0
100	15.8	60.4	350	22.5	72.5
110	16.0	60.8	360	22.7	72.9
120	16.3	61.3	370	22.9	73.2
130	16.6	61.9	380	23.2	73.7
140	16.9	62.4	390	23.4	74.1
150	17.2	63.0	400	23.7	74.7
160	17.6	63.7	410	23.9	75.0
170	17.9	64.2	420	24.1	75.4
180	18.2	64.8	430	24.3	75.7
190	18.5	65.3	440	24.6	76.3
200	18.8	65.8	450	24.8	76.6
210	19.0	66.2	460	25.0	77.0
220	19.3	66.7	470	25.2	77.4
230	19.6	67.3	480	25.5	77.9
240	19.8	67.6	490	25.7	78.3
250	20.1	68.2	500	25.9	78.6

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-88
Survey #2 05/05/81



TEMPERATURE LOG

S-GV-81-88

T. 31 N., R. 39 E., SW 1/4 of SW 1/4, Sec. 26

Hole completed 5/01/81

Survey #3 9/03/81 6:30 PM

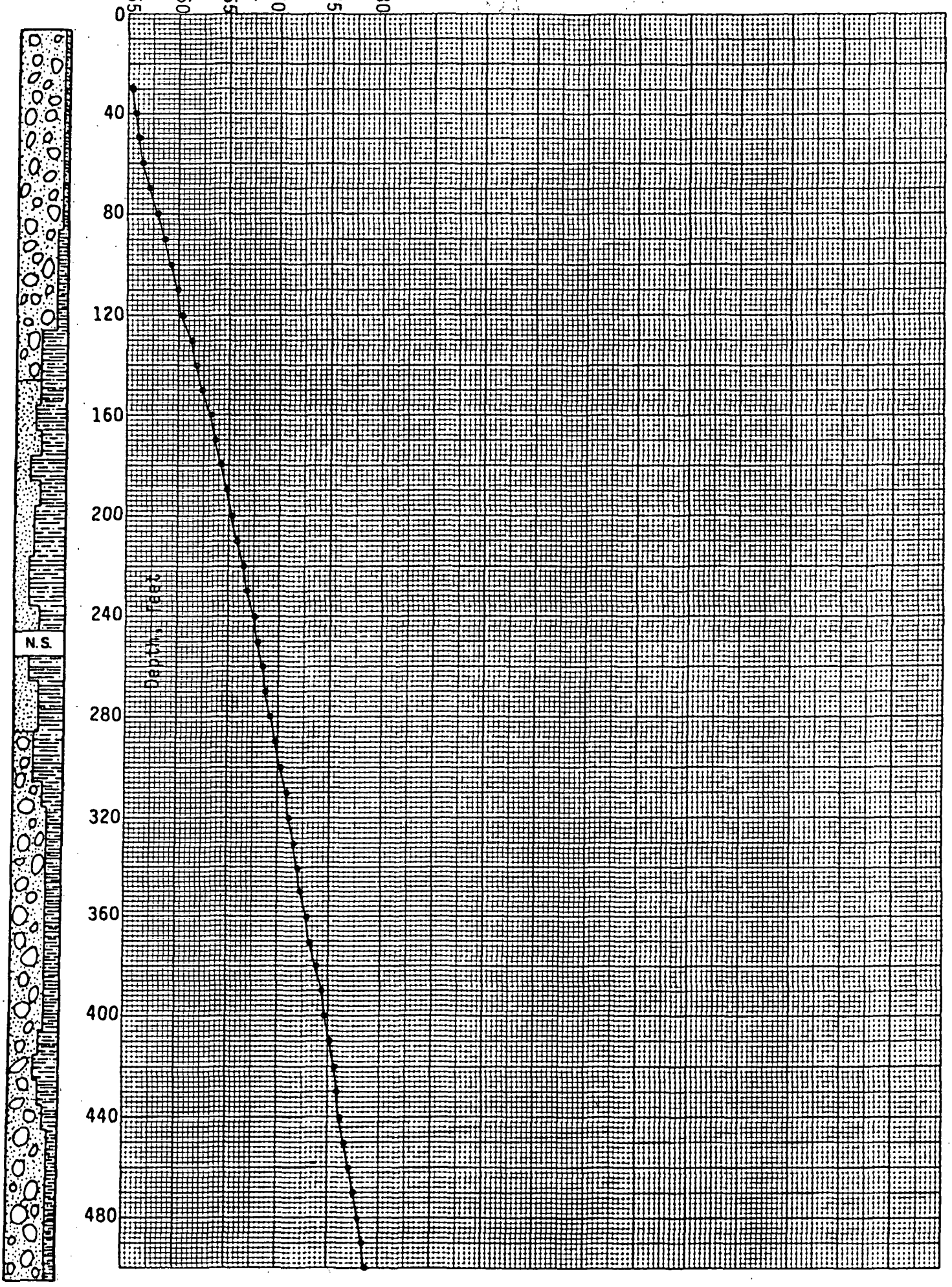
Elevation 5,180 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	--	--	260	20.2	68.4
20	--	--	270	20.4	68.7
30	12.9	55.2	280	20.7	69.3
40	13.2	55.8	290	21.0	69.8
50	13.4	56.1	300	21.2	70.2
60	13.6	56.5	310	21.5	70.7
70	14.0	57.2	320	21.8	71.2
80	14.4	57.9	330	22.0	71.6
90	14.8	58.6	340	22.2	72.0
100	15.1	59.2	350	22.4	72.3
110	15.5	59.9	360	22.7	72.9
120	15.8	60.4	370	22.9	73.2
130	16.2	61.2	380	23.2	73.8
140	16.5	61.7	390	23.5	74.3
150	16.8	62.2	400	23.7	74.7
160	17.2	63.0	410	24.0	75.2
170	17.5	63.5	420	24.2	75.6
180	17.9	64.2	430	24.4	75.9
190	18.2	64.8	440	24.6	76.3
200	18.5	65.3	450	24.8	76.6
210	18.8	65.8	460	25.1	77.2
220	19.1	66.4	470	25.3	77.5
230	19.4	66.9	480	25.5	77.9
240	19.7	67.5	490	25.8	78.4
250	19.9	67.8	500	26.0	78.8

TEMPERATURE LOG - SUN, Panther Canyon

S-GV-81-88
Survey #3 9/3/81



TEMPERATURE LOG

S-GV-81-90

T. 31 N., R. 39 E., SE 1/4 of SW 1/4, Sec. 31

Hole completed 05/16/81

Survey #1 05/18/81

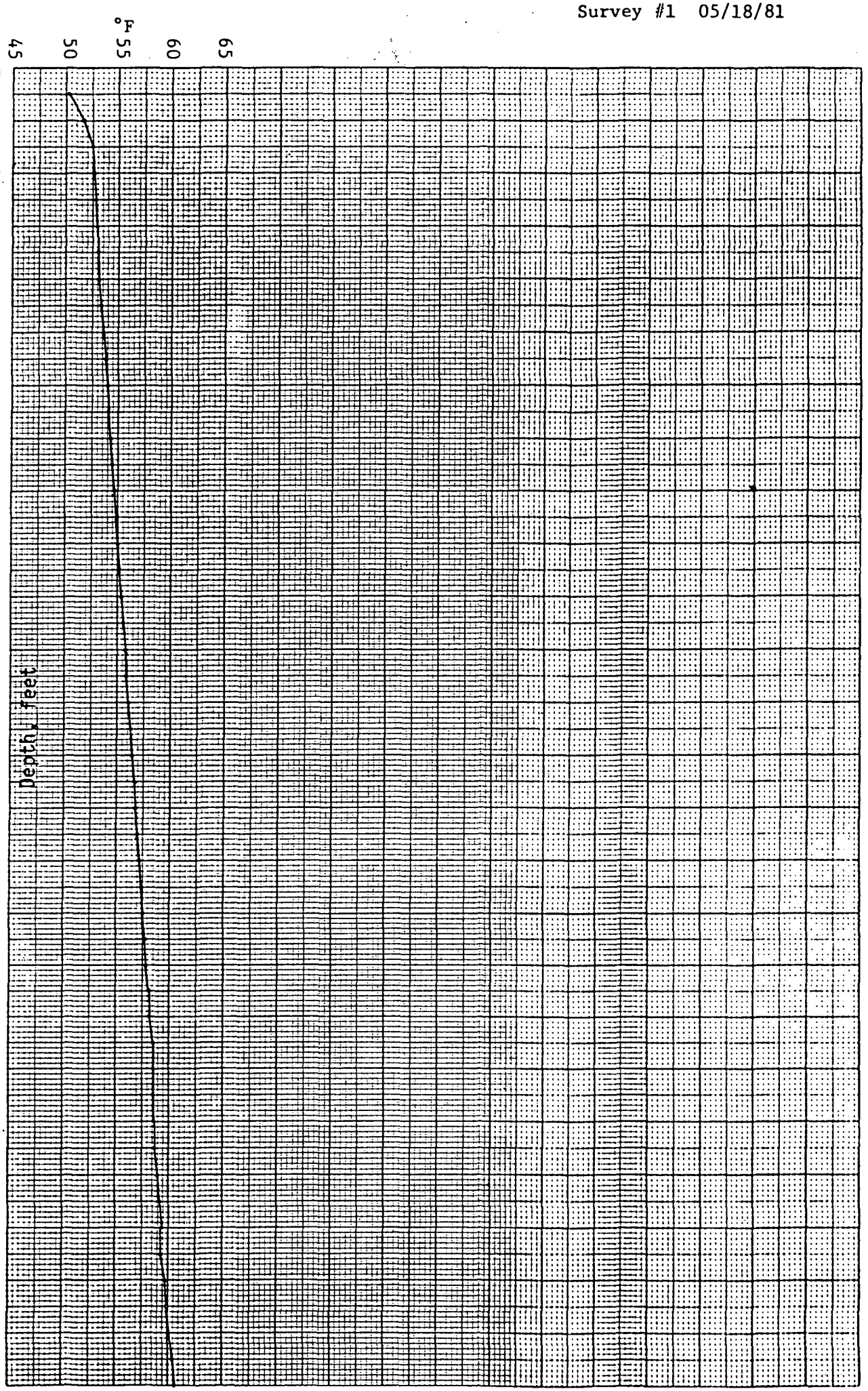
Elevation 5,000 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	10.1	50.2	260	13.6	56.5
20	10.9	51.6	270	13.7	56.7
30	11.4	52.5	280	13.8	56.8
40	11.5	52.7	290	13.9	57.0
50	11.6	52.9	300	14.0	57.2
60	11.6	52.9	310	14.1	57.4
70	11.7	53.1	320	14.2	57.6
80	11.8	53.2	330	14.3	57.7
90	11.9	53.4	340	14.4	57.9
100	12.0	53.6	350	14.5	58.1
110	12.1	53.8	360	14.6	58.3
120	12.2	54.0	370	14.7	58.5
130	12.3	54.1	380	14.7	58.5
140	12.4	54.3	390	14.8	58.6
150	12.5	54.5	400	14.8	58.6
160	12.6	54.7	410	14.9	58.8
170	12.7	54.9	420	15.0	59.0
180	12.8	55.0	430	15.1	59.2
190	12.9	55.2	440	15.2	59.4
200	13.0	55.4	450	15.3	59.4
210	13.1	55.6	460	15.4	59.7
220	13.2	55.8	470	15.5	59.9
230	13.3	55.9	480	15.6	60.1
240	13.4	56.1	490	15.8	60.4
250	13.5	56.3	500	15.9	60.6

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-90
Survey #1 05/18/81



TEMPERATURE LOG

S-GV-81-90

T. 31 N., R. 39 E., SE 1/4 of SW 1/4, Sec. 31

Hole completed 05/16/81

Survey #2 05/28/81

Elevation 5,000 feet

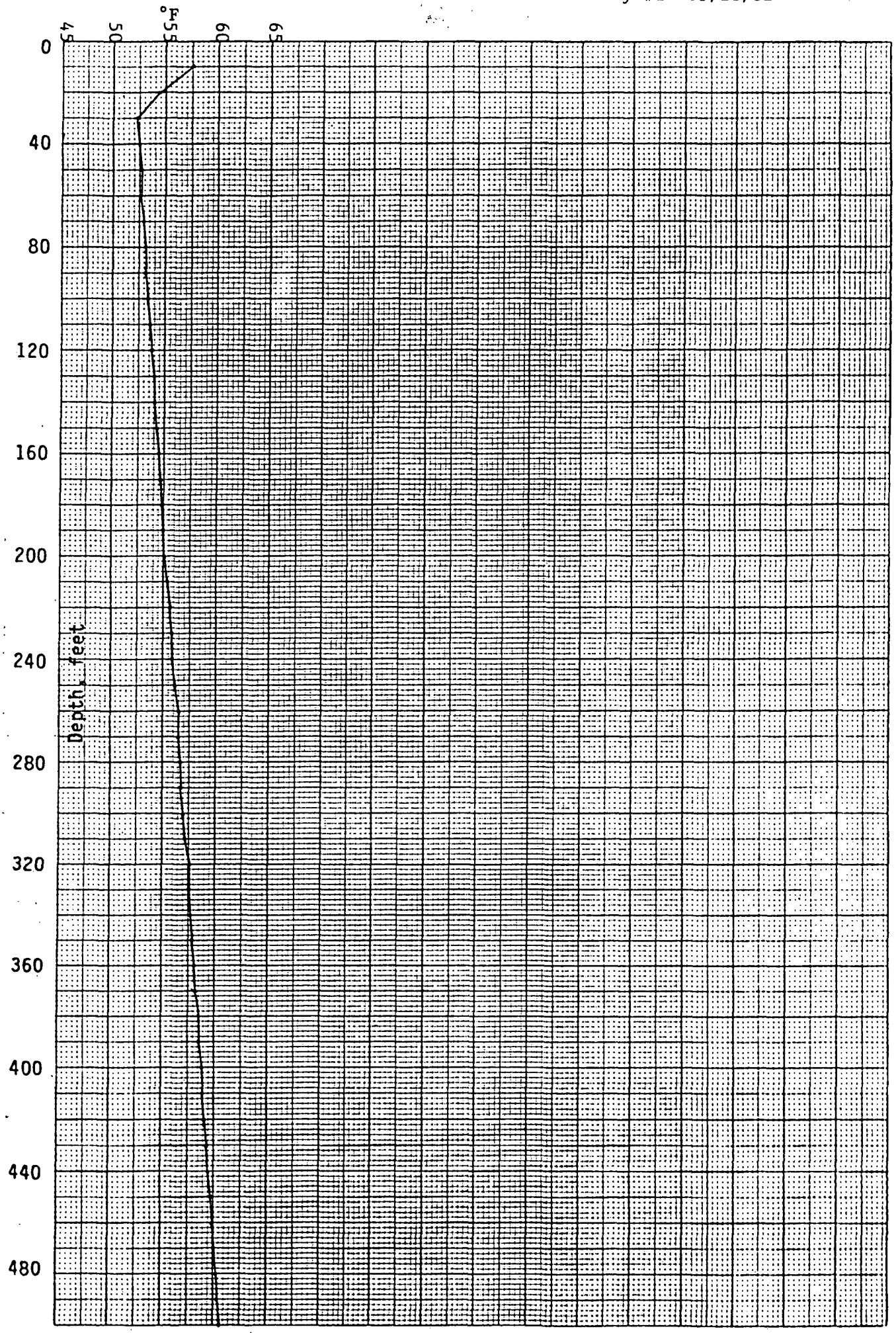
Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	14.2	57.6	260	13.6	56.5
20	12.5	54.5	270	13.6	56.5
30	11.3	52.3	280	13.7	56.7
40	11.4	52.5	290	13.8	56.8
50	11.5	52.7	300	13.9	57.0
60	11.5	52.7	310	14.0	57.2
70	11.6	52.9	320	14.2	57.6
80	11.7	53.1	330	14.2	57.6
90	11.8	53.2	340	14.3	57.7
100	11.9	53.4	350	14.4	57.9
110	12.0	53.6	360	14.5	58.1
120	12.1	53.8	370	14.6	58.3
130	12.2	54.0	380	14.7	58.5
140	12.3	54.1	390	14.8	58.6
150	12.4	54.3	400	14.9	58.8
160	12.5	54.5	410	15.0	59.0
170	12.6	54.7	420	15.1	59.2
180	12.7	54.9	430	15.2	59.4
190	12.8	55.0	440	15.3	59.5
200	12.9	55.2	450	15.4	59.7
210	13.0	55.4	460	15.5	59.9
220	13.1	55.6	470	15.6	60.1
230	13.2	55.8	480	15.7	60.3
240	13.3	55.9	490	15.8	60.4
250	13.4	56.1	500	15.9	60.4

Maximum reading thermometer: 75°F

TEMPERATURE LOG -- SUN-PANTHER CANYON

S-GV-81-90
Survey #2 05/28/81



TEMPERATURE LOG

S-GV-81-90

T. 31 N., R. 39 E., SE 1/4 of SW 1/4, Sec. 31

Hole completed 05/16/81

Survey #3 9/03/81 6:15 PM

Elevation 5,000 feet

Logged by GeothermEx, Inc.

Depth, in feet	°C	°F	Depth, in feet	°C	°F
10	--	--	260	13.5	56.3
20	11.7	53.1	270	13.6	56.5
30	11.4	52.5	280	13.7	56.7
40	11.2	52.2	290	13.8	56.8
50	11.3	52.3	300	13.9	57.0
60	11.4	52.5	310	14.0	57.2
70	11.5	52.7	320	14.1	57.4
80	11.6	52.9	330	14.2	57.6
90	11.7	53.1	340	14.3	57.7
100	11.8	53.2	350	14.4	57.9
110	11.9	53.4	360	14.5	58.1
120	12.0	53.6	370	14.7	58.5
130	12.1	53.8	380	14.8	58.6
140	12.2	54.0	390	14.9	58.8
150	12.3	54.1	400	15.0	59.0
160	12.4	54.3	410	15.1	59.2
170	12.5	54.5	420	15.2	59.4
180	12.4	54.3	430	15.3	59.5
190	12.7	54.9	440	15.3	59.5
200	12.8	55.0	450	15.4	59.7
210	12.9	55.2	460	15.5	59.9
220	13.0	55.4	470	15.6	60.1
230	13.2	55.8	480	15.7	60.3
240	13.3	55.9	490	15.8	60.4
250	13.4	56.1	498	15.9	60.6

TEMPERATURE LOG - SUN, Panther Canyon

S-GV-81-90
Survey #3 9/3/81