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TEMPERATURE-GRADIENT

AND HEAT-FLOW DATA

GRASS VALLEY, NEVADA

for

SUNOCO ENERGY DEVELOPMENT CO.

Dallas, Texas

by

GeothermEx, Inc.
Berkeley, California

November, 1979

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INTRODUCTION

A series of 16 shallow and intermediate-depth temperature-gradient holes were drilled for Sunoco Energy Development Co. in Grass Valley, Pershing County, Nevada, on leases held by Aminoil USA, Inc., under the cost-sharing industry-linked program of the Department of Energy. Thirteen shallow (85-152 m) and 3 intermediate-depth (360-457 m) holes were completed and logged during the period June through September, 1979. The locations of these holes and of pre-existing temperature-gradient holes are shown on plate 1. This report constitutes a final data transmittal and disclosure of results.

The drilling subcontractor was Southwest Drilling and Exploration, Inc. of Central, Utah. They provided a Gardner-Denver 15W rig, a 3-man crew, and supporting equipment. All holes were drilled with mud as the circulating medium. Drilling histories for each hole are summarized in table 1.

GeothermEx, Inc. performed on-site geological descriptions of the cuttings; obtained several temperature profiles for each hole, including an equilibrium profile taken 23 days or more after cessation of drilling; selected samples for thermal conductivity measurements; integrated temperature, temperature-gradient, and heat-flow data obtained in this project with published values; and prepared this report.

GEOLOGY

Grass Valley is bounded on the east by the Sonoma and Tobin Ranges and on the west by the Goldbanks Hills and the East Range. The geology of the area has been summarized by Beyer et al. (1976). Exposed bedrock in the project area ranges from Lower Paleozoic sediments to Tertiary basaltic and rhyolitic volcanics. The center of Grass Valley contains a thick layer of unconsolidated Quaternary and Tertiary alluvium.

Noble (1975) performed photogeologic interpretation of Grass Valley and identified numerous faults and scarps within the project area.

Lithologic logs and descriptions for each hole drilled in this project are given in Appendixes A and B. Only hole S-GV-79-105

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Table 1

Drilling Histories of Temperature-Gradient Holes, Grass Valley, Nevada
Sunoco Energy Development Co.

Shallow Holes

S-GV-79-2
Spud: 7/15/79
Complete: 7/16/79
TD: 500 feet

Some difficulty with caving by gravel was reported for upper 120 feet of hole.

S-GV-79-3
Spud: 6/15/79
Complete: 6/18/79
TD: 500 feet

S-GV-79-4
Spud: 7/17/79
Complete: 7/18/79
TD: 500 feet

From 340-500 feet, hole was making its own mud. Insignificant amount of returns dropping out of mud.

S-GV-79-5
Spud: 6/19/79
Complete: 6/19/79
TD: 80 feet

Much caving from 20 to 80 feet. Lost circulation at 80 feet. Moved drill rig 80 yards west to site 5A.

S-GV-79-5A
Spud: 6/19/79
Complete: 6/21/79
TD: 500 feet

S-GV-79-7
Spud: 6/21/79
Complete: 6/23/79
TD: 282 feet

Small lost circulation zone at 60 feet. Hole completed at 282 feet because of junk lost in hole.

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S-GV-79-8
Spud: 6/28/79
Complete: 6/29/79
TD: 500 feet

S-GV-79-9
Spud: 6/30/79
Complete: 7/2/79
TD: 440 feet

Very hard drilling reported in zones 220-300 feet and also from 400 to 440 feet.

S-GV-79-10
Spud: 7/2/79
Complete: 7/5/79
TD: 500 feet

Very hard drilling reported in zones 343-420 feet. Note that hole was suspended for one day during drilling (July 4 holiday).

S-GV-79-11
Spud: 7/7/79
Complete: 7/8/79
TD: 500 feet

Top 200 feet of hole tended to cave. Lost circulation zone at about 240 feet. In zone 260-320 feet, continued lost circulation and caving.

S-GV-79-12
Spud: 7/6/79
Complete: 7/7/79
TD: 500 feet

In zone 100-200 feet, there were almost no returns, but hole was making its own mud.

S-GV-79-13
Spud: 7/13/79
Complete: 7/14/79
TD: 480 feet

Much caving in zone 0-180 feet. No clay in returns in zone 400-480 feet, but mud was thick.

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S-GV-79-14 Spud: 7/19/79
Complete: 7/22/79
TD: 500 feet

Drilling equipment breakdown; hole suspended at 100 feet for 48 hours. Much caving reported for zones 120-200 feet and 250-300 feet.

S-GV-79-15 Spud: 7/22/79
Complete: 7/23/79
TD: 500 feet

Intermediate-Depth Holes

S-GV-79-105 Spud: 8/12/79
Complete: 8/22/79
TD: 1,185 feet

S-GV-79-106 Spud: 8/28/79
Complete: 9/6/79
TD: 1,500 feet

S-GV-79-108 Spud: 7/28/79
Complete: 8/7/79
TD: 1,470 feet

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penetrated consolidated rocks: light gray rhyolite in the interval 323-360 m. All other holes intersected unconsolidated sand, clay and gravel.

TEMPERATURE DATA

Preliminary and equilibrium temperature logs for each hole are given in Appendix C and D, and bottom-hole temperatures are summarized in table 2.

Temperatures observed at 30 and 50 m depths are shown on plate 1, and those observed at 100 m depth and greater are summarized on plate 2. Temperature gradients in the interval 30-50 m are shown on plate 3. Gradients computed for the interval 130-150 are shown on plate 4; and characteristic gradients for various depth intervals in holes deeper than 150 m are shown on plate 5.

HEAT FLOW

Heat flow computed for these holes are summarized in table 2 and are shown on plate 6, along with published values. Most values were computed using a thermal conductivity measured from the appropriate interval, but in some cases it was necessary to extrapolate values from zones of similar lithology.

All thermal conductivities were measured on unconsolidated materials. The calculations of heat-flow values were made using a range of likely porosities (20-40%) and assuming water-saturated conditions throughout. The resulting range of heat-flow values takes into account the fact that in situ porosities in poorly consolidated sedimentary rocks cannot be measured directly, and usually cannot be estimated closely from drill cuttings. Calculations that assume high porosities yield lower heat-flow values than do low porosities, because the thermal conductivity of water is 1.381 thermal conductivity units (TCU; 10^{-3} cal/cm-sec-°C), whereas the measured thermal conductivity of the rock material ranges from 4.4 to 9.1 TCU.

Terrain corrections were estimated from the topographic setting of each hole; they have relatively little effect on computed heat flows, as all holes were located on the valley floor.

Table 2

Bottomhole Temperatures, Temperature Gradients and Computed Heat Flow, Grass Valley, Nevada

Hole Number	Total Depth, meters	Bottom Hole Temperature, °C	Depth Interval, meters	Temperature Gradient, °C/km	Thermal Conductivity TCU[1]	Terrain Correction percent	Range of Heat Flow values, HFU[2] Maximum Porosity Conditions	Range of Heat Flow values, HFU[2] Minimum Porosity Conditions
S-GV-79-2	150	24.1	30- 50	66.3	7.8[3]	0	2.59	3.66
			50- 80	73.7	7.57	0	3.21	4.51
			110-150	80.7	7.12	0	2.98	4.14
S-GV-79-3	150	21.9	20-150	56.2	6.4[4]	0	1.95	2.64
S-GV-79-4	150	20.8	30- 70	52.5	7.57	0	2.01	2.83
			70-150	66.2	7.47	0	2.52	3.53
S-GV-79-5A	150	33.9	30- 80	142.2	8.89	-5	5.71	8.29
			80-150	111.0	8.4[4]	0	4.53	6.50
S-GV-79-7	85	17.8	40- 70	3.6	9.97	-5	0.15	0.23
			70- 85	37.2	5.3[3]	0	1.15	1.51
S-GV-79-8	151	21.1	60-150	42.7	6.8[4]	0	1.53	2.11
S-GV-79-9	135	17.2	45- 70	31.2	7.70	-5	1.15	1.62
S-GV-79-10	152	20.1	35-150	53.2	8.4[4]	0	2.17	3.12
S-GV-79-11	152	17.4	30-105	29.0	9.07	0	1.24	1.80
			105-150	46.8	7.80	0	1.83	2.58
S-GV-79-12	152	27.8	45-100	102.3	6.34	0	3.52	4.78
			100-150	116.7	6.76	0	4.18	5.74
S-GV-79-13	146	22.1	10-100	61.8	7.82	0	2.41	3.42
			100-145	74.4	7.73	0	2.89	4.07

Hole Number	Total Depth, meters	Bottom Hole Temperature, °C	Depth Interval, meters	Temperature Gradient, °C/km	Thermal Conductivity TCU[1]	Terrain Correction percent	Range of Heat Flow values, HFU[2]	
							Maximum Porosity Conditions	Minimum Porosity Conditions
S-GV-79-14	152	17.9	30- 60	25.7	8.10	0	1.03	1.46
			60-150	54.3	5.8[4]	0	1.77	2.36
S-GV-79-15	152	19.1	20-150	45.4	8.2[4]	0	1.83	2.61
S-GV-79-105	353	94.1	160-210	230	4.66	0	6.64	8.46
			230-270	158	5.4[4]	0	4.98	6.54
			290-310	290	5.90	0	9.6	12.9
S-GV-79-106	455	29.6	230-340	44.5	6.31	0	1.54	2.09
			370-450	60.0	6.0[4]	0	2.01	2.70
S-GV-79-108	440	62.3	230-340	104	9.41	0	4.57	6.71
			340-440	110	8.32	0	4.49	6.44

Notes:

[1]TCU = thermal conductivity units, 10^{-3} cal/cm-sec-°C

[2]HFU = heat flow units, 10^{-6} cal/cm^2-sec. Because all holes penetrated unconsolidated alluvium, water-saturated conditions were assumed throughout, and heat-flow values were calculated using 20% and 40% as the minimum and maximum porosities expected in this setting.

[3]No conductivity value measured in this depth interval. Conductivity given is average of values measured on similar lithology.

[4]Average of several conductivity values measured in this depth interval.

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Beyer, H., Dey, A., Liaw, A., Majer, E., McEvilly, T. V., Morrison, H. F. and Wollenberg, H., 1976, Preliminary Open File Report: Geological and Geophysical Studies in Grass Valley, Nevada: Lawrence Berkeley Laboratory, LBL-5262, 143 p.

Noble, D. C., 1975, Geologic history and geothermal potential of the Leach Hot Springs area, Pershing County, Nevada: Preliminary Report to Lawrence Berkeley Laboratory.

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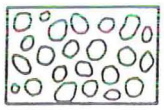
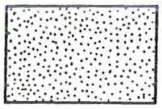
APPENDIX A.

Lithologic logs of shallow (85-152 m)
temperature-gradient holes.

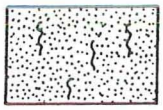
EXPLANATION OF SYMBOLS ON WELL LOGS



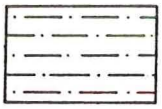
Gravel (conglomerate)



Sand (sandstone)

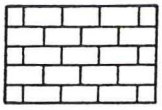


Quartzite

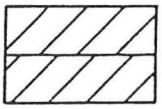


Silt (siltstone and mudstone)

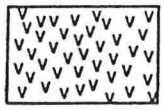
Clay (shale, claystone, argillite)



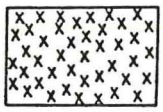
Limestone



Dolomite



Tuff (volcanic ash)



Lava flow

N.S. indicates that no sample is available

ABBREVIATIONS USED IN LITHOLOGIC DESCRIPTIONS

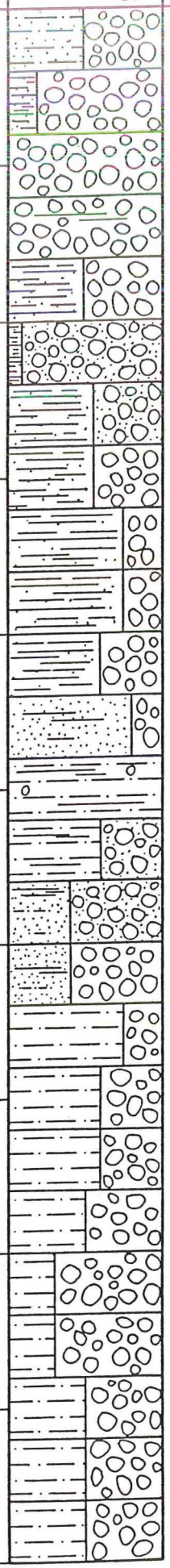
about	abt.	carbonaceous	carb.
above	abv.	cavernous	cav.
abundant	abnt.	caving	cvg.
accessory	acces.	cement, cemented	cmt.
acicular	acic.	center, centered	cntr.
agglomerate	aglm.	cephalopod	Ceph.
aggregate	agg.	chalcedony	chal.
algae, algal	Alg.	chalk, chalky	chk.
altered, altering	alt.	chert	cht.
amorphous	amor.	cherty	chty.
amount	amt.	chitin, chitinous	chit.
angular	ang.	clastic	clas.
anhedral	anhed.	clay, clayey	cly.
anhydrite, anhydritic	anhy.	claystone	clyst.
aphanitic	aphan.	clean	cln.
apparent	apr.	clear	clr.
appears	aprs.	clusters	clus.
approximate, approximately	approx.	coarse, coarsely	c.
aragonite	arag.	cobble	cbl.
arenaceous	aren.	color, colored	col.
argillaceous	arg.	common	com.
arkose, arkosic	ark.	compact	cpct.
asphalt, asphaltic	asph.	composition	comp.
assorted	asstd.	conchoidal	conch.
at	@	concretion, concretionary	conc.
average	av.	conodont	Cono.
band, banded	bnd.	concentric	cncn.
barite, baritic	bar.	conglomerate	cgl.
basalt	bas.	consolidated	cons.
bed	bd.	contact	ctc.
bedded	bdd.	contain	cont.
bedding	bdg.	contaminated	contam.
bentonite, bentonitic	bent.	contorted	cntrt.
biotite	biot.	coquina	coq.
bitumen, bituminous	bit.	covered	cov.
black	blk.	crenulated	cren.
block, blocky	blky.	crevice	crev.
blue, bluish	bl.	crinkled	crnk.
botryoidal	btry.	crinoid, crinoidal	Crin.
boulder	bldr.	cross-bedded, cross-bedding	xbdg., xbdg.
brachipod	Brach.	cross-laminated	xlam.
breccia, brecciated	brec.	cross-stratified	xstrat.
brittle	brit.	cryptocrystalline	crpxl.
bright	bri.	cryptograined	crpgr.
brown	brn.	crystal, crystalline	xl., xln.
bryozoan	Bry.	cuttings	ctgs.
calcite, calcareous	calc.	dark	dk.
calichified	calich.	dead	dd.

debris	deb.
decrease, decreasing	decr.
dendritic	dend.
dense	dns.
determine	dtrm.
detrital, detritus	dtrl.
diameter	diam.
difference	dif.
disaggregated	disagg.
disseminated	dissem.
dolocast, colocastic	dolc.
dolomite, dolomitic	dol.
dolomold, dolomoldic	dolmd.
dominant	dom.
druse, drusy	drsy.
drilling	drlg.
earthy	rthy.
echinoid	Ech.
elliptical	elip.
elevation	elev.
elongate	elg.
embedded	embd.
enlarged	enl.
equivalent	equiv.
euhedral	euhed
evaporitic	evap.
expose, exposed, exposure	exp.
extraneous	extran.
extrusion, extrusive	extr.
faceted	fac.
faint	fnt.
fair	fr.
fault	flt.
fauna	fau.
feldspar, feldspathic	fld.
ferruginous	Fe
fibrous	fib.
figured	fig.
fine, finely	f.
fissile	fis.
flaggy	flgy.
flake	flk(s).
flaky	flky.
flat, flattened	flat.
floating	fltg.
fluorescence	flor.
foliated	fol.
foraminiferan	Foram.
formation	fm.
fossil, fossiliferous	fos.
fracture, fractured	frac.
fragment, fragmental	frag.
fresh	frs.
friable	fri.
frosted	fros.
fusulinid	Fus.
gabbro	gab.
gastropod	Gast.
glauconite, glauconitic	glau.
glassy	gl.
gloss, glossy	glos.
gneiss	gns.
good	g.
grade, grades, graded	grd.
Grading	grdg.
grain, grained	g.
granite	grnt.
granodiorite	granod.
graptolite	Grap.
granular	gran.
granule	grnl.
gravel	gvl.
gray	gy.
graywacke	gywke.
greasy	gsy.
green	grn.
greenstone	grnst.
gritty	grty.
gypsum, gypsiferous	gyp.
hackly	hky.
hard	hd.
heavy	hvy.
hematite, hematic	hem.
heterogeneous	heterog.
hexagonal	hex.
high	hi.
homogeneous	homog.
horizontal	hztl.
hornblende	hbl.
hornfels	hfls.
hydrocarbon	hydc.
igneous	ig.
imbedded	imbd.
impression	imp.
included, inclusion	incl.
increase, increasing	incr.
indistinct	indst.
indurated	ind.
interbedded	intbdd.
intercalated	intcl.
intercrystalline	intxl.
interfingered	intfr.
intergranular	intgran.

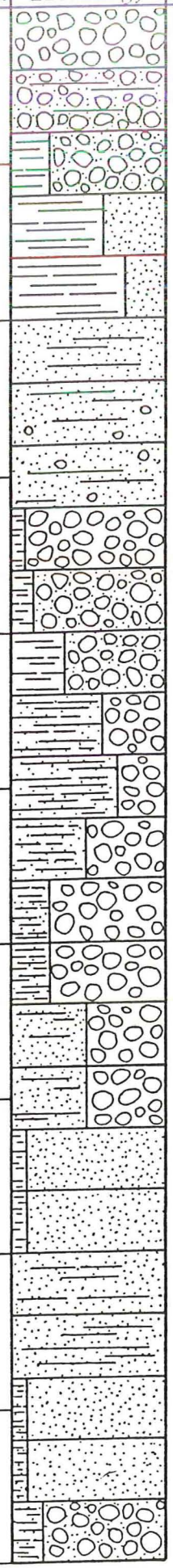
intergrown	intgwn.
interlaminated	intlam.
interstitial	intstl.
interval	intv.
intraformational	intfm.
intrusion, intrusive	intr.
invertebrate	invrtb.
iron	Fe
ironstone	Fe-st.
irregular	ireg.
irridescent	irid.
jasper, jasperoid	jasp.
jointed	jntd.
joints	jnts.
kaolin	kao.
laminated	lam.
large, larger	lrg.
lavender	lav.
leached	lchd.
ledge	ldg.
lentil, lenticular	len.
lignite, lignitic	lig.
light, lighter	lt.
limonite, limonitic	lmn.
limestone	ls.
limy	lmy.
lithic, lithology, lithographic	lith.
little	ltl.
long	lg.
loose	lse.
lower	low.
lumpy	lmpy.
lustre	lstr.
magnetic	mgn.
marlstone	mrlst.
maroon	mar.
massive	mas.
material, matter	mat.
matrix	mtx.
maximum	max.
median	mdn.
medium	m.
member	mbr.
metamorphic	meta.
mica, micaceous	mica.
microcrystalline	micxln.
microfossil, microfossiliferous	micfos.
micrograined	micgr.
micro-micaceous	mic-mica.
middle	mid.
mineral, mineralized	mnrl.
minimum	min
minor	mnr.
minute	mnut
miscellaneous	misc.
moderate	mod.
mollusc	Mol.
mottled, mottling	mot.
mudstone	mdst.
muscovite	musc.
nacreous	nac.
nepheline	neph.
no, non-	n.
nodule	nod.
numerous	num.
object	obj.
occasional	occas.
ochre	och.
odor	od.
oil	o.
oil sand	o. sd.
oil stain	O. stn.
olive	olv.
oolicast, oolicastic	ooc.
oolite, oolitic	ool.
oomold, oomoldic	oom.
opaque	op.
orange	orng.
organic	org.
orthoclase	orth.
ostracod	Ost.
outcrop	otcp.
oxidized, oxide	ox.
part, partly	pt.
parting	ptg.
pearl, pearly	prly.
pebble	pbl.
pebbly	pbly.
pelecypod	Plcy.
pellet	pel.
peridotite	perid.
permeability	perm.
petroleum, petroliferous	pet.
phenocryst	phen.
phosphate, phosphatic	phos.
pink	pk.
pin-point	p-p.
pisolite, pisolitic	piso.
pitted	pit.
plagioclase	plag.

plant fossils	pl. fos.	sediment, sedimentary	sed.
plastic	plas.	selenite	sel.
platy	plty.	serpentine	sp.
point	pt.	several	sev.
polish, polished	pol.	shadow	shad.
poor, poorly	p.	shale	sh.
porcelaneous	porc.	shaly	shy.
porosity, porous	por.	siderite, sideritic	sid.
porphyritic	porph.	silica, siliceous	sil.
possible, possibility	pos.	silicified, silicification	silicif.
predominate, predominantly	pred.	silky	slky.
preserved, preservation	pres.	silt	slt.
primary	prim.	siltstone	sltst.
prism, prismatic	pris.	silty	slty.
probable, probably	prob.	size	sz.
prominent, prominently	prom.	slabby	slab.
pseudo	psdo.	slickensided	sks.
purple	purp.	slight, slightly	sl.
pyrite, pyritized	pyr.	small	s.
pyrobitumen	pyrbit.	smooth	smth.
pyroclastic	pyrclas.	soft	sft.
pyroxene	pyx.	solution	sol.
quartz	qtz.	sort	srt.
quartzite	qtzt.	sorted	srtd.
quartzitic	qtzc.	sorting	srtg.
quartzose	qtzs.	speck, speckled	spec.
radiate, radiating	rad.	sphalerite	sphal.
range, ranging	rng.	spherules	sph.
rare	rr.	spicule, spicular	spic.
regular	reg.	splintery	splty.
remains, remnant	rmn.	sponge	Spg.
replaced, replacing replacement	repl.	spore	Spr.
residue, residual	resd.	spot, spotted, spotty	sp.
resinous	rsns.	stain, stained, staining	stn.
rhomb, rhombic	rhmb.	station	sta.
rhyolite	rhy.	stippled	stip.
rock	rk.	stone	st.
round, rounded	rd.	strata, stratified, stratification	strat.
rubbly	rbly.	streak	str.
sample	spl.	striated	stri.
sand	sd.	stringer	strg.
sandstone	ss.	stromatoporoid	Strom.
sandy	sdy.	structure	struc.
saturated, saturation	sat.	stylotite	styl.
scales	sc.	subangular	sbang.
scarce	scs.	subhedral	sbhed.
scattered	scat.	subrounded	sbrd.
schist	sch.	sucrose	suc.
scolecodonts	Scol.	Sulphur	S
secondary	sec.	surface	surf.

tabular	tab.
temperature	T.
texture	tex.
thick	thk.
thin	thn.
throughout	thru.
tight, tightly	tt.
trace	tr.
translucent	trnsl.
transparent	trnsp.
trilobite	Trilo.
tripoli, tripolitic	trip.
tubular	tub.
tuffaceous	tuf.
unconformity	unconf.
unconsolidated	uncons.
unidentified	unident.
upper	up.
variable	var.
varicolored	vcol.
varigated	vgt.
varved	vrvd.
vegetation	veg.
vein	vn.
vertebrate	vrtb.
very	v.
vesicular	ves.
vitreous	vit.
volcanics	volc.
vug, vuggy, vugular	vug.
water	wtr.
wavy	wvy.
waxy	wxy.
weather, weathered	wthr., wthrd.
well	w.
white	wh.
with	w/
xenolith	xen.
yellow	yel.
zone	zn.



Description
Slt., sdy.; & Gvl. (1-2cm), ang.-rd.; clasts = mixed aphan. rk. & cht.
Gvl., as above; & Cly., sdy., calich.
Gvl. (0.5-1.5cm), sbang.-sbrd.; clasts = aphan. rk., cht., & brn. f.g. silicif. ss.
Gvl., cly.; clasts as above + wh. f.g. silicif. rk.
Cly., sdy.; & Gvl.; clasts as above
Gvl. (1cm), sdy.; clasts as above; & Clay, sdy.
Cly., sdy.; & Gravel, as above
Cly., as above; & Gvl. (∿0.5cm); clasts as above
Cly., as above; & Gvl., as above
Cly., as above; & Gvl., as above
Cly., as above; & Gvl. (0.5-1cm); clasts = cht., yel. aphan. rk., & brn. f.g. silicif. ss.
Sd., cly.; & Gvl. (0.2-1.5cm); clasts as above
Slt., cly., pbly.
Slt., cly.; & Gvl. (0.2-0.6cm), ang.-rd., sdy.; clasts as above
Gvl., as above; & Sd., cly., slty.
Gvl. (∿0.5cm); & Sd., as above
Slt., cly., sdy.; & Gvl., as above
Slt., as above; & Gvl., as above
Slt., as above; & Gvl., as above
Slt., as above; & Gvl., as above
Gvl. (1cm); clasts as above; & Slt., cly., sdy.
Gvl., as above; & Silt, as above
Slt., as above; & Gvl., as above
Slt., as above; & Gvl., as above
Slt., as above; & Gvl., as above



Gvl., sbang.; clasts = bl.-grn. dns. rk.

Gvl., sdy., cly.; clasts as above

Gvl., sdy.; clasts as above; & Cly., bl. & tan

Cly., as above; & Sd., sbang.; clasts = bl.-grn. rk.

Cly., as above; & Sd., as above

Sd., cly., c.g., sbang.; clasts = bl.-grn. rk., lt. aphan. rk. & tr. fib. calc.

Sd., cly., pbly.; clasts as above

Sd., as above

Gvl.; clasts = bl.-grn. mot. rk. & lt. buff rk.; & Cly., bl., tan

Gvl., sdy.; clasts = bl.-grn. rk. & bnd. purp. & blk. rk.; & Cly., bl.

Gvl., as above; & Cly., as above

Cly., bl. or tan, sdy.; & Gvl. (∿0.5cm); clasts as above

Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

Gvl., as above; & Cly., sdy.

Gvl., as above; & Cly., as above

Sd., cly., c.g., ang.; clasts mostly sil. w/bl.-grn. rk. & lt. buff rk.; & Gvl. (0.5-1cm); clasts = sil. & bl.-grn. rk.

Sd., as above; & Gvl., as above

Sd., as above; & Cly.

Sd.; clasts = bl.-grn. rk. & sil. in = amounts; & Cly.

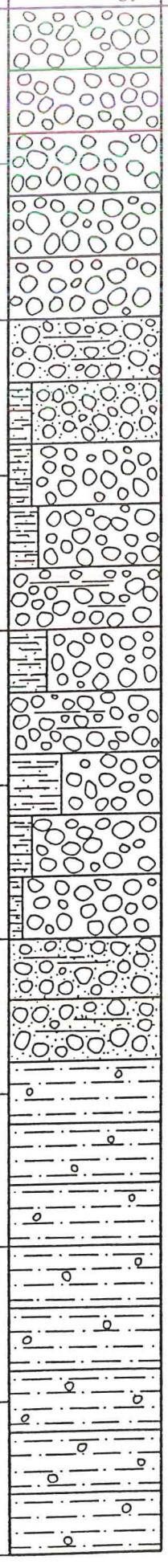
Sd., cly.; clasts mostly bl.-grn. rk. w/some sil.

Sd. (1-4mm), cly., ang.; clasts = 45% bl.-grn. rk., 10% sil., & 45% dk. red-brn. volc. rk.

Sd. (1-3mm); clasts = bl.-grn. rk., sil. & tr. volc. rk.; & Cly., sdy.

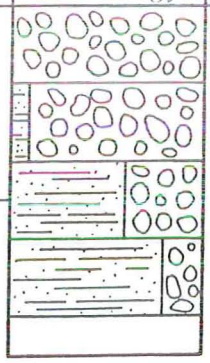
Sd., as above; & Cly., as above

Gvl. (∿0.5cm), sdy.; clasts = bl.-grn. rk., sil. & yel. aphan. rk.; & Cly., as above

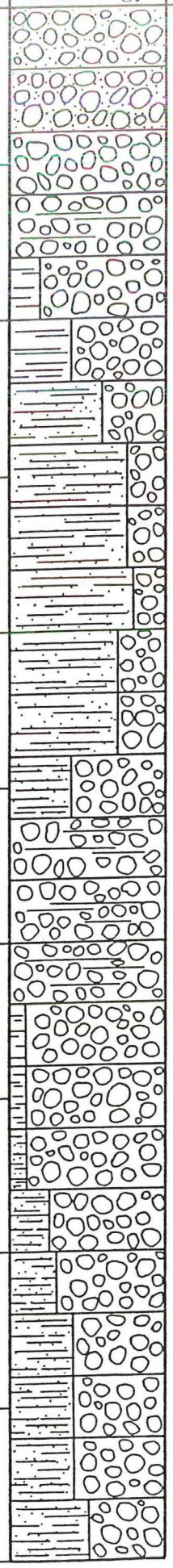


Depth	Description
	Gvl. (0.3-1.5cm), sbrd.; clasts = silicif. rk., cht., etc.
	Gvl. (0.3-1cm), as above; clasts, as above
50'	Gvl., as above; clasts incl. some clods of slt. & sd.
	Gvl., as above
	Gvl., as above
100'	Gvl. (0.4cm), sbang.-sbrd., cly., sdy.
	Gvl. (0.4cm), sbang.-sbrd., sdy.; & Clay, sdy.
150'	Gvl. (∿1cm), sbang.-sbrd.; & Clay, as above
	Gvl. (∿1cm); clasts = abnt. gry.-grn. rk., silicif. aphan. rks. & cht. & brn. f.g. silicif. ss.; & Cly., sdy.
	Gvl., cly., clasts, as above
200'	Gvl.; clasts, as above; & Clay, sdy.
	Gvl., cly.; clasts, as above
250'	Gvl.; clasts = silicif. ss., all col. cht., gry., blk., purp., brn. & yel. volc. rks. & tr. cons. slt.; & Cly., sdy.
	Gvl., as above; & Clay, as above
	Gvl., as above; clasts cont. tr. bl.-grn. mot. rk.; & Clay, as above
300'	Gvl., cly., sdy.; clasts, as above
	Gvl., as above
350'	Slt., pbly.
	Slt., as above
	Slt., as above
400'	Slt., as above
	Slt., as above
450'	Slt., as above
	Slt., as above
500'	Slt., as above

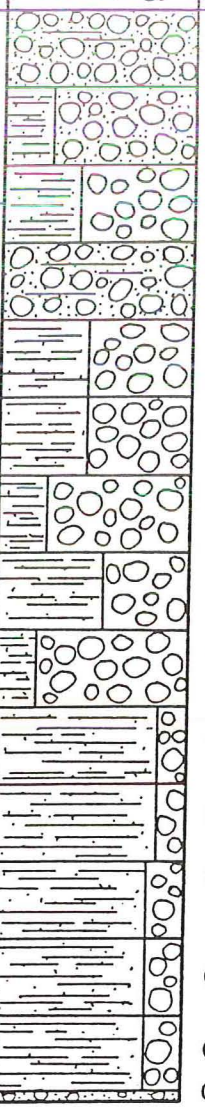
Note: 340-500' hole making own mud; insignificant amount of returns dropping out of mud.

Depth	Lithology	Description
		Gvl., sbang.-sbrd.; clasts (caliche coated) = 50% bl.-grn. mot. rk., 20% wh. fri. mat., 10% lt. gry. cht. & 20% mixed
		Gvl., as above; & Cly., sdy.
50'		Cly., sdy.; & Gvl.; clasts of bl.-grn. rk. & yel. silicif. rk.
		Cly., as above; & Gvl., as above
		N.S.

Note: Lost circulation at 80'. Moved drill rig 80 yards west to site 5A.

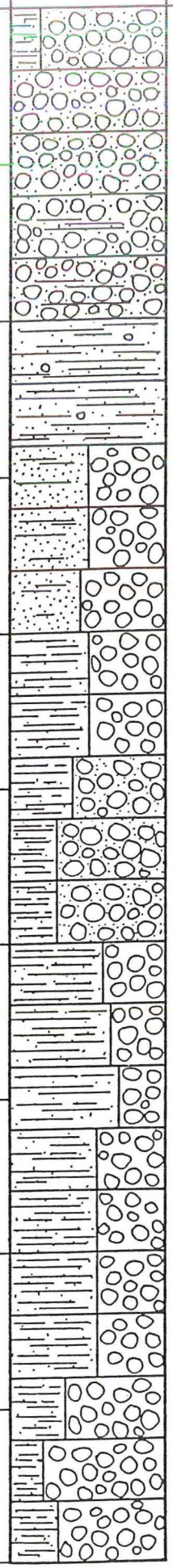


Depth	Description
	Gvl., sbang., sdy.; clasts mainly mat. of c. sd. in f.g. buff col. mtx., also some bl.-grn. mat.
	Gvl., as above; clasts coated w/caliche
50'	Gvl.; clasts = 50% wh. Fe-stn. fri. rk. & 50% bl.-grn. rk. & cht.
	Gvl. cly.; clasts = 75% wh. fri. mat., 10% wh. cht., & 15% mixed comp.
	Gvl.; clasts as above w/some of wh. mat. silicif.; & Cly., wh.
100'	Gvl., as above; & Cly., as above
	Cly., sdy.; & Gvl., as above
150'	Cly., as above; & Gvl., as above
	Cly., as above; & Gvl., as above
	Cly., as above; & Gvl., as above
200'	Cly., as above; & Gvl., as above
	Cly., as above; & Gvl., as above
250'	Gvl. (∿0.4cm); clasts = mostly dk. gry. aphan. volc. rk. + some wh. fri. rk. & cht.; & Cly., as above
	Gvl., cly.; clasts as above
	Gvl., as above
300'	Gvl., cly.; clasts mostly silicif. volc. rk. + some clr. qtz.
	Gvl.; clasts as above; & Cly.
350'	Gvl., as above; & Cly.
	Gvl., as above; clasts = blk. aphan. rk., bl.-grn. rk., lt. grn. to brn. silicif. rk. & brn. f.g. silicif. ss.; & Cly., sdy.
	Gvl., as above; & Cly., as above
400'	Gvl., as above; & Cly., as above
	Gvl., as above; & Cly., as above
450'	Gvl., as above; & Cly., as above
	Gvl., as above; & Cly., as above
500'	Gvl., clasts = mixed comp. but w/abnt. brn. silicif. ss.; & Cly., bl., sdy.

Depth	Lithology	Description
		Gvl. & Sd., cly.
		Gvl., sdy.; clasts = off-wh. fri. rk., brn. f.g. silicif. ss.; & Cly., sdy., tr. pure wh. cly.
50'		Gvl. (∿0.4cm); clasts = wh. fri. rk., wh. v.f.g. ss., brn. f.g. silicif. ss., asstd. cht.; & Cly., sdy. & pure wh.
		Gvl., red, sdy., cly.; clasts as above
		Gvl., sbang.-ang.; clasts as above; & Cly., sdy.
100'		Gvl., ang.; clasts = off-wh. sdy. fri. rk., v.f.g. silicif. ss. & blk. cht.; & Cly., sdy.
		Gvl., ang.; clasts as above; & Clay, sdy.
150'		Cly., sdy. & some pure; & Gvl., as above
		Gvl., as above; & Cly., as above
		Cly., sdy.; & Gvl.; clasts = v.f.g. silicif. ss.
200'		Cly., as above; & Gvl., as above
		Cly., sdy., tr. pure wh.; & Gvl.; clasts = v.f.g. silicif. ss. & yel silicif. volc. rk.
250'		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
		Gvl., ang., sdy.; clasts = yel. silicif. volc. rk., v.f.g. gry. sil. ss. & blk. cht.

Note: Lost cones in hole at 282'. Move off hole.

S-GV-79-8



Gvl., sdy.; clasts = calich. soil & some blk. cht.; & Cly., sdy.

Gvl., sdy.; clasts caliche coated w/abnt. cht. & silicif. grnst.

Gvl., as above

Gvl., sbang.-sbrd., sdy., cly.; clasts mostly silicif. rks.

Gvl., as above

Cly., wh., sdy.; & tr. Gvl.

Cly., as above

Gvl. (∿0.4cm); clasts mostly silicif. rks.; & Sd., red, cly.

Gvl., as above; & Sd., as above

Gvl., as above; & Sd., as above

Cly., sdy.; & Gvl. (∿1cm); clasts as above

Cly., as above; & Gvl., as above

Gvl., ang., sdy.; clasts mostly cht.; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Cly., bl., sdy.; & Gvl.; clasts cht.-rich

Cly., wh., olv. grn. or deep red-brn., pure & sdy.; & Gvl., as above

Cly., as above; & Gvl.; clasts = cht. & wh. fri. sdy. mat.

Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

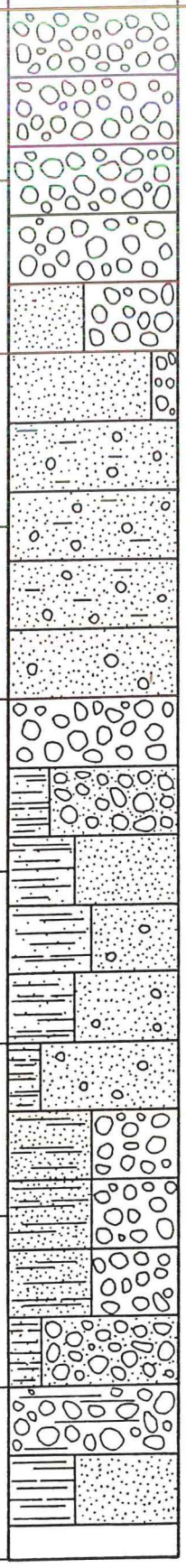
Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

Gvl., sbang.-ang.; clasts = cht.; & Cly., sdy.

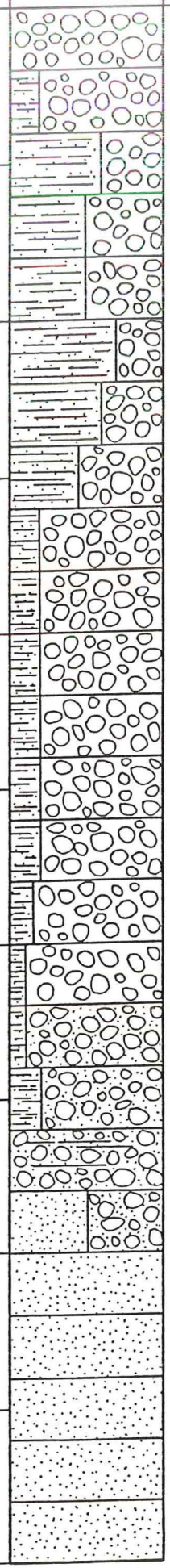
Gvl.; clasts = cht. & wh. fri. rk.; & Cly., pure & sdy.

Gvl., ang.-sbang.; clasts = cht.; & Cly., wh. or grn., pure & sdy.



Depth	Description
	Gvl. (1-2cm), sbang.-sbrd.; clasts calice-coated of brn. to yel. silicif. aphan. rk. & gry. to wh. cht.
	Gvl., as above
50'	Gvl., as above
	Gvl., as above; clasts as above w/wh. fri. mat.
	Gvl., as above; & Sd., c., sbang.
100'	Sd., c.; clasts = cht. & volc. rk.; & Gvl., as above
	Sd., muddy, pbly.; clasts as above
150'	Sd., as above
	Sd., as above
	Sd., c., pbly.; clasts as above
200'	Gvl. (~1cm), ang.; clasts almost all gry. cht.
	Gvl., sdy.; clasts = cht. & volc. rk.; & Cly., sdy.
250'	Sd.; clasts = gry. & wh. cht. & red, brn. & gry. volc. rks.; & Cly., sdy.
	Sd., pbly.; clasts as above; & Cly., as above
	Sd., as above; & Cly., as above
300'	Sd., as above; & Cly., as above
	Gvl.; clasts = yel.-brn. & grn. volc. rk. & cht.; Sd., cly.; clasts = gry. & wh. cht., red, brn. & gry. volc. rks. & f. xln. calc.
350'	Gvl., as above; & Sd., as above
	Gvl, as above; & Sd., as above
	Gvl., sdy.; clasts = yel.-brn. volc. rk. & cht.; & Cly., sdy.
400'	Gvl., cly.; clasts as above
	Sd., c., ang.; clasts as above; & Cly.
450'	N.S.

S-GV-79-10



Gvl. (0.5-2cm), ang.-sbang.; clasts mostly cht. & cht. brec.

Gvl., as above; & Cly., red, sdy.

Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

Cly., as above; & Gvl., as above

Gvl., as above; & Cly., as above

Gvl. (0.3-2cm), sbang.-ang.; clasts = cht.; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., sdy.; clasts = cht. & silicif. volc. rk.; & Cly., as above

Gvl., as above; & Cly., as above

Gvl., sdy., cly.

Sd. (1-4mm), ang.; clasts = cht.; & Gvl., sdy.

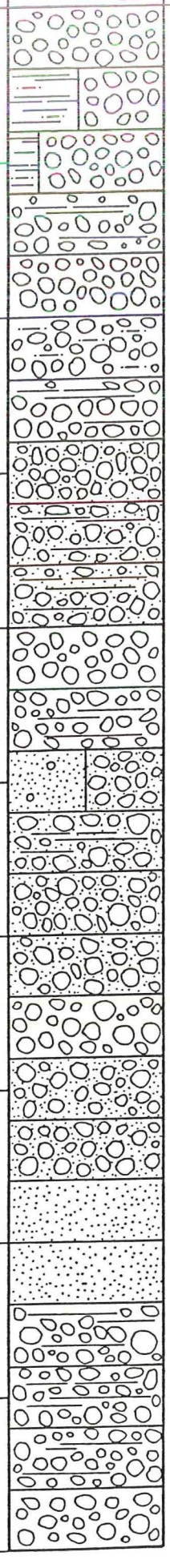
Sd., as above

Sd., as above

Sd., f.g.; clasts = cht.

Sd., as above

Sd., as above



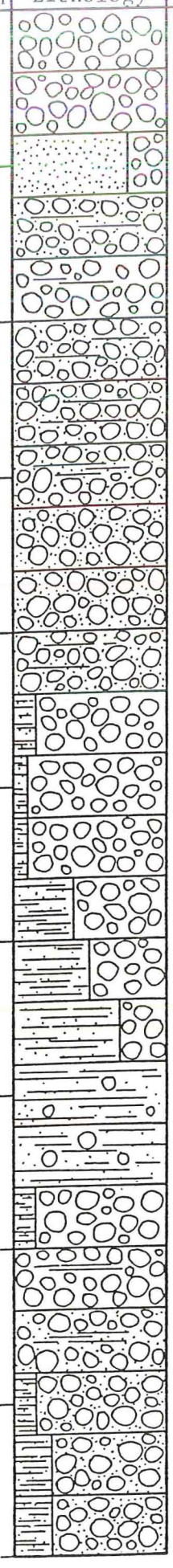
Description
Gvl. (0.1-1cm), sbang.; clasts = blk., red, grn., bl. & gry. cht., & brn. & yel. volc. rk.
Gvl. (0.4-2cm), sbang.-sbrd.; & Cly., brn., slty.
Gvl.; clasts mostly cht. w/silicif. volc. rks. & brn. f.g. silicif. ss.; & Cly., as above
Gvl., cly.; clasts as above
Gvl., sbang.-ang.; clasts mostly cht.
Gvl., slty.
Gvl., cly.
Gvl., sdy.; clasts mostly cht.
Gvl., sdy., cly.
Gvl., as above
Gvl. (0.4-0.5cm), ang.; clasts = cht.
Gvl., cly.
Sd. (1-4mm), pbly., sbang.-ang.; clasts = cht.; & Gvl., sdy.
Gvl., sdy., cly.; clasts = cht. & mot. brn. aphan. or f.g. rk.
Gvl., sdy.; clasts as above
Gvl., sdy.; clasts = cht. & asstd. types
Gvl.; clasts = 25% cht. + yel., brn., gry. & blk. aphan. rk.
Gvl., sdy.; clasts as above
Gvl., sdy.; clasts = 20% fri. f.g. wh. rk. + cht. & volc. rks.
Sd., c.; clasts = 50% fri. mat. & 50% cht.-rich rks.
Sd., as above
Gvl., cly.; clasts = cht. & volc. rk.
Gvl., cly.; clasts = cht., volc. rks. & wh. fri. mat.
Gvl., as above
Gvl.; clasts as above

Depth	Lithology	Description
		Sd., c.g., cly., ang.; clasts = gry. cht. & yel. volc. rk.
		Gvl. (0.3-1.5cm), ang.-sbang.; clasts as above
50'		Gvl., as above
		Gvl., as above
		Gvl., as above
100'		Slt., gvly.
		Slt., as above
150'		Slt., as above
		Slt., as above
		Slt., as above
200'		Cly., sdy.; & Gvl. (~0.5cm); clasts = cht. & volc. rk.
		Cly., as above; & Gvl., as above
250'		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
300'		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
350'		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
400'		Gvl., sbrd.; clasts mostly cht. & volc. rk.
		Gvl., as above
450'		Gvl., as above; & Cly., sdy.
		Gvl., as above; & Cly., as above
		Gvl., as above; & Cly., as above
500'		

Note: 100-200' almost no returns, but hole making its own mud.

Depth	Lithology	Description
		Gvl., f., ang.; clasts of olv. grn., gry. & blk. cht., & of yel., brn. & gry. silicif. volc. rks.
		Gvl., cly.; clasts as above
50'		Gvl., as above
		Gvl. (1-1.5cm), cly.; clasts as above
		Gvl. (0.4-1.2cm), sdy.; clasts as above
100'		Gvl., as above
		Gvl. (0.3-0.5cm), sbang.-ang.; clasts are heterog. w/some f.g. silicif. ss. & grn. chal.
150'		Gvl., sdy.; clasts as above
		Cly., sdy.; & Gvl.; clasts as above
		Cly., as above; & Gvl. (∿0.4cm); clasts as above
200'		Cly., as above; & Gvl. (0.4-1cm), sbang.-ang.; clasts as above
		Cly., as above; & Gvl., as above
250'		Gvl., as above; & Cly., sdy.
		Gvl. (∿1cm); clasts as above; & Cly., sdy.
		Gvl., cly.; clasts as above
300'		Gvl.; clasts as above; Cly., sdy.
		Gvl. (0.5-1.5cm), cly.; clasts = cht., volc. rk. & brn. silicif. ss.
350'		Gvl. (∿1cm), sdy., cly.; clasts as above
		Gvl., as above
		Gvl., as above
400'		Gvl. (1-1.5cm), ang-sbang.; clasts as above
		Gvl., sdy.; clasts as above
450'		Gvl. (1-1.5cm), sbang.-sbrd., cly., sdy.; clasts as above
		Gvl. (1cm); clasts as above

Note: 400-480' no clay in returns but mud thick



Depth	Description
	Gvl. (1-3.5cm), sbang.-sbrd.; clasts = aphan. or v.f.g. rks. & cht.
	Gvl., as above; clasts coated w/orng. Fe-ox.
50'	Sd. (1-3mm); & Gvl., as above
	Gvl. cly. sdy.; clasts as above
	Gvl., cly.; clasts as above
100'	Gvl. (0.3-0.5cm), sdy., cly.; clasts mixed, incl. gry., red & blk. cht. & yel. & brn. aphan. rks.
	Gvl., as above
150'	Gvl., as above
	Gvl., sdy.; clasts as above
	Gvl., as above
200'	Gvl. (∿1cm), sdy., cly.; clasts as above
	Gvl. (0.3-1.5cm); clasts as above; & Cly., sdy.
250'	Gvl. (0.8-1.5cm), ang.-sbang.; clasts as above; & Cly., as above
	Gvl. (1-2cm), ang.-sbrd.; clasts cht.-rich; & Cly., as above
	Gvl., as above; & Cly., as above
300'	Cly., as above; & Gvl., as above
	Cly., as above; & Gvl., as above
350'	Cly., sdy., pbly.
	Cly., as above
	Gvl. (∿1cm); clasts = bl.-grn. mot. rk., blk. or red bas., milky qtz. & yel. & brn. aphan. rks.; & Cly., sdy.
400'	Gvl., cly.; clasts as above
	Gvl., sdy., cly.; clasts as above
450'	Gvl. (0.5-0.7cm), sdy.; clasts as above; & Cly., sdy.
	Gvl., as above; & Cly., as above
	Gvl., as above; & Cly., as above
500'	

Depth	Lithology	Description
		Gvl. (1-3cm), cly.; clasts = cht., silicif. volc. rk. & f.g. silicif. ss.
		Gvl.; clasts as above; & Cly., sdy.
50'		Gvl., as above; & Cly., as above
		Gvl., cly.; clasts as above
		Gvl., as above
100'		Gvl., as above
		Gvl., as above
150'		Gvl., as above
		Gvl., as above
		Gvl., as above
200'		Gvl.; clasts as above; & Cly., brn.
		Cly., as above; & Gvl., as above
250'		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above
		Gvl. (∿1cm), sbang.; clasts mostly cht.
300'		Gvl. (0.5-2cm), cly., sbang.-ang.; clasts cht.-rich
		Gvl.; clasts as above; & Cly., sdy.
350'		Gvl., as above; & Cly., as above
		Gvl., as above; & Cly., as above
		Gvl. (0.5-2cm), cly.; clasts as above
400'		Gvl., as above
		Gvl., as above
450'		Gvl., as above
		Gvl., as above
500'		Gvl., as above

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APPENDIX B.

Lithologic logs of intermediate-depth (360-457 m) temperature-gradient holes.

Depth	Lithology	Description
		Sd. (1-3mm), slty., pbly.; clasts sbang.-sbrd. of cht., grnst. & blk. aphan. rk.
		Gvl. (0.5-7mm), sdy.; clasts sbrd.-sbang. of 70% grnst. & 30% lt. col. cht.
50'		Gvl., as above
		Gvl., as above
		Gvl. (0.1-1.5cm), sdy.; clasts = 30% grnst., 30% silicif. ss., 25% gry. aphan. rk. & 15% cht. & qtz.
100'		Gvl., as above
		Gvl. (0.2-0.7cm), sdy.; clasts as above
150'		Gvl. (0.2-0.5cm), sdy.; clasts as above; & Cly.
		Cly., brn., slty., sdy.
		Cly., as above
200'		Slt., sdy., fri.
		Sd. (≈1.5mm); clasts = brn. f.g. ss. & cht.; & Cly.
250'		Cly.; & Sd., as above
		Cly., & Sd. (<1mm); clasts = brn. f.g. ss., cht., qtz. & bas.
		Cly., bl.; & Sd., as above; & Ls., wh.
300'		Sd. (0.5-2mm); clasts sbrd.-sbang. of mixed comp.; & Cly., bl.-gry.
		Sd., as above
350'		Gvl. (0.5-5mm), sdy.; clasts = grn. cht., & grnst.
		Cly., sdy.
		Cly., as above
400'		Cly.; & Gvl. (0.1-0.5cm), sdy.; clasts = cht., qtz. & aphan. rk.
		Cly., sdy.
450'		Cly., as above
		Cly., as above
		Cly.; & Sd.; clasts of cht. & aphan. rk.
500'		Cly., brn. to gry., slty.
		Cly., sdy.; clasts of cht., grnst., ig. rk. & ls.
550'		Cly.; & Sd.; clasts of cht., grnst., ig. rk. & ls.
		Cly., & Sd. (0.5-2mm), pbly.; clasts as above
		Cly., bl.-gry. to pale grn., sdy.
600'		Cly., sdy.
		Cly., as above
650'		Cly., as above
		Cly., as above
		Cly., as above
700'		Cly., as above
		Cly., as above
750'		Cly.; & Gvl., sdy.; clasts = cht., qtz. & bas.
		Gvl., as above
		Gvl., as above
800'		Gvl., sdy., cly.; clasts as above
		Gvl., sdy.; clasts as above
850'		Gvl., as above
		Gvl., as above; & Cly.
		Gvl., sdy., cly.; clasts as above
900'		Gvl., sdy., cly.; clasts = cht., qtz., bas. & tr. f.g. equigrnlr. ig. rk.
		Gvl., sdy., cly.; clasts = cht., qtz. & bas.
950'		Gvl., sdy.; clasts mostly cht.; & Cly.
		Gvl., as above; & Cly.
		Gvl., as above; & Cly.
1,000'		Gvl., as above; & Cly., brn., sdy.
		Gvl., as above
1,050'		Cly., brn.
		Rhy., lt. gry.; phen. = hbl. & qtz., w/flecks pyr. alt.
		Rhy., as above
1,100'		Rhy., as above
		Rhy., as above
1,150'		Rhy., as above
		Rhy., as above

Note: Pronounced change from tan to red-brown clay to gray and blue-gray clay below 290'. Lost circulation material in samples from 690-710'. Driller mistook pump malfunction for loss of circulation. Below 1,100' depth the drilling rate slowed to less than 10'/hour.

Depth	Lithology	Description
		Sd. (<2mm), slty.; clasts = gry.-wh. cht., qtz., ss., bas., grnst. & red volc. rk.
		Gvl. (≈1cm); clasts sbrd.-ang., of gry.-wh. cht., qtz., ss., bas., grnst. & red volc. rk.
50'		Gvl. (0.2-1cm), sdy.; clasts as above
		Gvl. (0.5-1.5cm), cly.; clasts as above
		Gvl., as above
100'		Gvl. (0.2-1cm), sdy., cly.; clasts as above
		Gvl., sdy., cly.; clasts pred. cht. & bas.
150'		Gvl., clasts as above; & Cly.
		Gvl., cly.; clasts = cht., red volc. rk., bas. & f.g. ss.
		Gvl. (0.2-0.5cm), sdy.; clasts = mostly cht.
200'		Gvl. (0.2-0.5cm), sdy., cly.; clasts as above
		Gvl., (0.2-0.5cm), sdy.; clasts as above; & Cly.
250'		Gvl. (0.3-1cm); clasts as above + tr. $CaCO_3$
		Gvl., as above; & Cly., sdy.
		Gvl., as above; & Cly., as above
300'		Gvl. (0.2-1.5cm), sdy.; clasts as above; & Cly., as above
		Gvl., as above; & Cly., as above
350'		Gvl., cly.; clasts mostly cht., bas. & brn. silicif. tuff
		Gvl.; clasts as above
		Gvl. (0.5-1.5cm); clasts as above; & Cly., sdy
400'		Cly., as above; & Sd. (≤ 3mm); clasts mostly cht., bas. & brn. silicif. tuff
		Gvl. (0.5-1.5cm), clasts mostly cht., bas. & brn. silicif. tuff; & Cly., as above
450'		Gvl. (0.2-0.7cm), sdy.; clasts as above
		Gvl., as above; & Cly., sdy.
		Gvl. (0.2-0.5cm),as above
500'		Sd. (<2mm); clasts sbrd.-sbang., of cht., bas. & brn. silicif. tuff
		Sd., as above
550'		Gvl. (0.2-1cm), sdy.; clasts sbrd.-sbang., of cht., bas. & brn. silicif. tuff
		Gvl., as above
		Gvl., as above
600'		Gvl., (0.2-1cm), sdy., cly.; clasts as above
		Gvl., as above
650'		Gvl., as above
		Gvl., (0.2-1cm), sdy.; clasts as above; & Cly., sdy.
		Gvl., as above; & Cly., as above
700'		Gvl. (<0.5cm), sdy., clasts as above; & Cly., as above
		Gvl., as above; & Cly., as above
750'		Gvl., as above; & Cly., as above
		Cly., as above; & Gvl., as above
		Cly., as above; & Gvl., as above + tr. wh. f.g. ls. clasts
800'		Cly., as above; & Gvl., as above
		Gvl., (≤ 0.5cm), sdy.; clasts = mixed comp.
850'		Sd. (≤ 1mm); clasts = mixed comp.
		Cly., sdy.; & Sd., as above
		Cly., as above; & Sd., as above
900'		Cly., as above; & Sd., (≤ 2mm); clasts as above
		Cly., as above; & Sd., as above
950'		Cly., as above; & Sd., as above
		Cly., as above; & Sd., as above
		Cly., as above; & Sd., as above
1,000'		Sd. (<2mm), cly.; clasts = cht., bas., red volc. rk., tuff, qtz. & grnst.
		Sd., as above
1,050'		Sd., as above
		Sd., as above
		Sd., as above
1,100'		Gvl. (0.2-0.7cm), sdy.; clasts = cht., bas., red volc. rk., tuff, qtz., grnst. & tr. wh. v.f.g. sdy. fri. ls.
		Gvl., sdy.; clasts = 60% mixed comp. & 40% sdy. fri. ls.
1,150'		Cly., sdy.
		Gvl., sdy.; clasts incl. tr. sdy. fri. ls.; & Cly., as above
		Sd. (<2mm); clasts incl. tr. sdy. fri. ls.; & Cly., as above
1,200'		Sd., as above; & Cly., as above
		Sd., as above
1,250'		Sd., as above; & Cly., sdy.
		Cly., as above; & Sd., as above
		Sd., as above; & Cly., as above
1,300'		Sd., (≤ 3mm), cly., pbly.; clasts = cht., qtzt., bas.
		Sd., as above
1,350'		Cly., sdy., calc.; & Sd. (≤ 3mm), pbly.; clasts as above
		Sd., as above; & Cly., sdy.
		Sd., as above
1,400'		Cly., sdy.; & Sd., as above
		Cly., as above; & Sd., as above
1,450'		Cly., as above; & Gvl. (≈0.7cm); clasts = cht., qtzt., bas.
		Cly., as above; & Sd. (≤2mm), pbly.; clasts = cht., qtzt., bas.
1,500'		Cly., as above; & Sd., as above

Depth	Lithology	Description
		Gvl. (0.5-1cm), slty.; clasts ang., mixed comp. incl. 10% milky to trnsl. sil.
		Gvl. (0.5-1cm); clasts = cht., qtz., & aphan. rks.; & Sd. (1-4mm); clasts sbang.
50'		Gvl. (0.2-0.8cm), clasts as above
		Gvl. (0.2-1cm); clasts as above; & Sd. (0.5-1mm)
		Gvl. (0.3-1.3cm); clasts sbang.-ang., as above
100'		Gvl. (0.2-0.9cm); clasts as above
		Gvl., as above; & Sd. (0.5-1mm)
150'		Gvl., as above
		Gvl. (0.1-5mm), sdy.; clasts as above
		Gvl., as above
200'		Gvl. (0.3-0.8cm); clasts sbang., mostly cht.
		Gvl. (0.2-1.1cm); clasts of mixed comp. incl. cht. & yel., blk., red & grn. volc. rks.
250'		Gvl. (0.3-1.5cm); clasts cht.-rich
		Gvl., as above
		Gvl. (0.3-2cm); clasts as above; & Sd. (0.5-2mm)
300'		Gvl., as above
		Gvl., cly., as above
350'		Gvl., as above
		Gvl. (0.3-1cm); clasts as above
		Gvl., cly., as above
400'		Gvl., (0.7-1cm), cly.; clasts sbang., as above
		Gvl., as above
450'		Gvl. (0.7-1cm), cly.; clasts pred. cht. + volc. rk. & buff-col. ss.
		Gvl. (0.7-1cm); clasts as above; & Cly.
		Gvl., as above; & Cly.
500'		Gvl., cly.; clasts pred. cht.
		Gvl. (≈0.5cm); clasts as above; & Cly., buff-col.
550'		Gvl., as above; & Cly.
		Gvl., as above; & Cly.
		Gvl. (0.7-1cm), clasts as above; & Cly.
600'		Gvl. (0.3-1.5cm); clasts = sbrd.-sbang. cht. & volc. rk.; & Cly.
		Gvl. (0.2-0.7cm); clasts as above; & Cly.
650'		Gvl., as above; & Cly.
		Gvl., as above; & Cly.
		Gvl., as above; & Cly.
700'		Gvl., as above; & Cly.
		Gvl.; clasts = cht., volc. rk., grn. silicif. tuff & alt. bas.; & Cly.
750'		Gvl., cly.; clasts as above
		Gvl., as above
		Gvl., as above
800'		Gvl., clasts = cht., volc. rk., grnst. & ss.
		Gvl., as above
850'		Gvl., cly.; clasts as above
		Gvl., as above
		Gvl., as above
900'		Gvl.; clasts as above
		Gvl., cly.; clasts as above
950'		Sd. (≤ 3mm), cly. clasts = cht., volc. rk., grnst. & ss.
		Sd., as above; & Cly.
		Sd., as above; & Cly.
1,000'		Sd. (<1mm); clasts cht.-rich; & Cly.
		Sd., as above
1,050'		Sd., as above
		Sd., as above
		Sd., as above
1,100'		Sd., as above
		Sd., pbly., as above
1,150'		Sd. (<1mm); clasts as above
		Sd., as above
		Sd., as above
1,200'		Sd. (<2mm); clasts sbrd., mostly cht.
		Sd., as above
		Sd., as above
1,250'		Sd., as above
		Sd., as above
		Sd., as above
1,300'		Sd., as above
		Sd., as above
		Sd., as above
1,350'		Sd., as above
		Sd., as above
		Sd., as above
1,400'		Sd., pbly., as above
		Sd. (<2mm); clasts as above
1,450'		Sd., as above
		Sd., as above
1,500'		Sd., as above

Note: Samples from 150-200' contaminated with cement.

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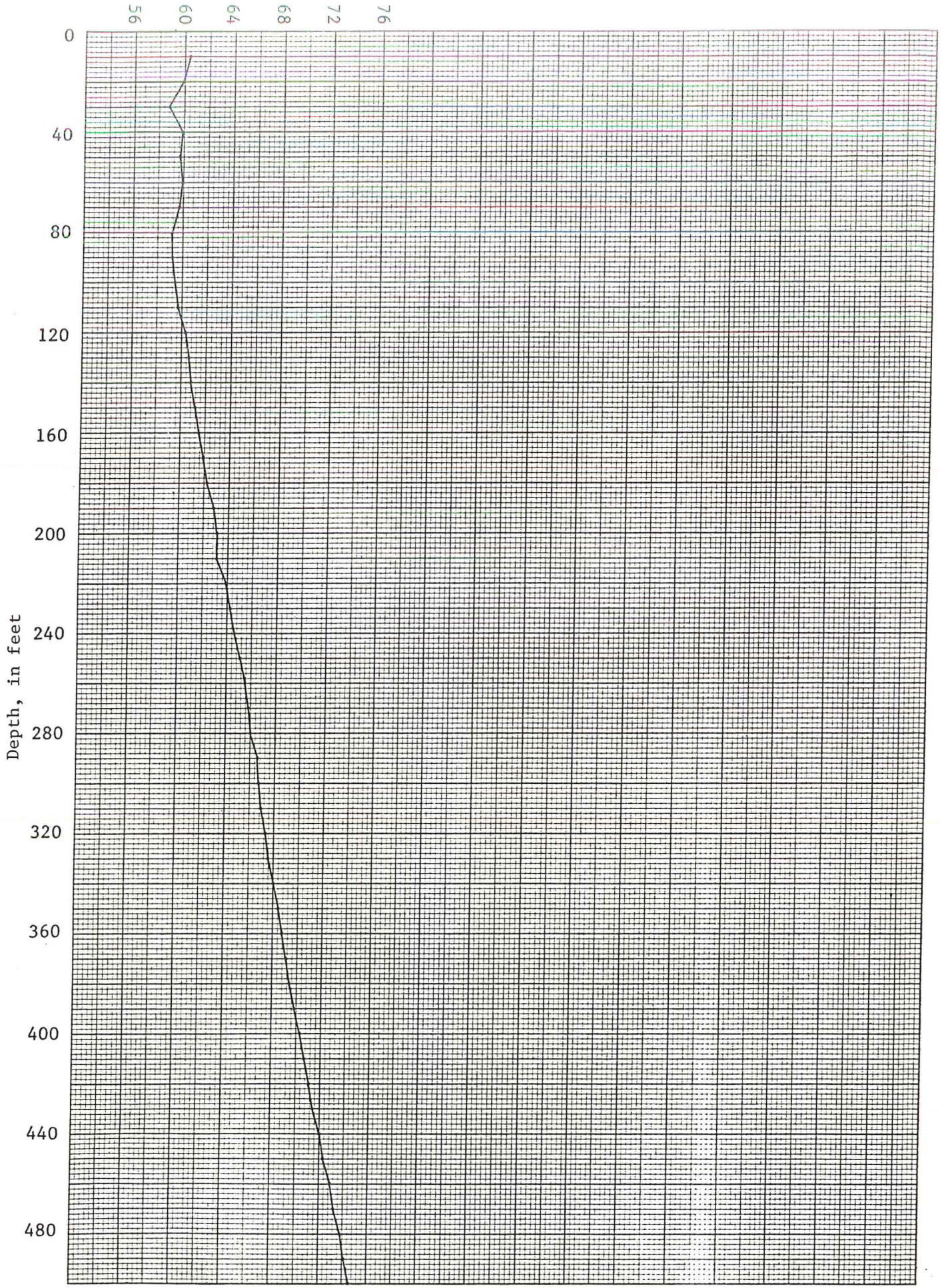
APPENDIX C.

Temperature logs of shallow (85-152 m)
temperature-gradient holes.

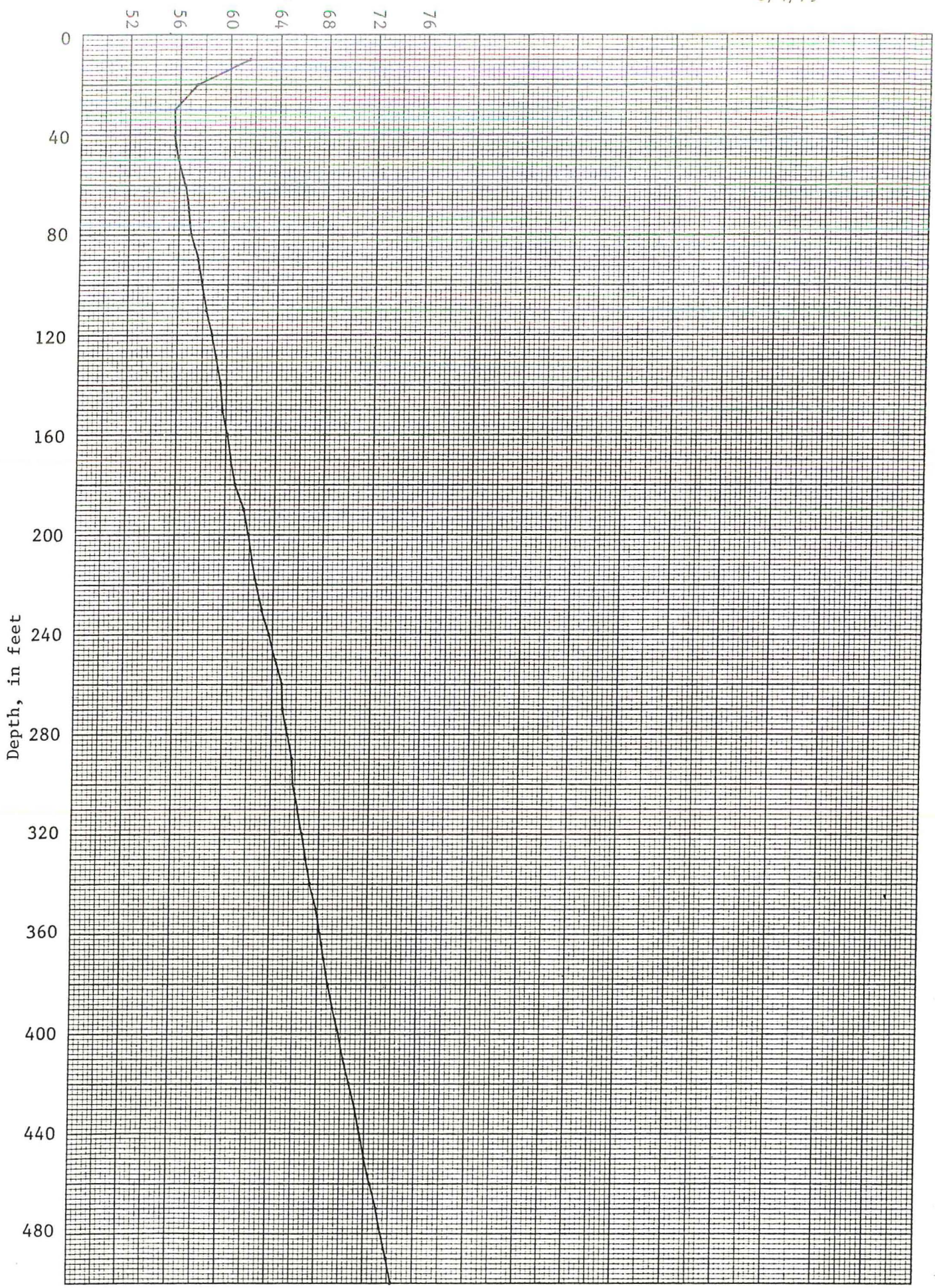
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-2
7/18/79



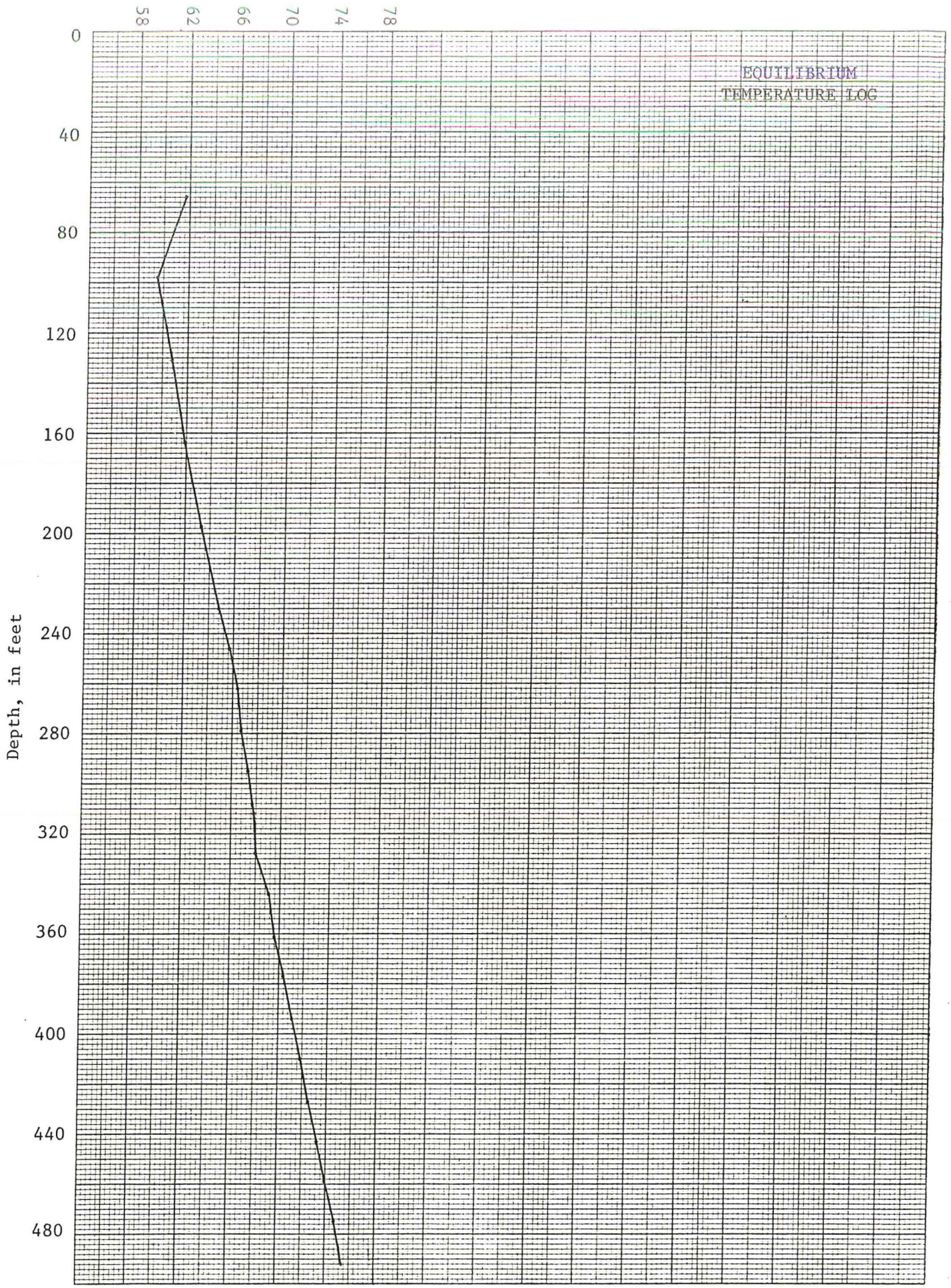
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-2
8/4/79



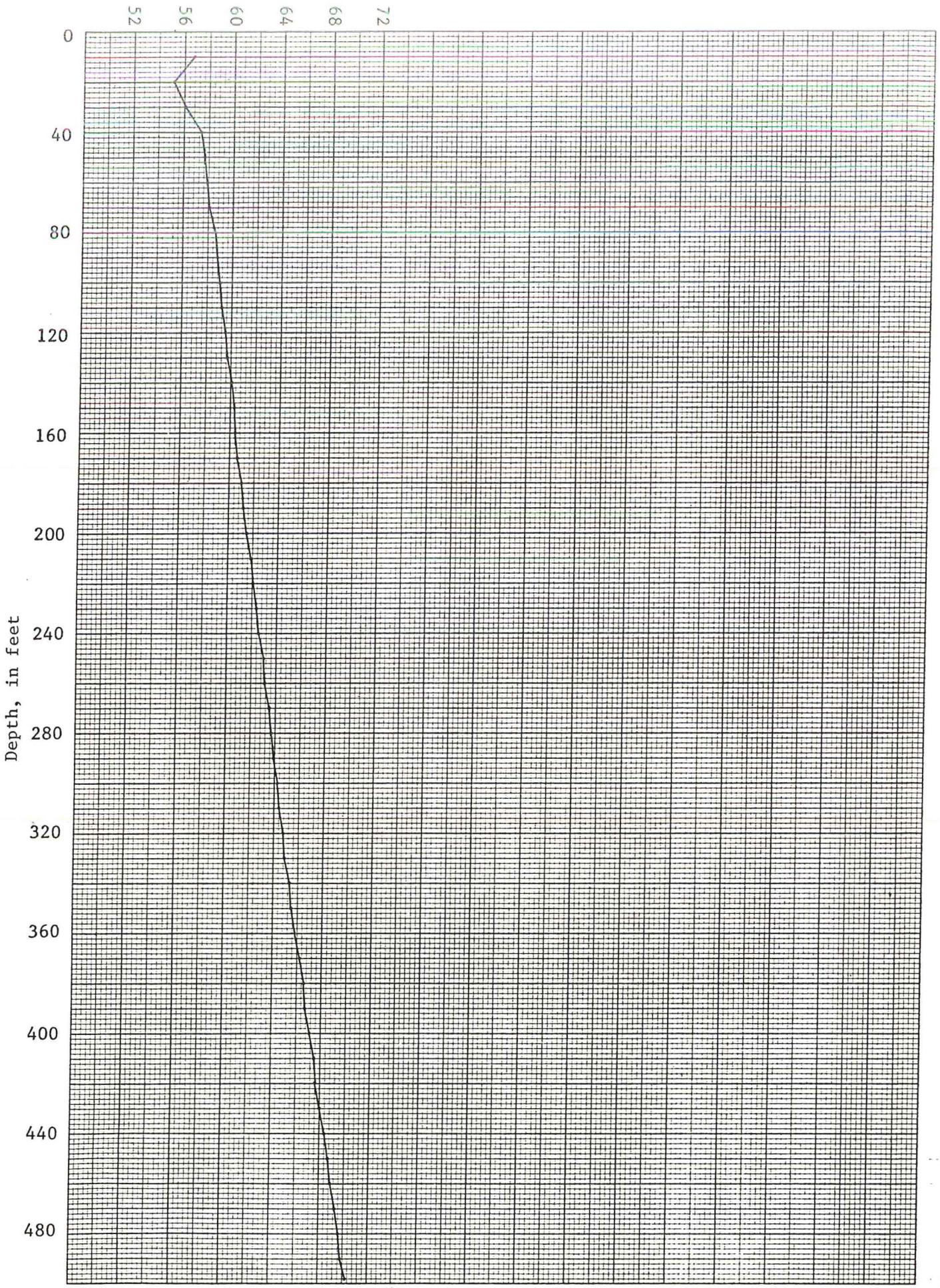
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-2
9/30/79



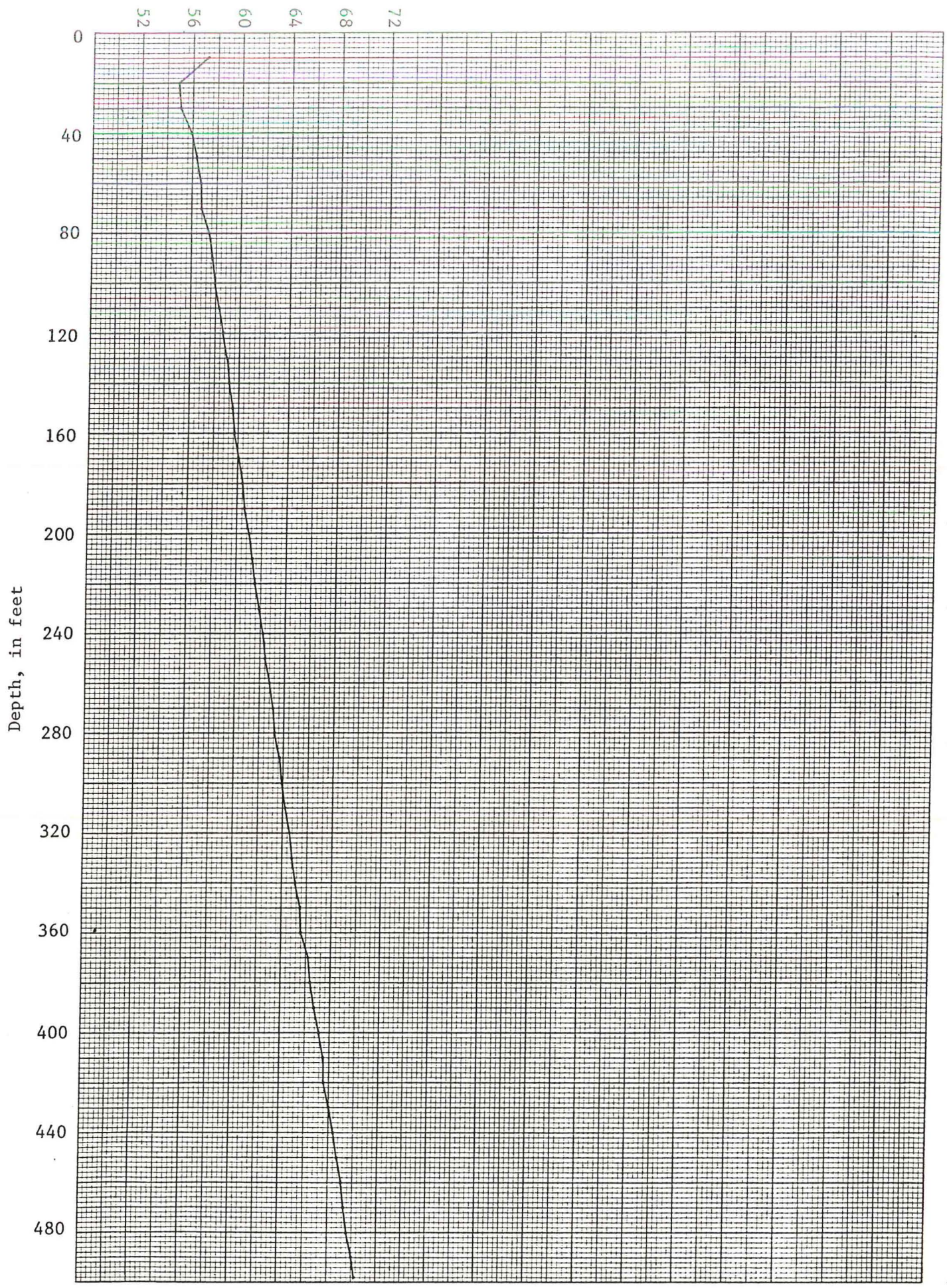
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-3
6/20/79



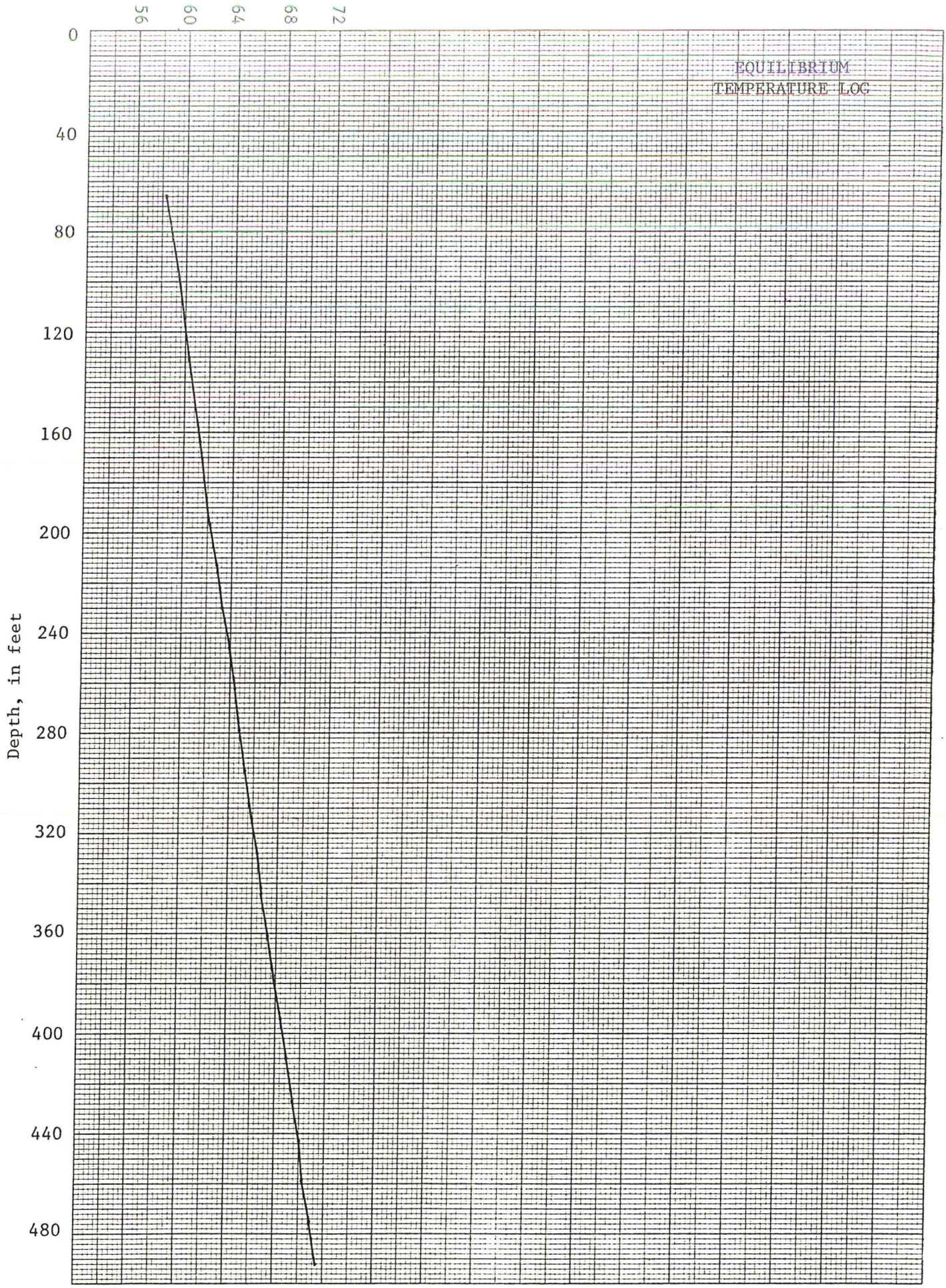
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-3
6/29/79



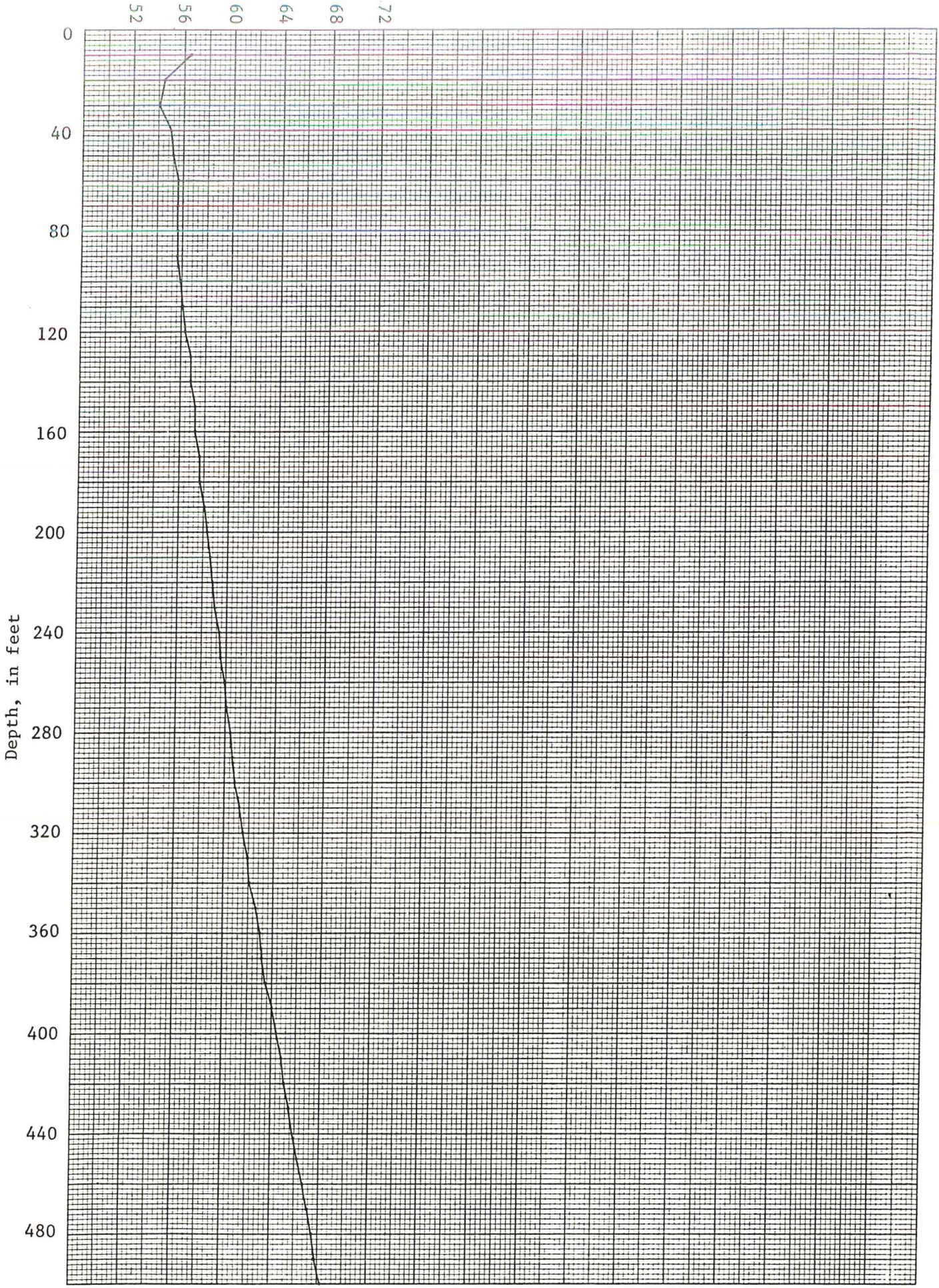
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-3
9/30/79



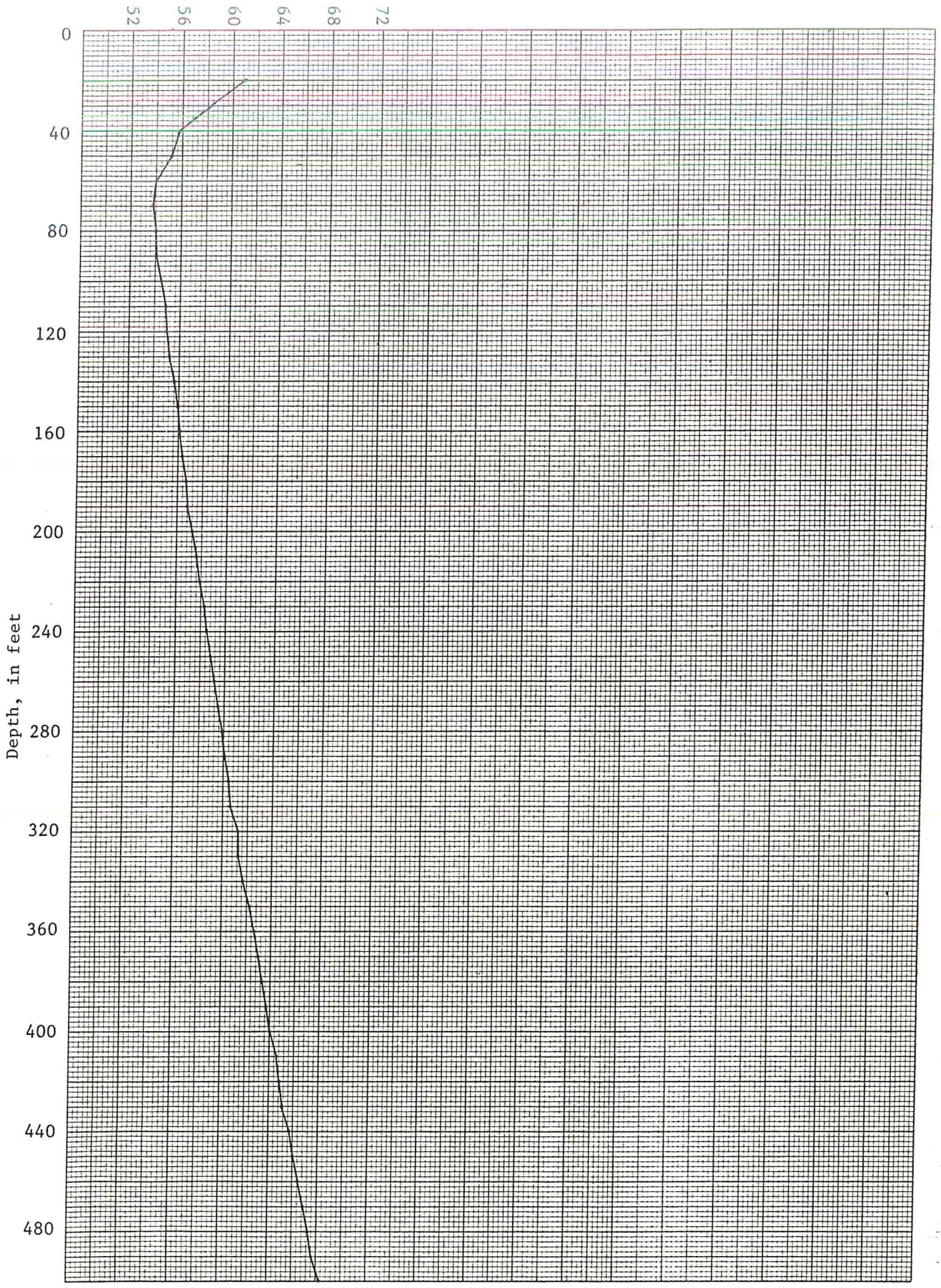
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-4
7/20/79



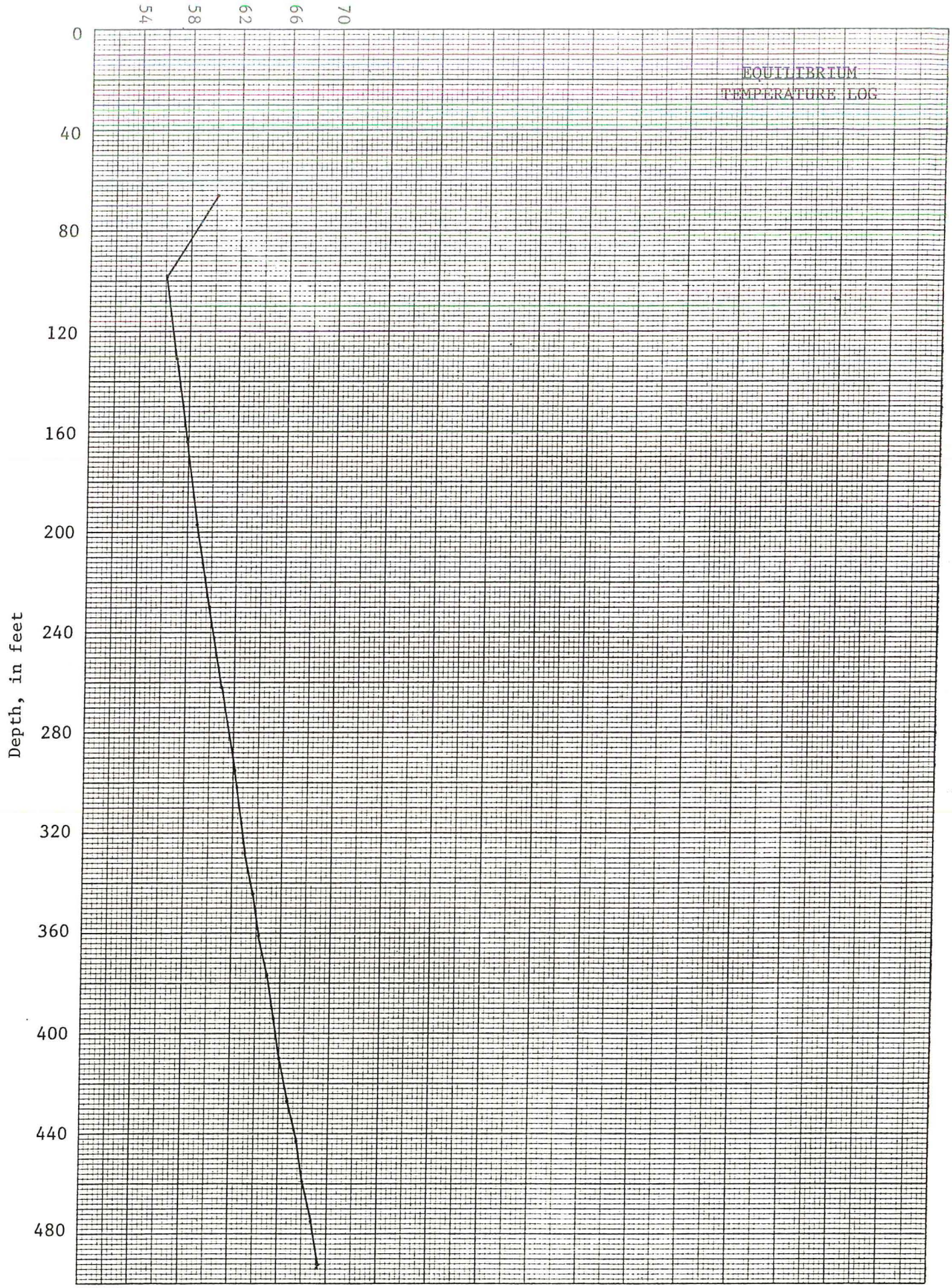
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-4
8/3/79



TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

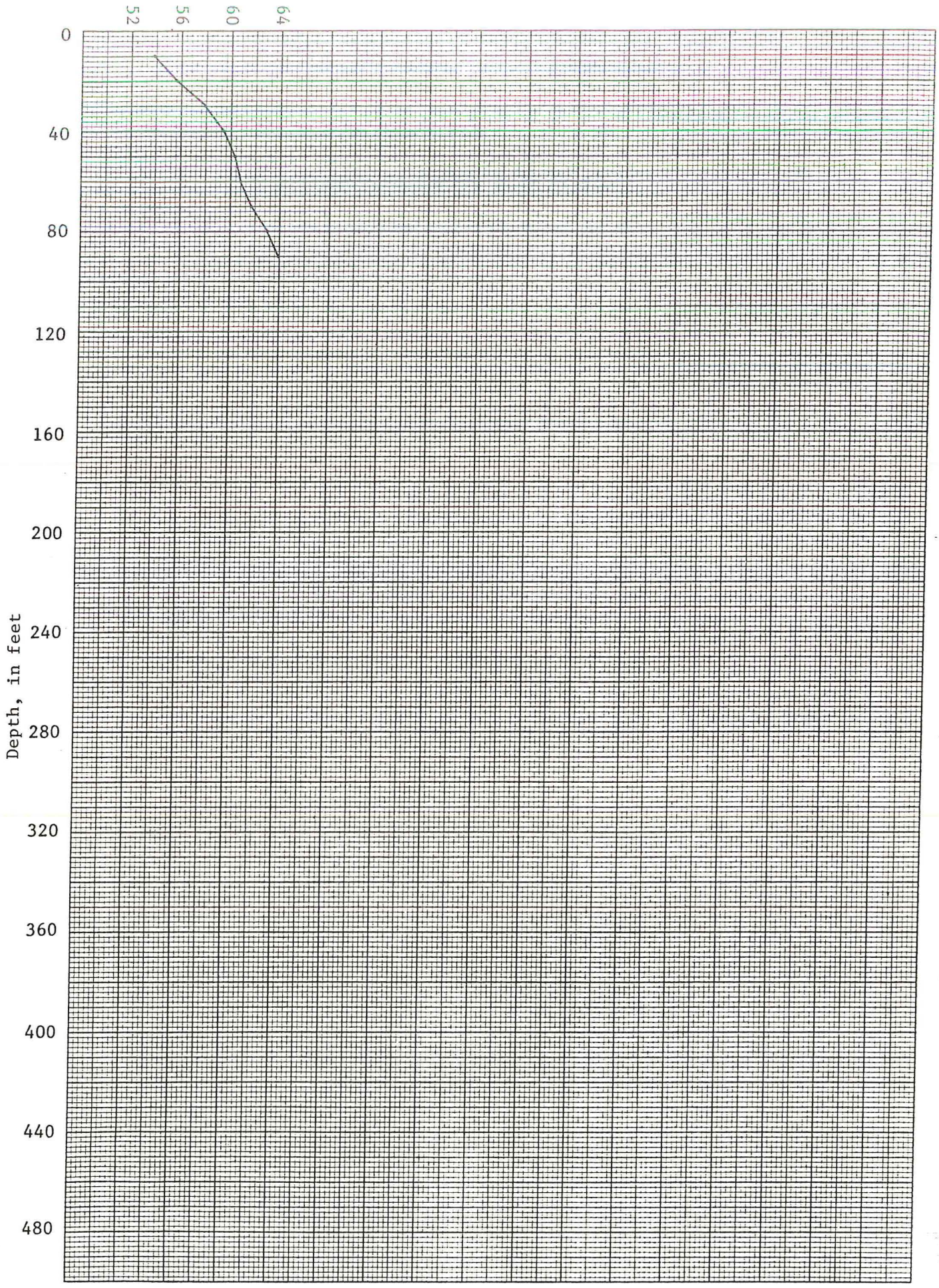
S-GV-79-4
9/30/79



TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

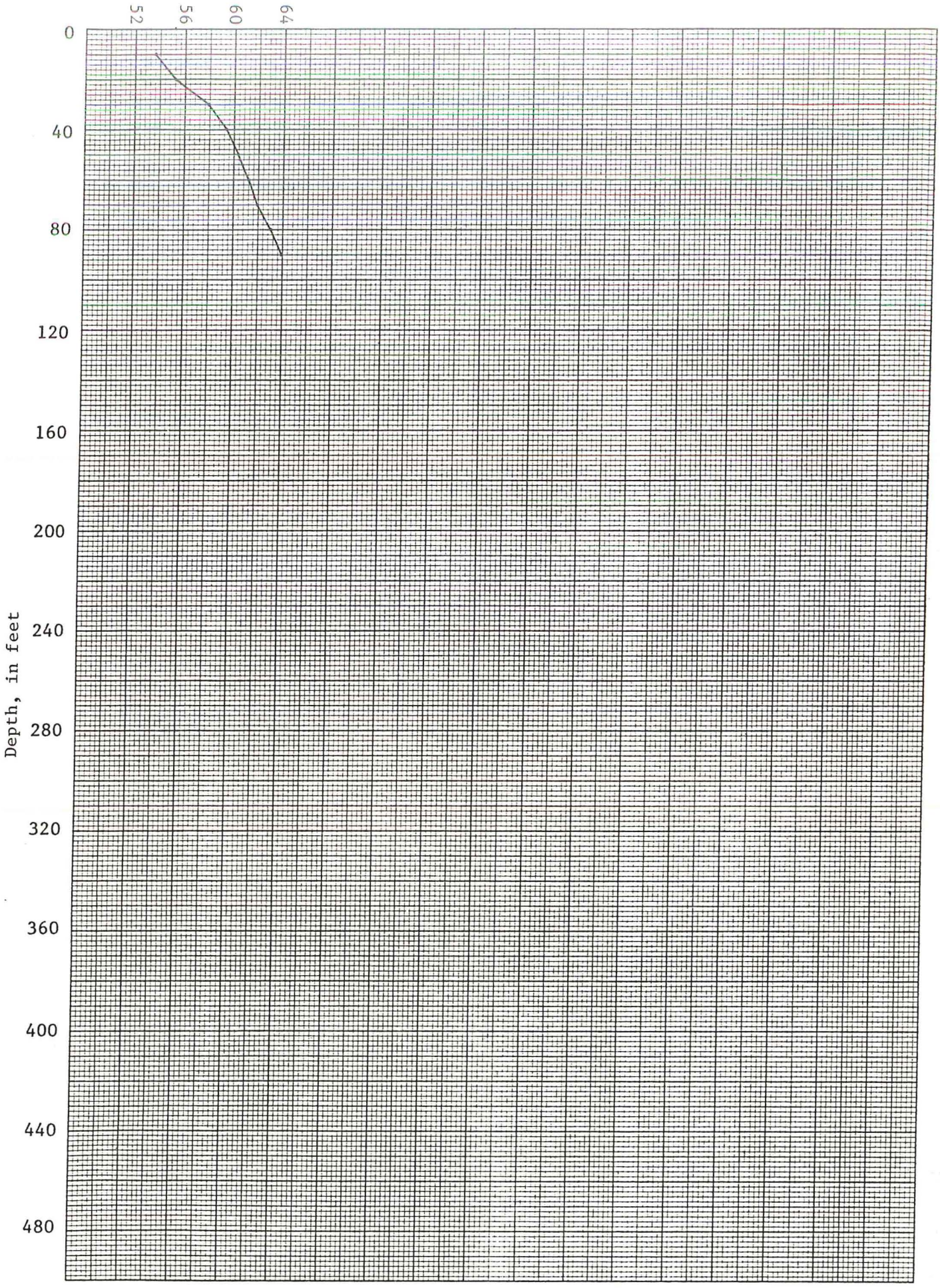
S-GV-79-5

6/22/79



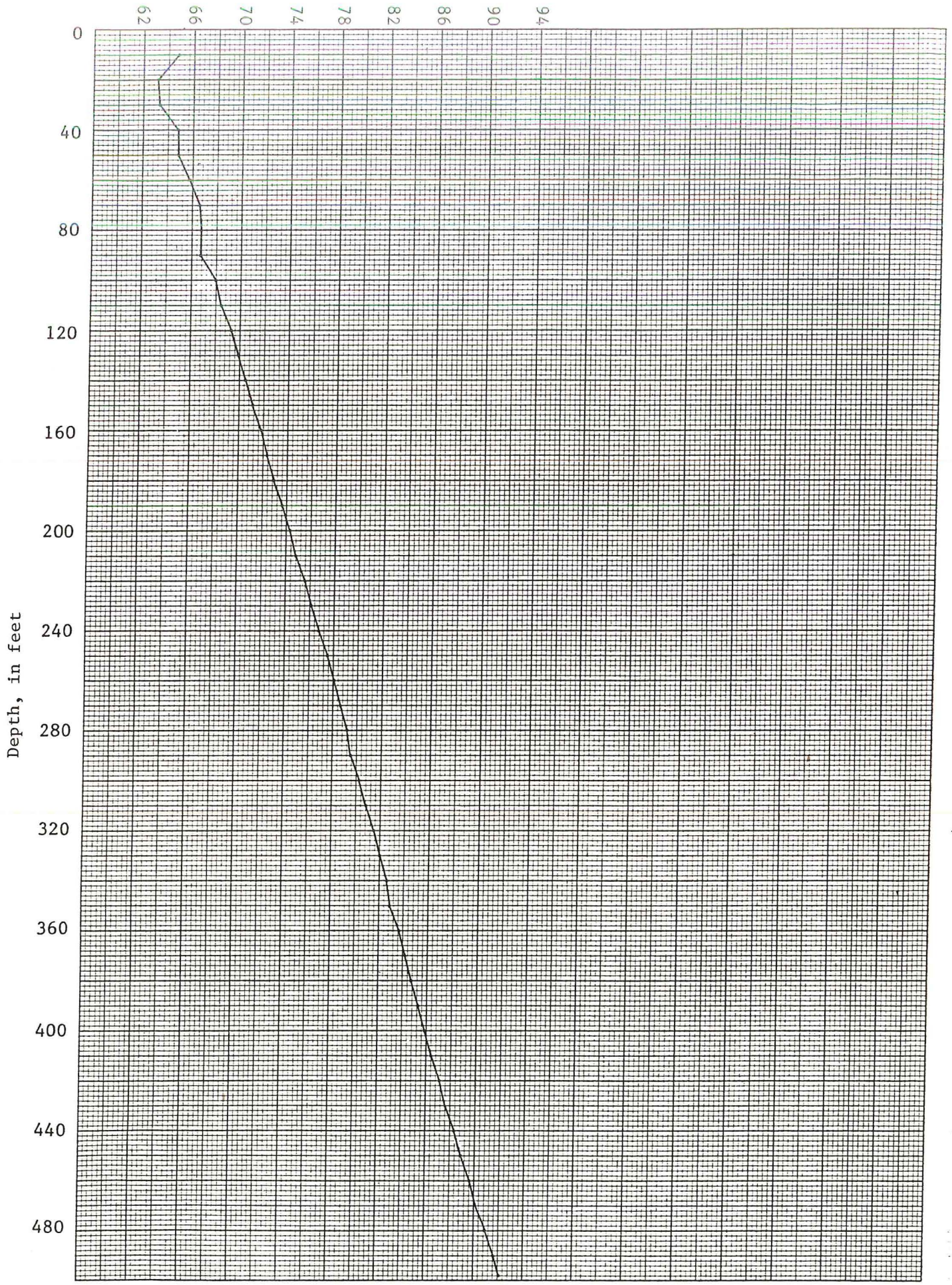
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-5
6/30/79



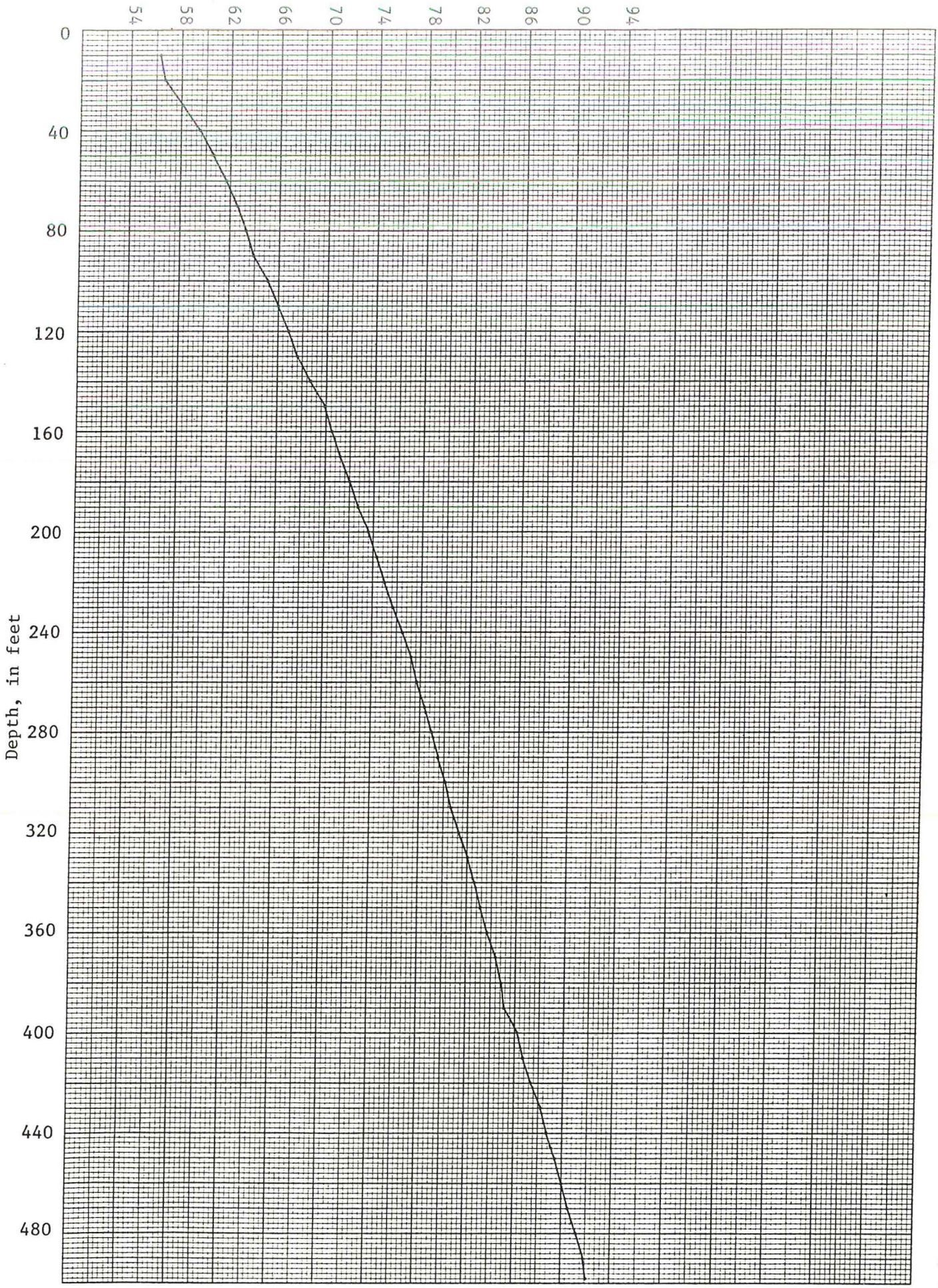
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-5A
6/22/79



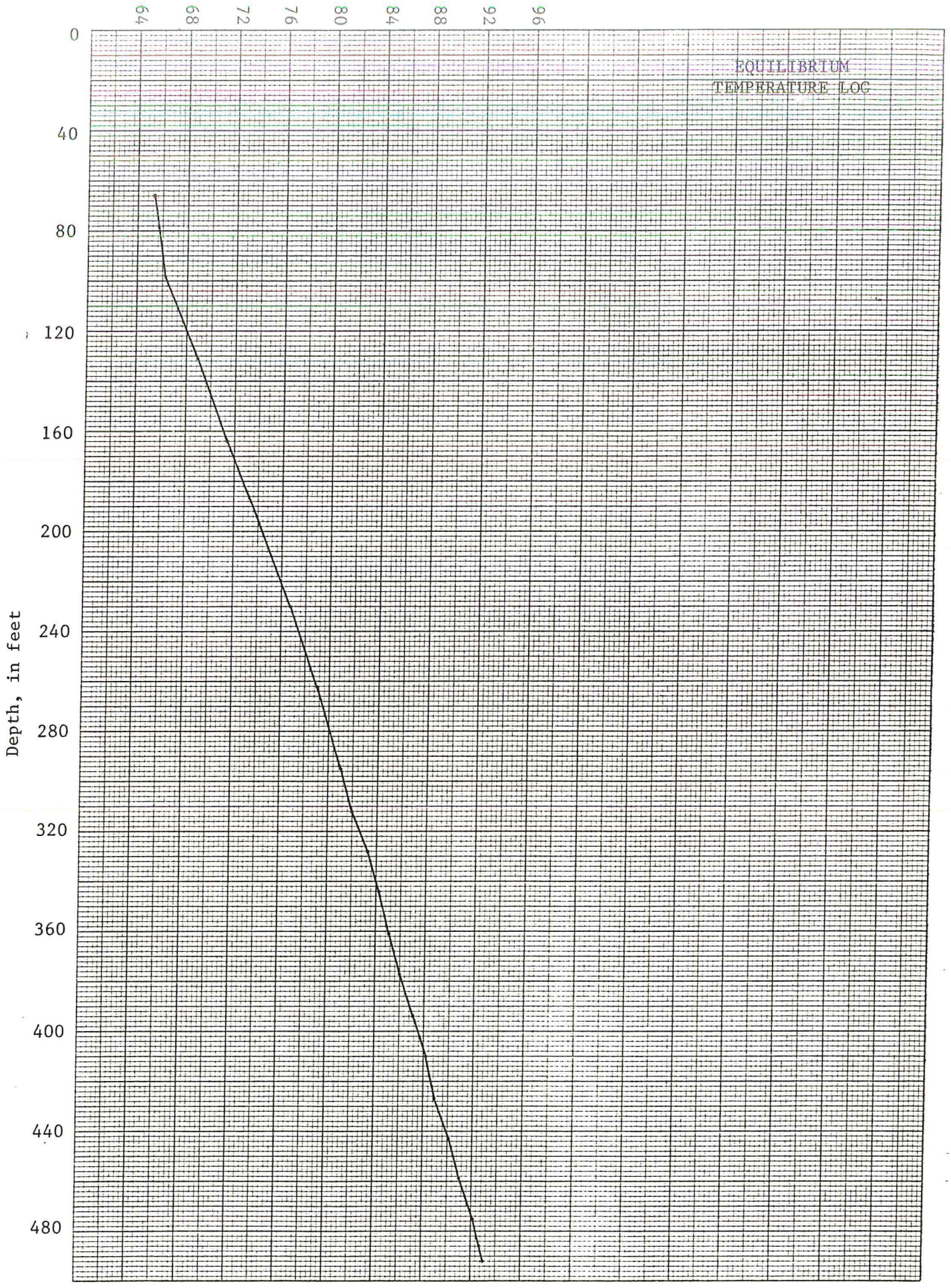
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-5A
6/30/79



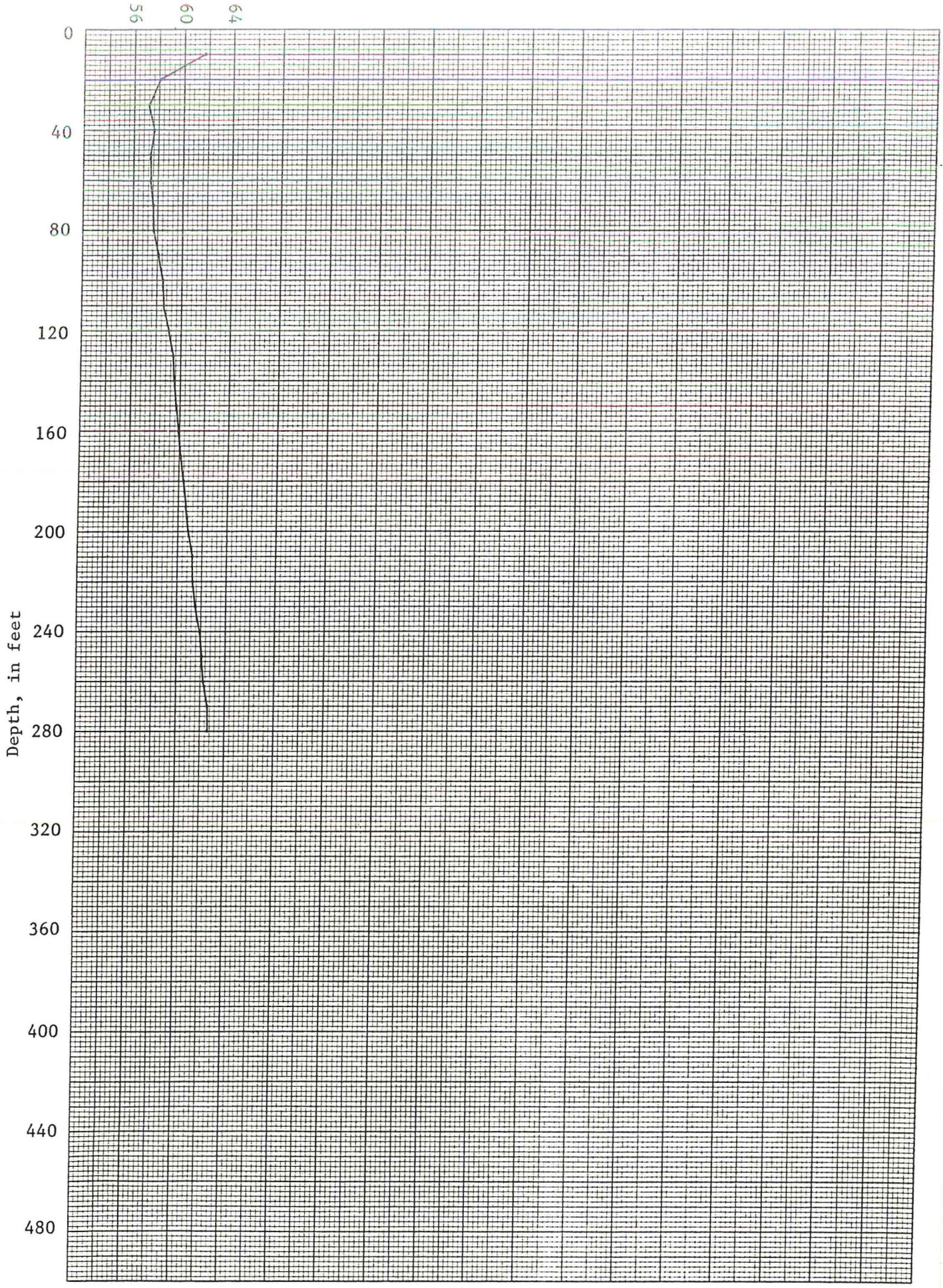
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-5A
9/30/79



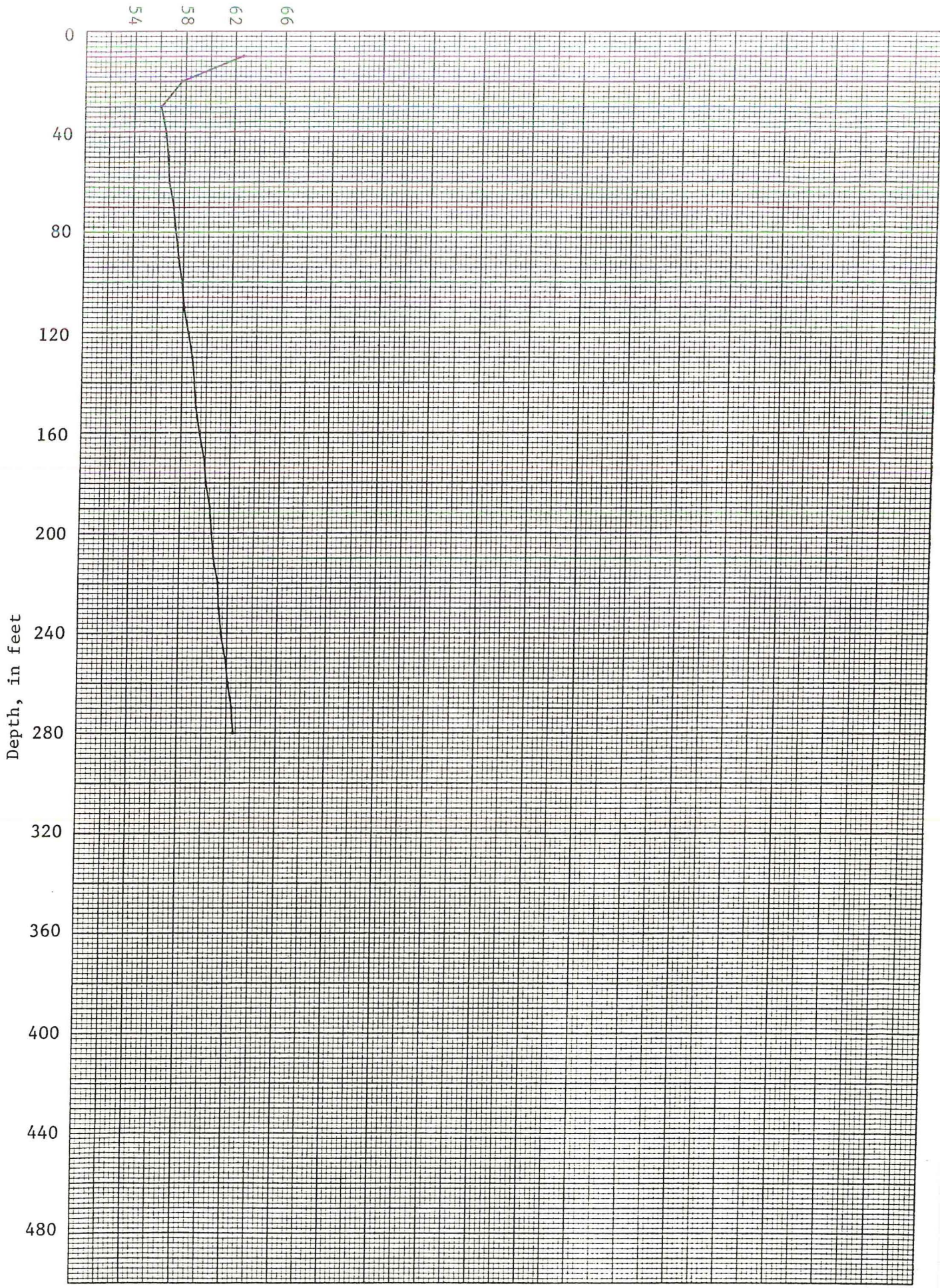
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-7
6/28/79



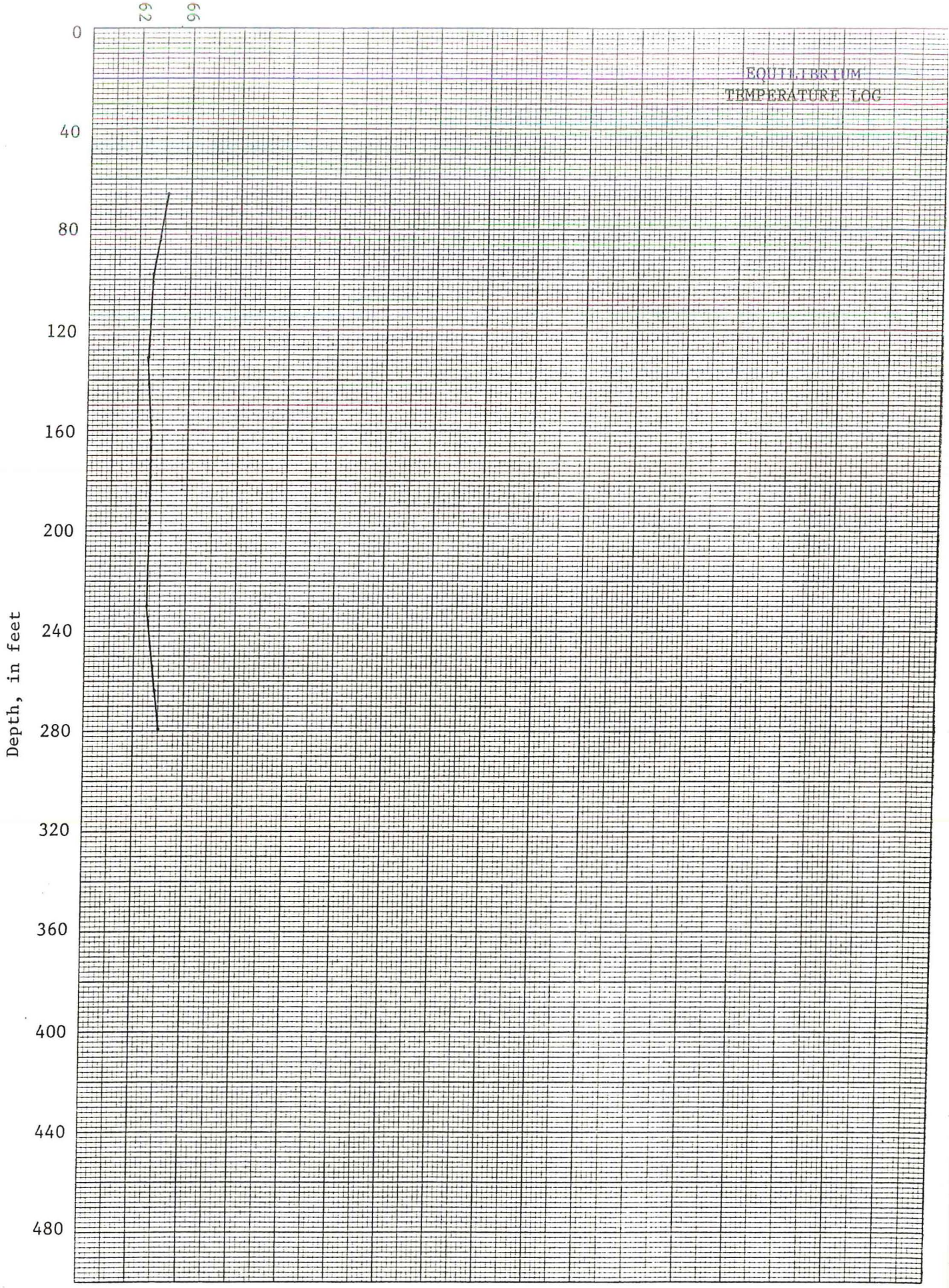
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-7
7/6/79



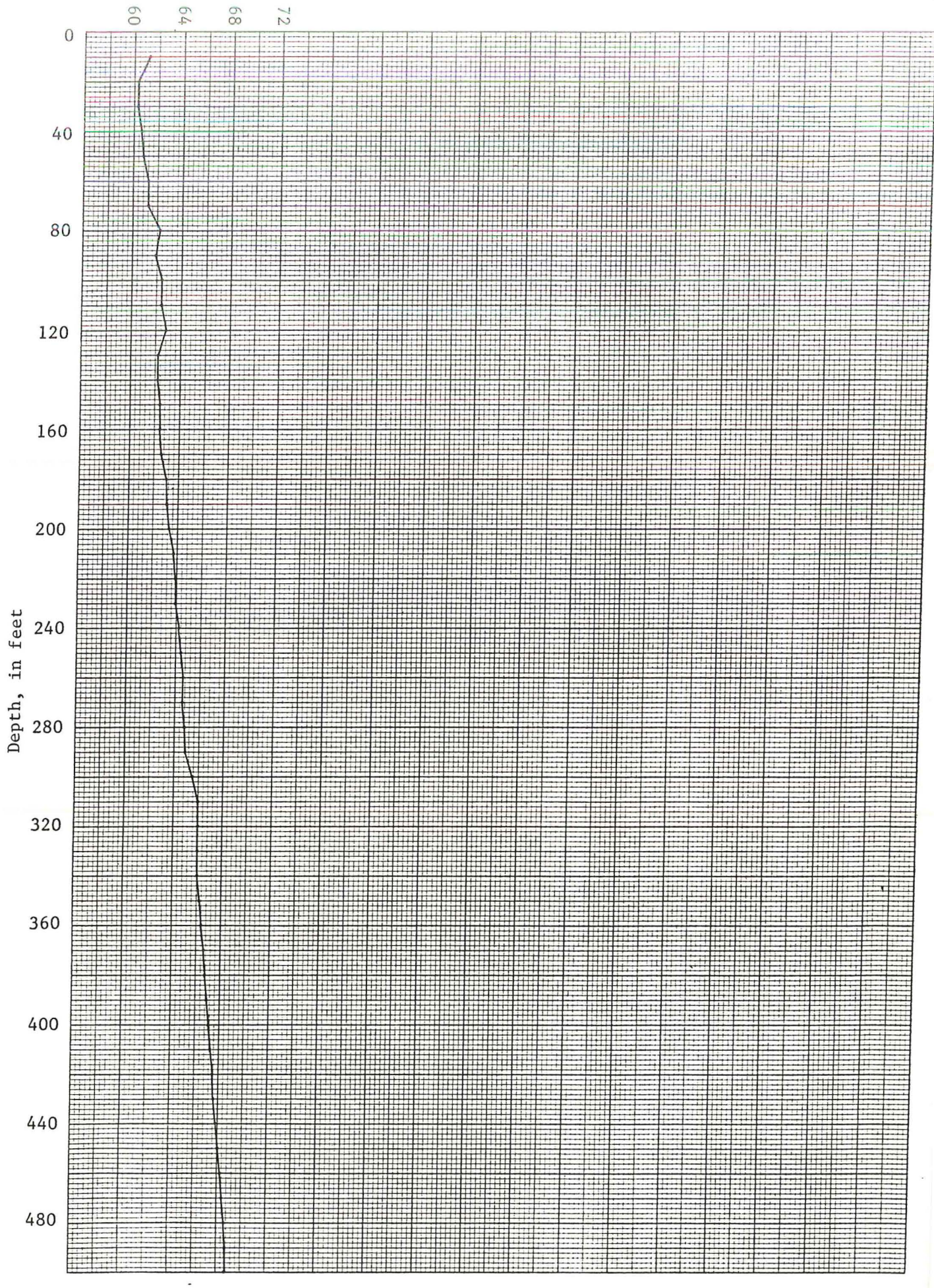
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-7
9/30/79



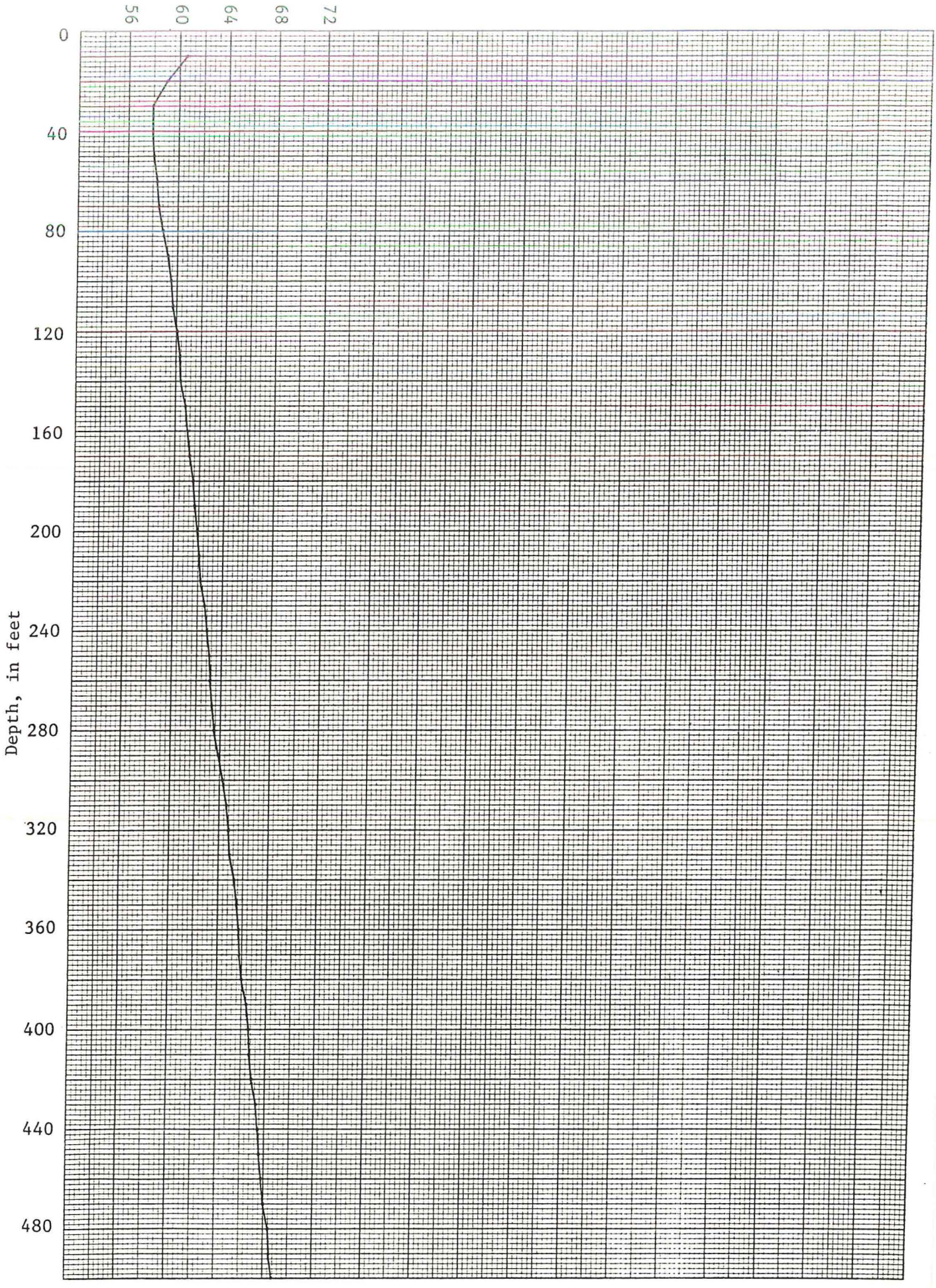
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-8
7/1/79



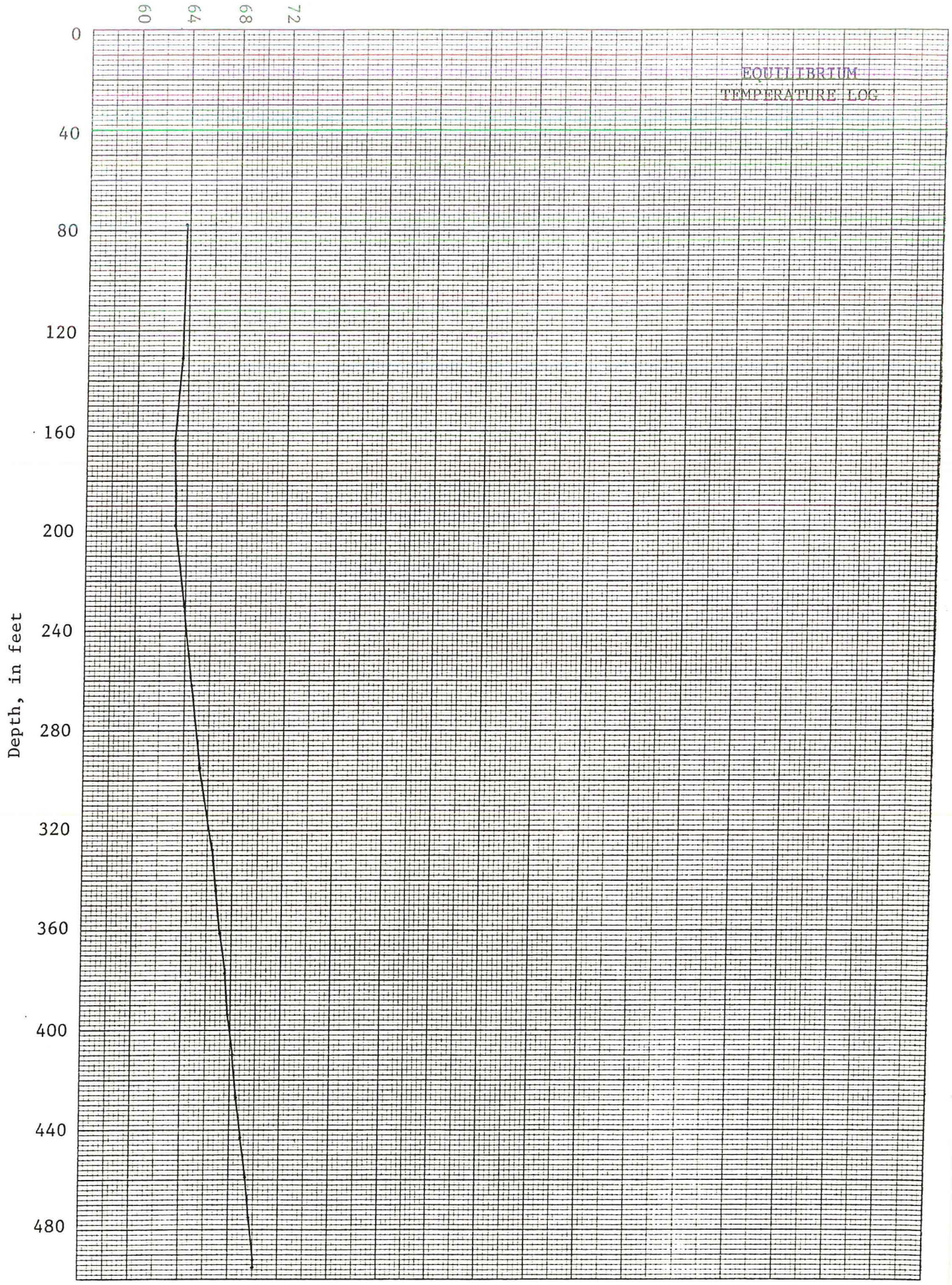
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-8
7/14/79



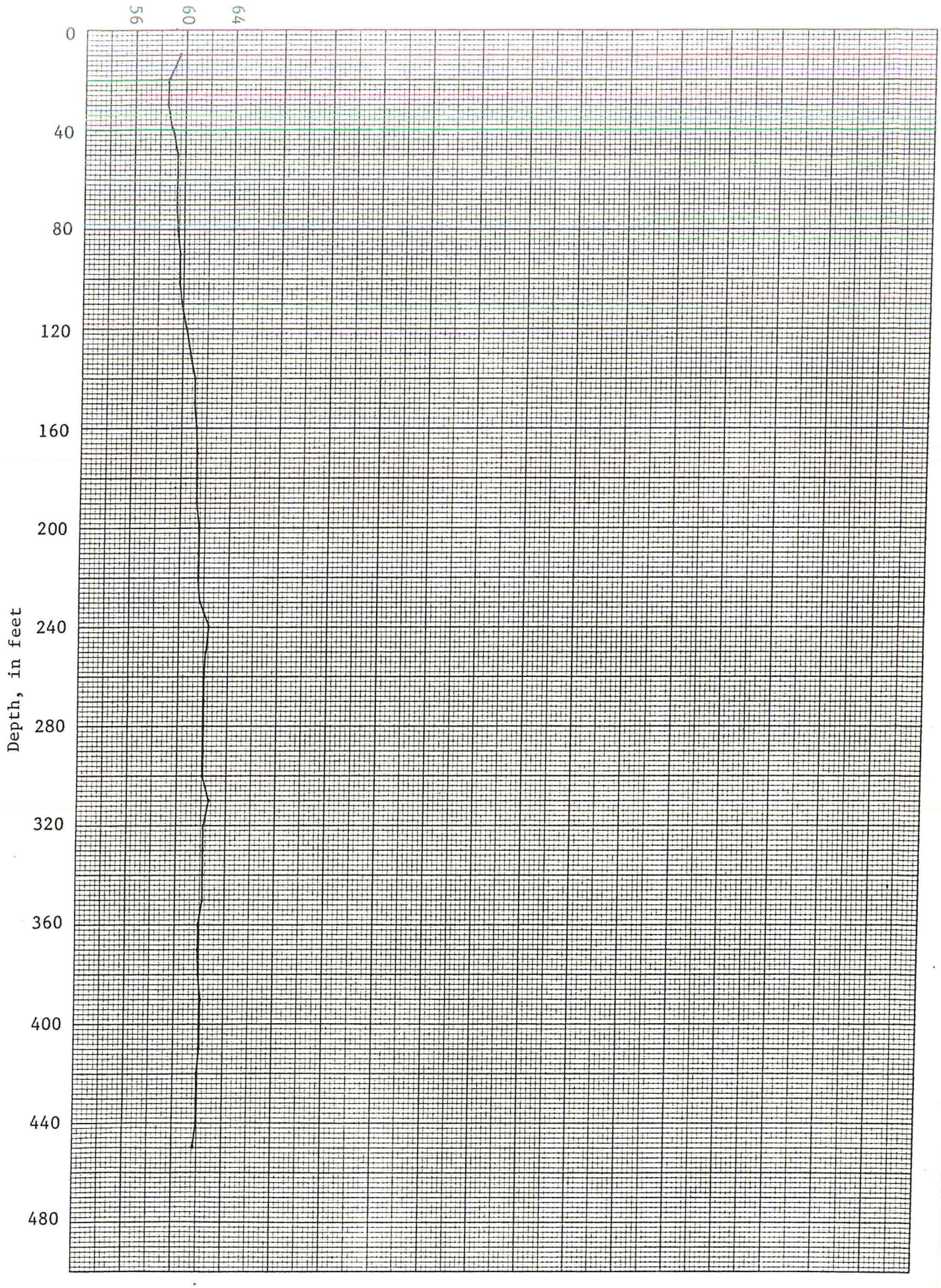
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-8
9/30/79



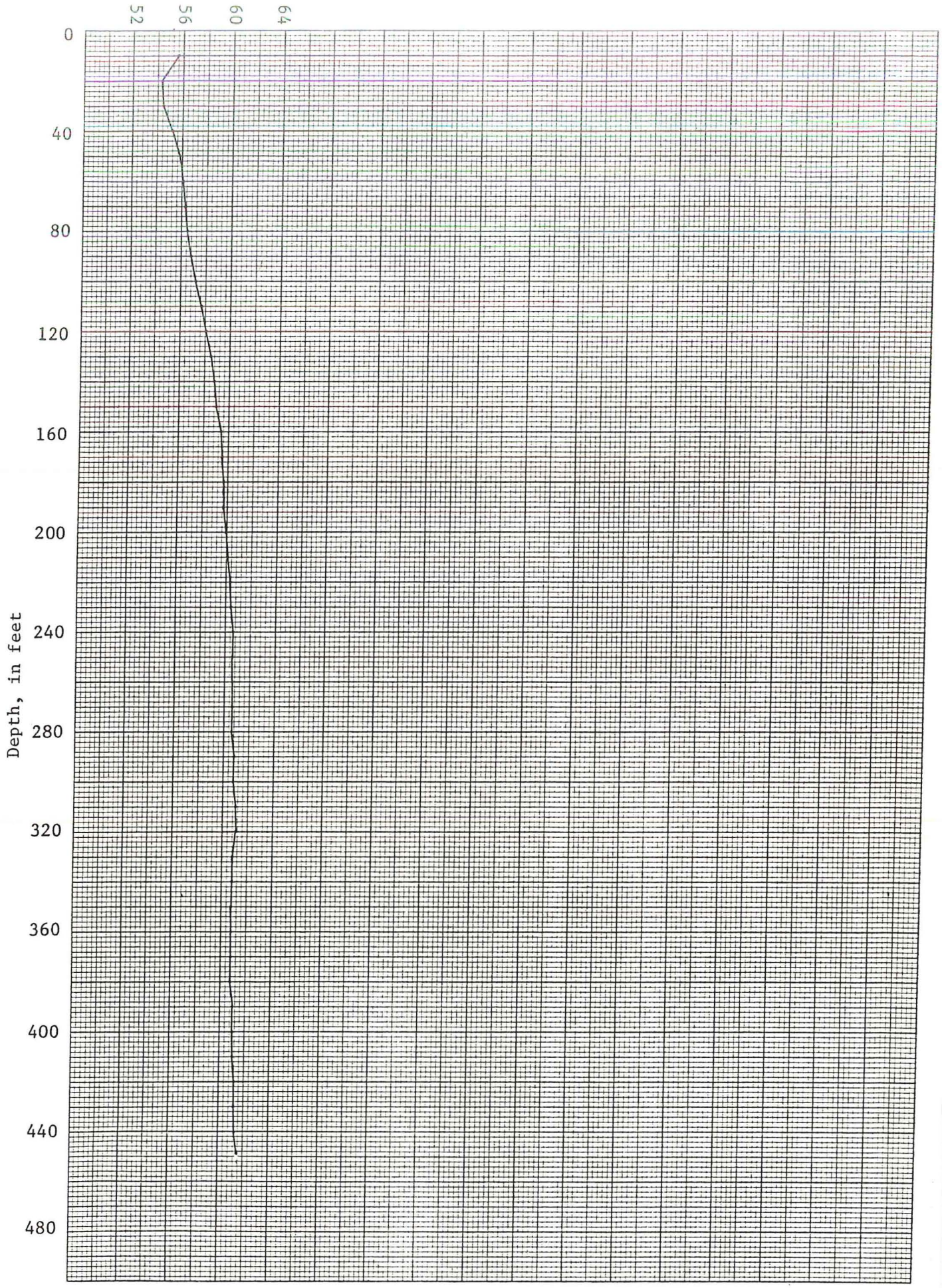
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-9
7/3/79



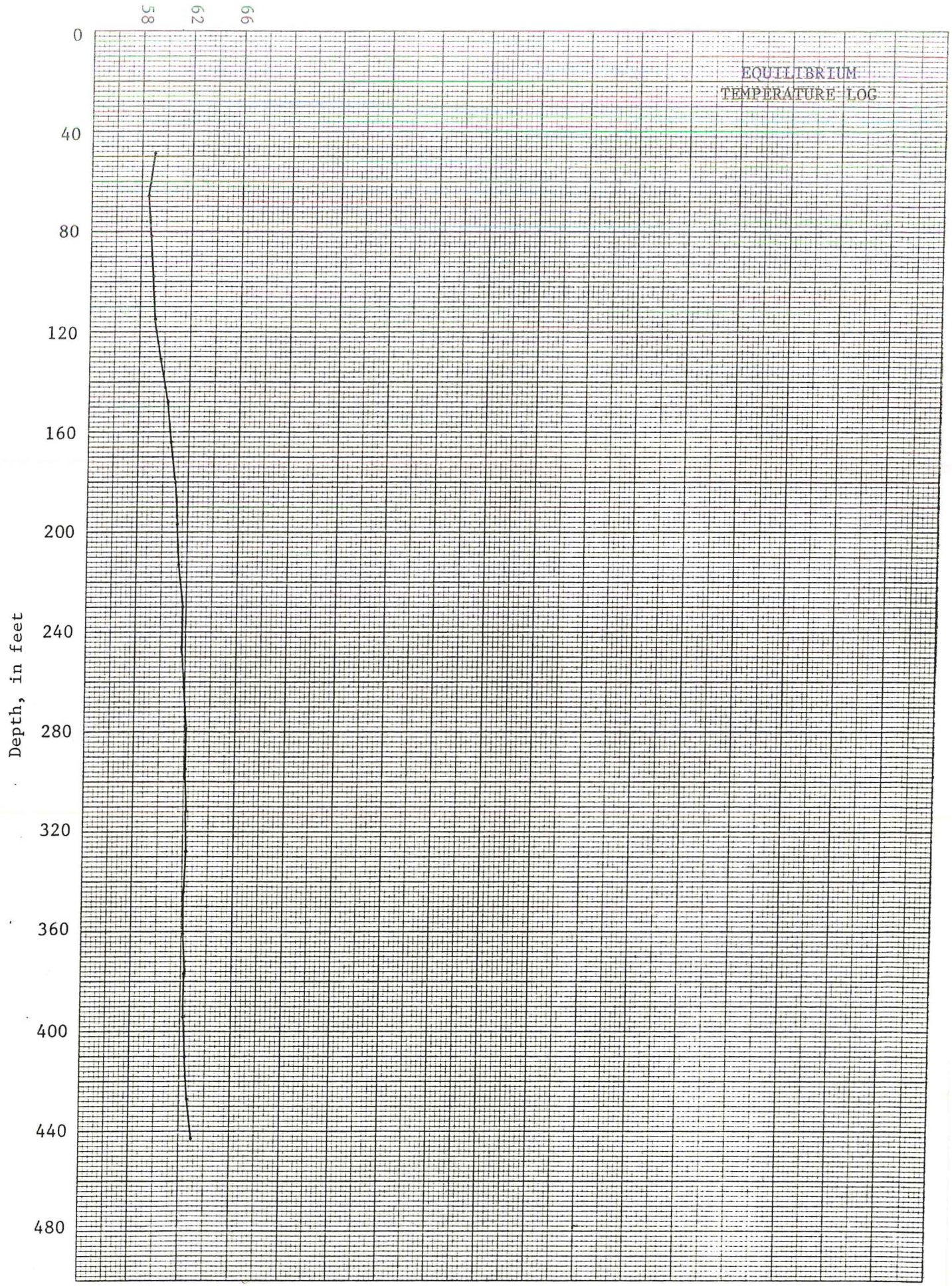
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-9
7/14/79



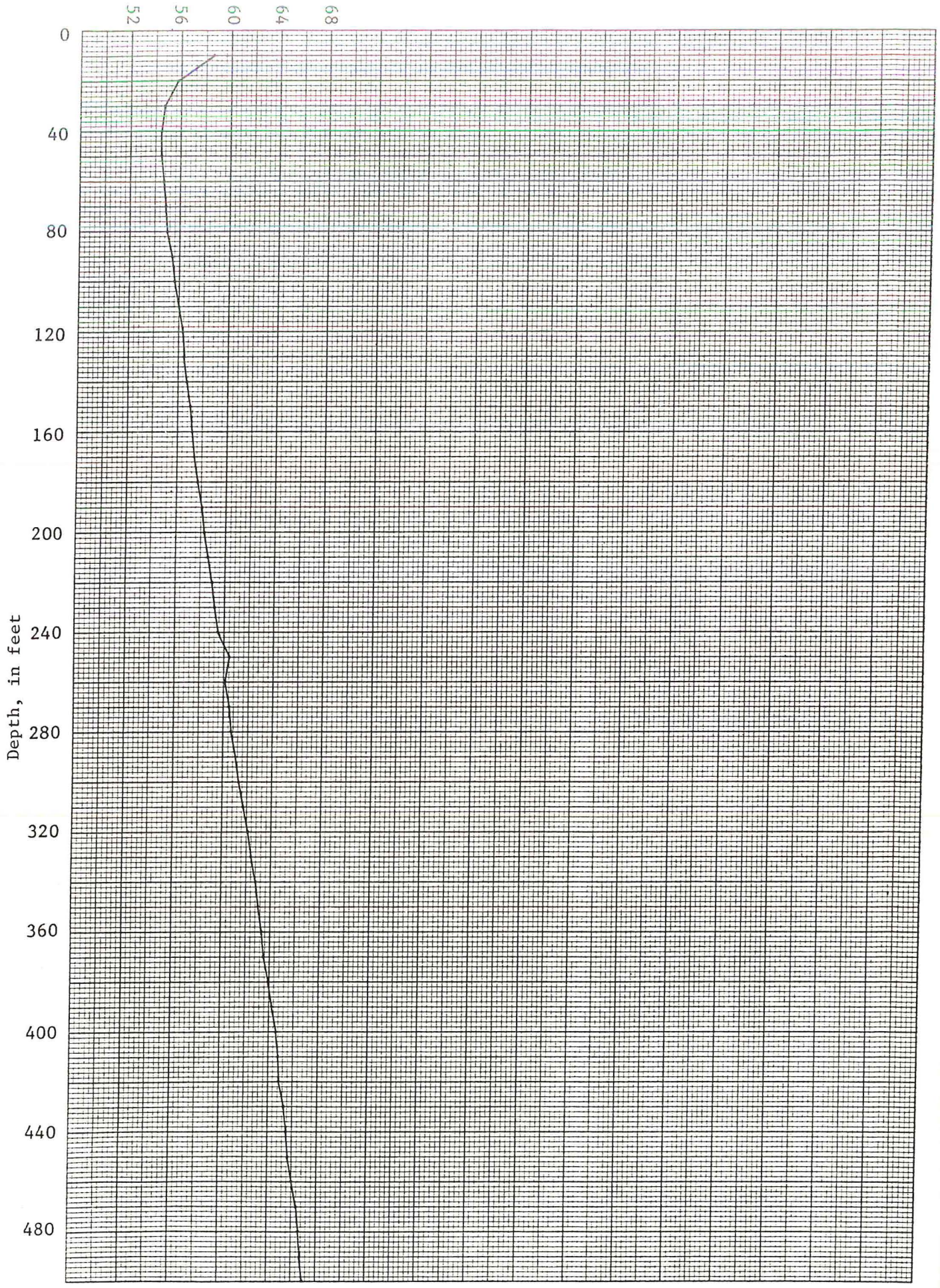
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-9
9/24/79



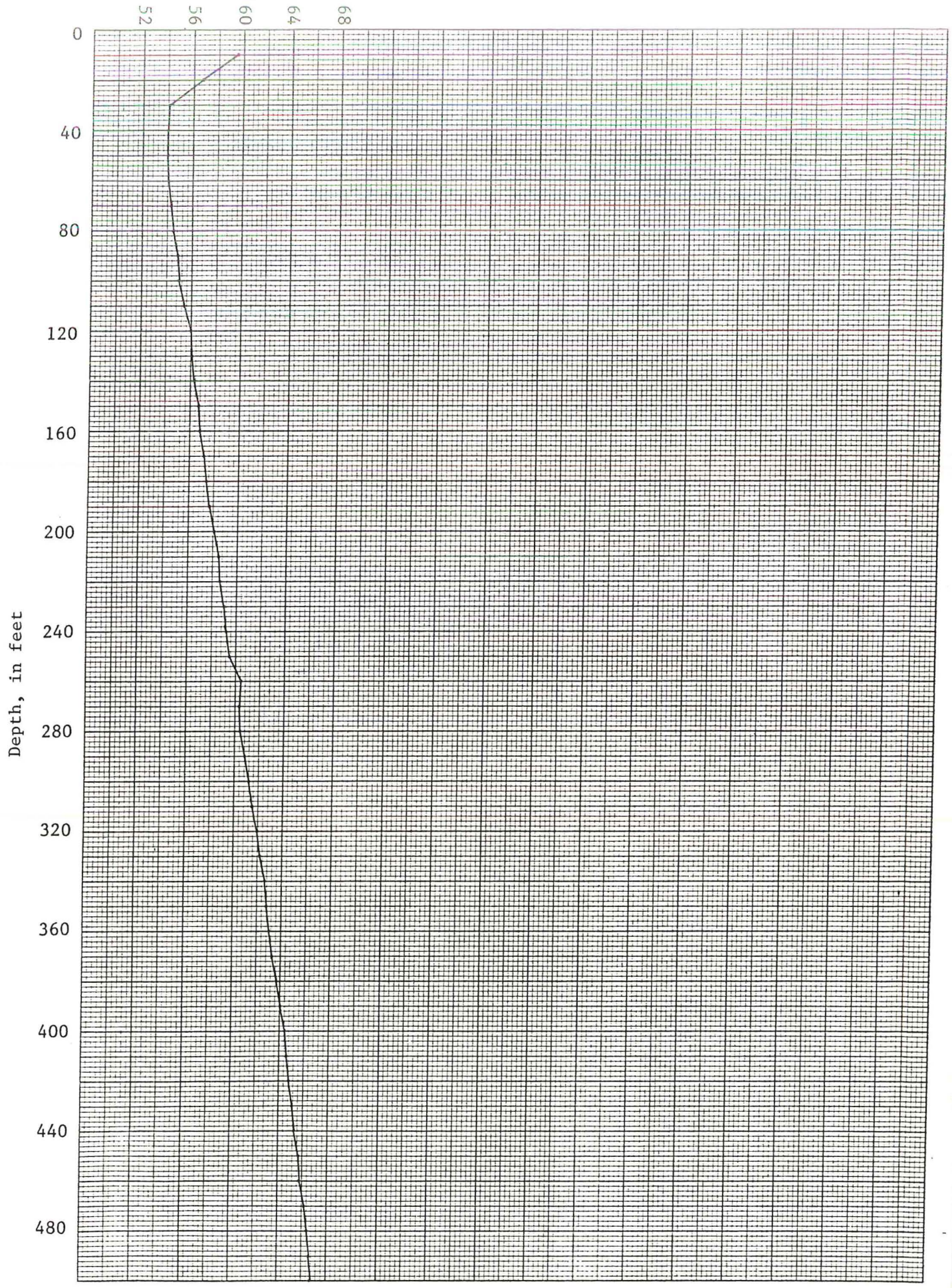
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-10
7/13/79



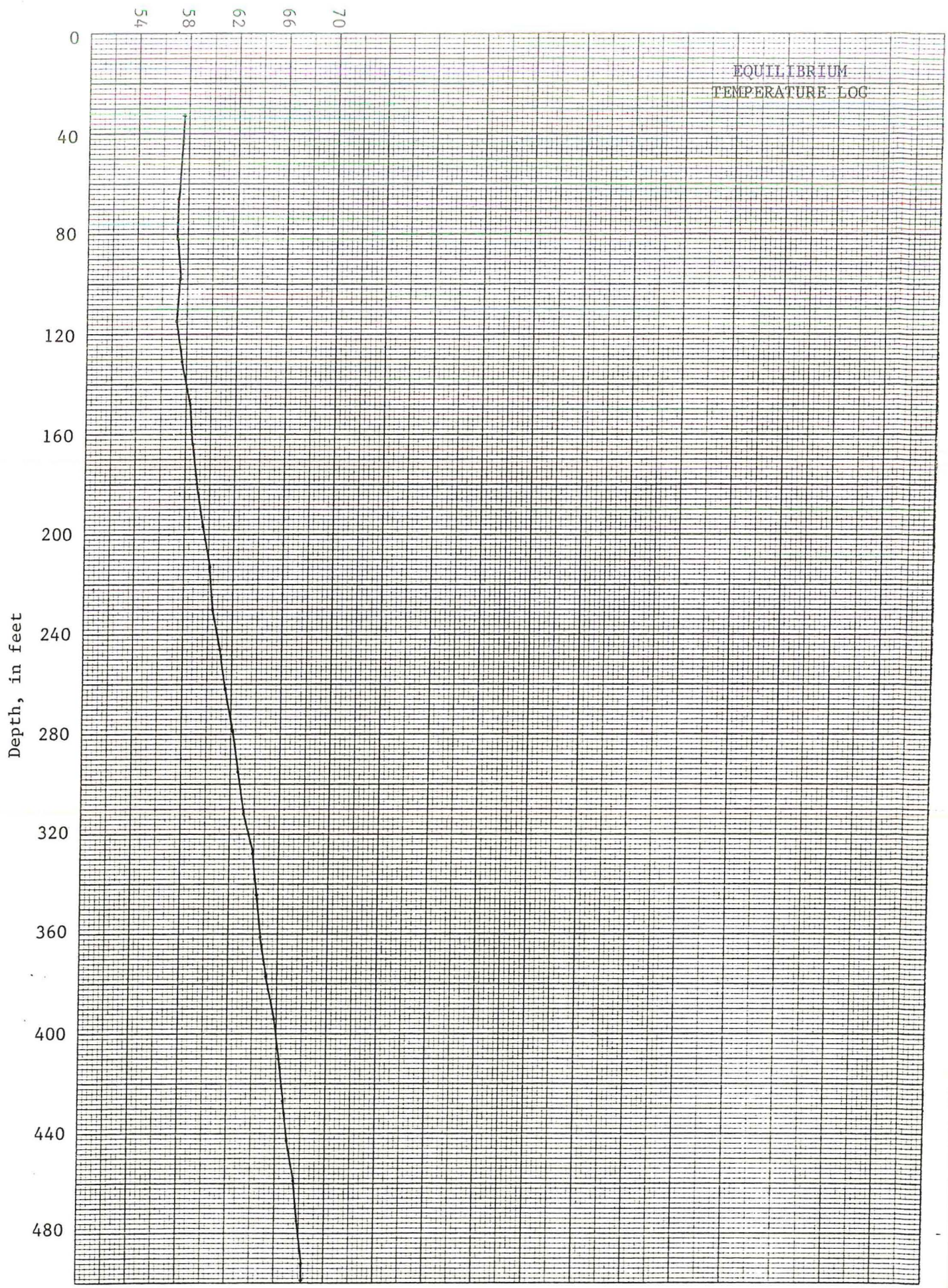
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-10
8/1/79



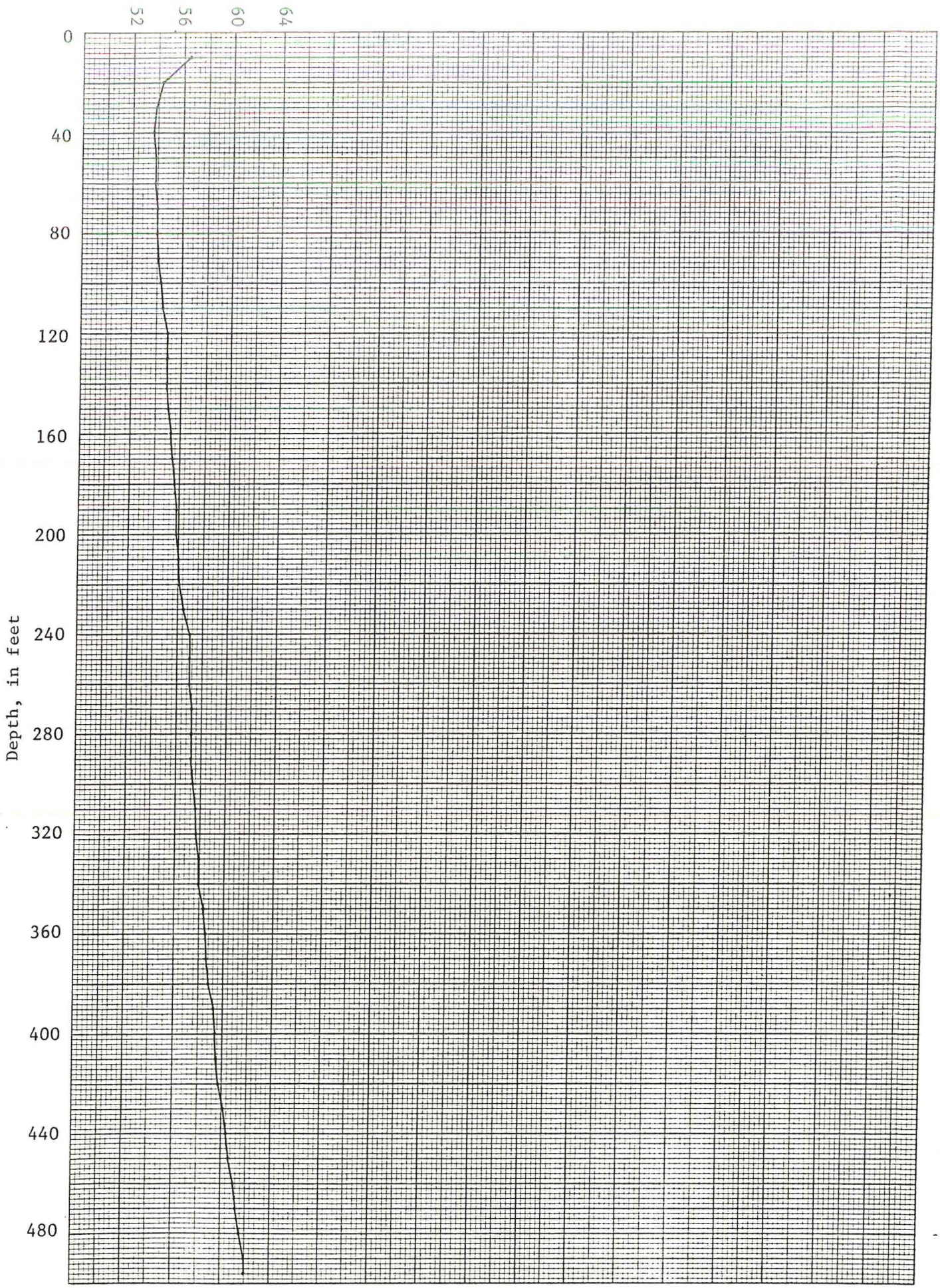
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-10
9/24/79



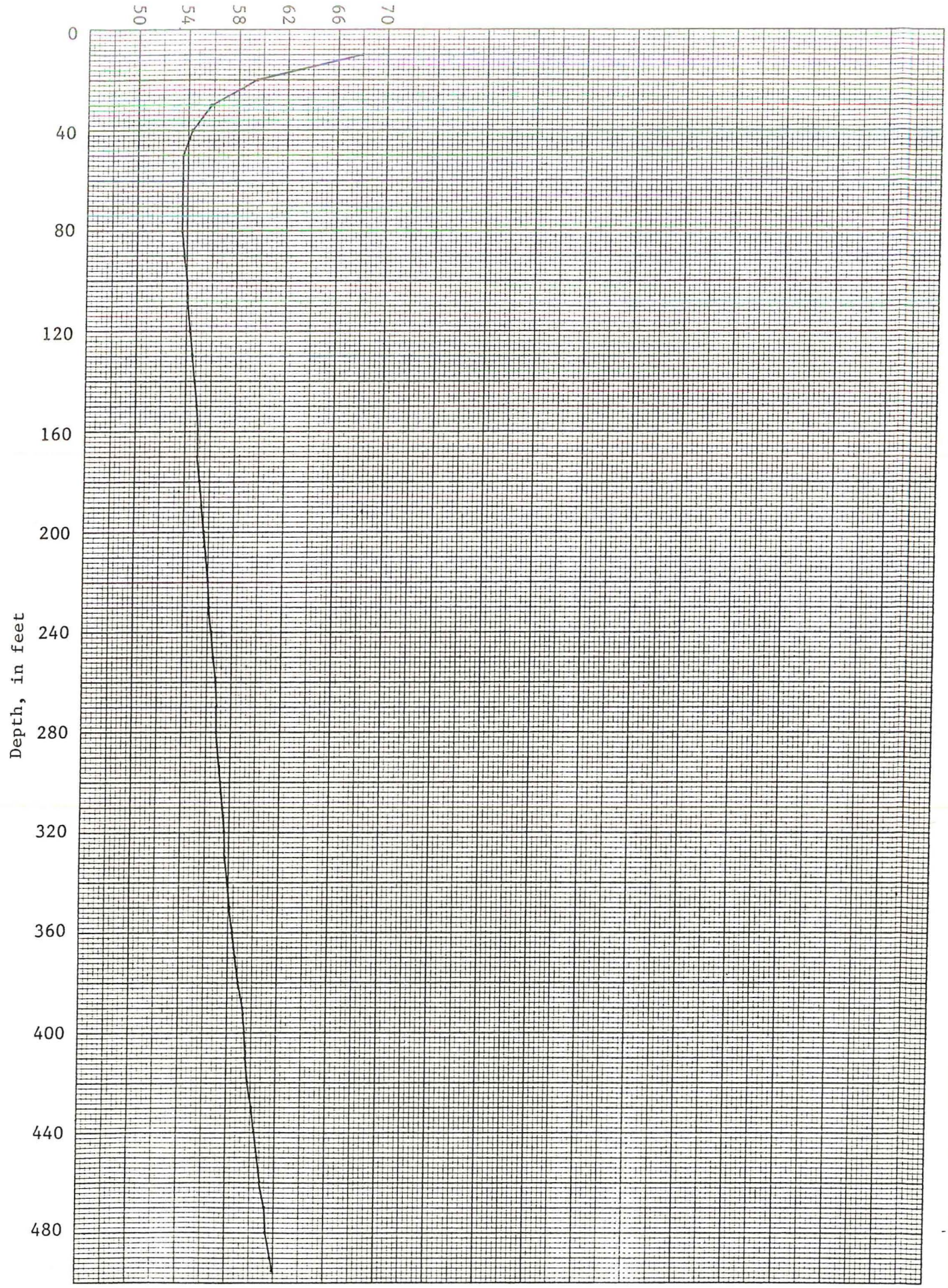
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-11
7/13/79



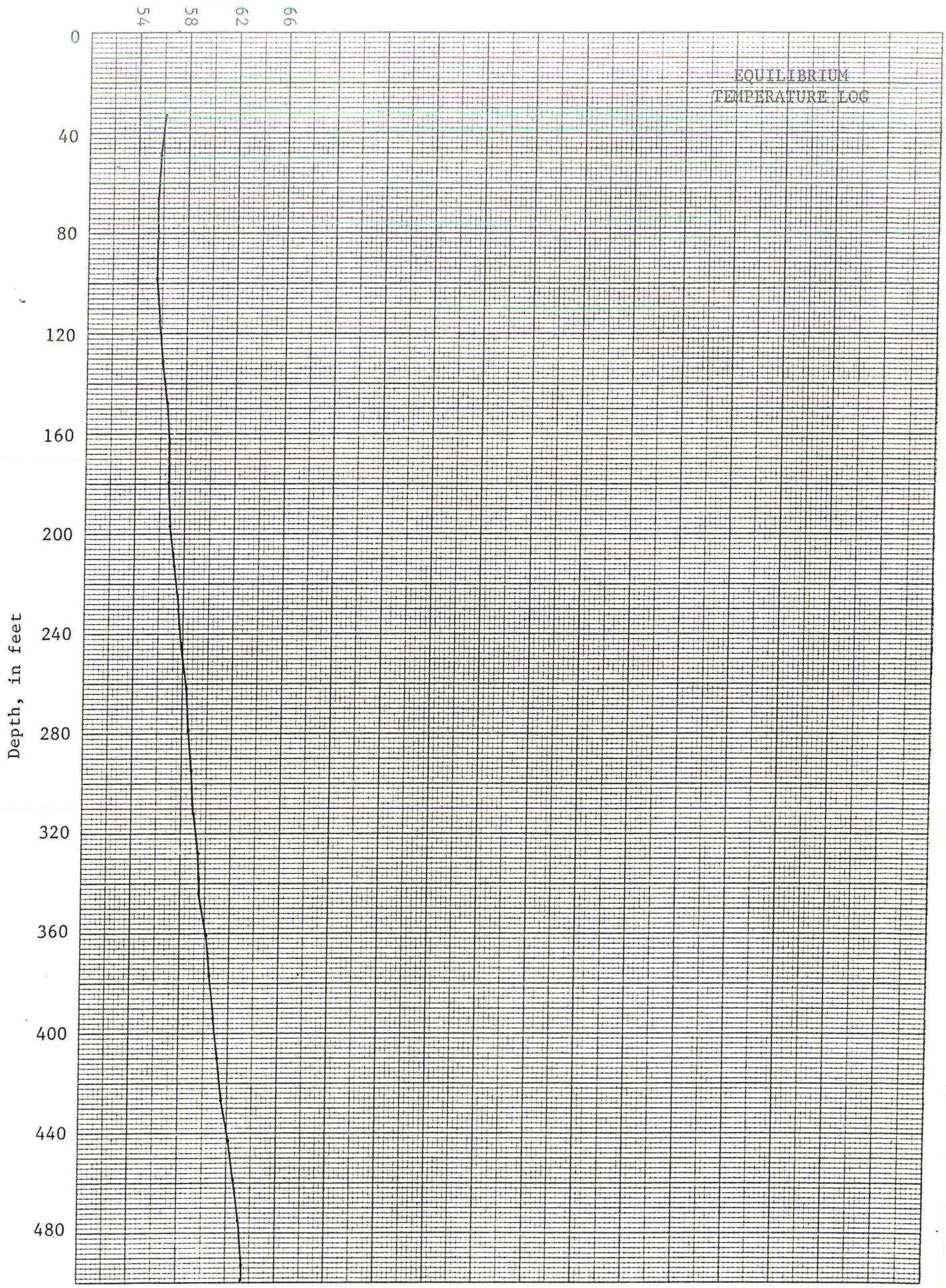
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-11
8/1/79



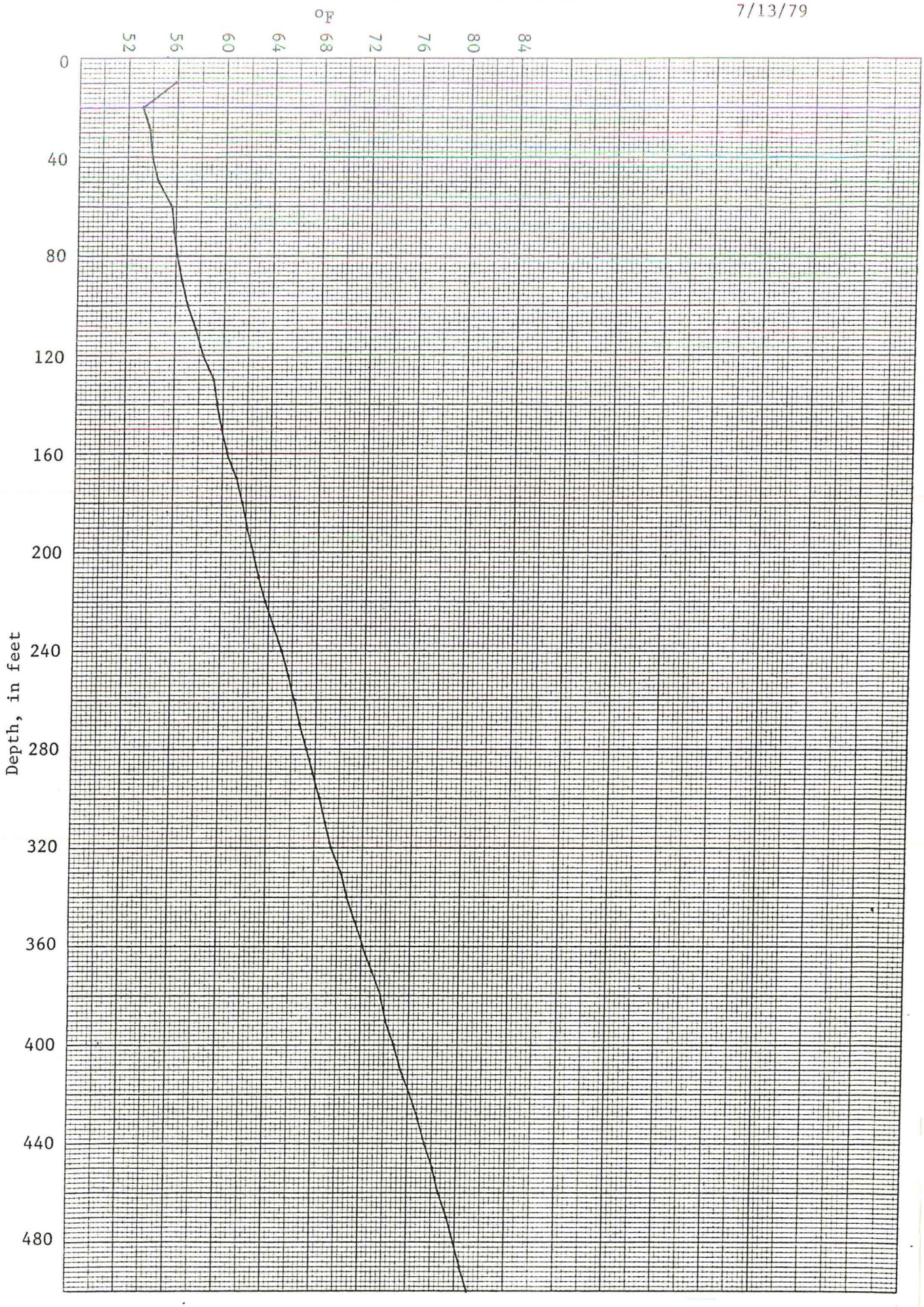
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-11
9/24/79



TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

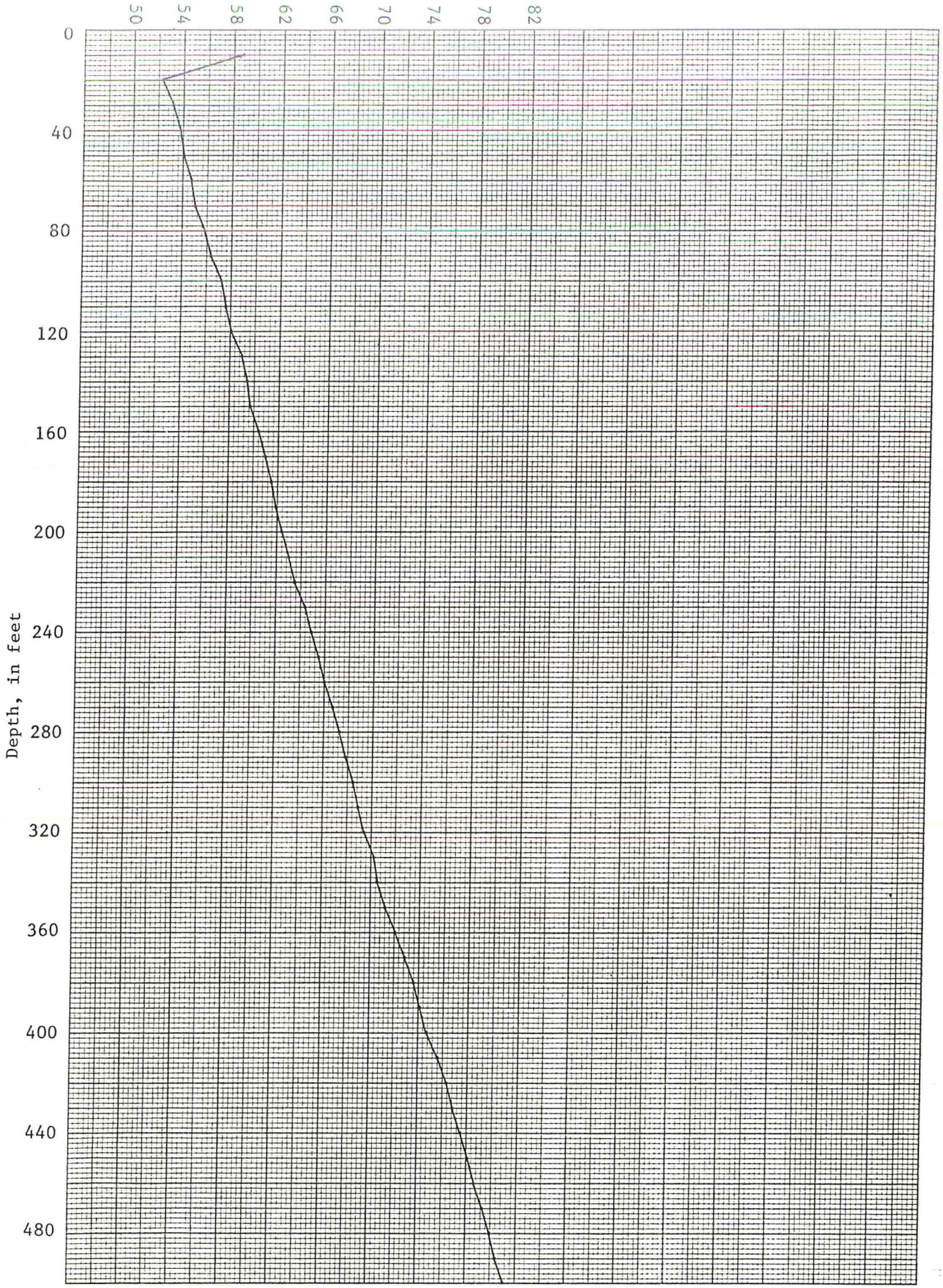
S-GV-79-12
7/13/79



TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

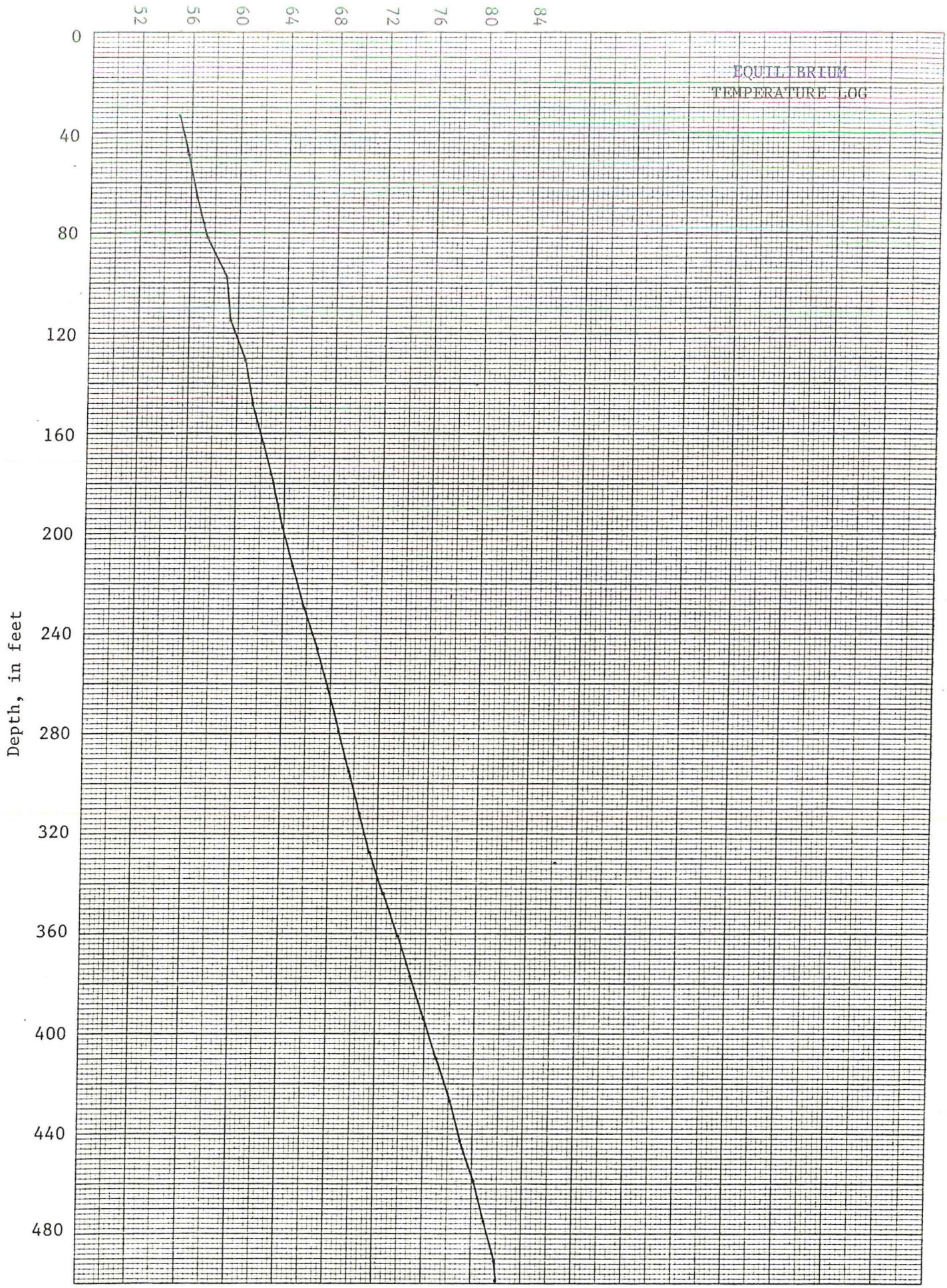
S-GV-79-12

8/1/79



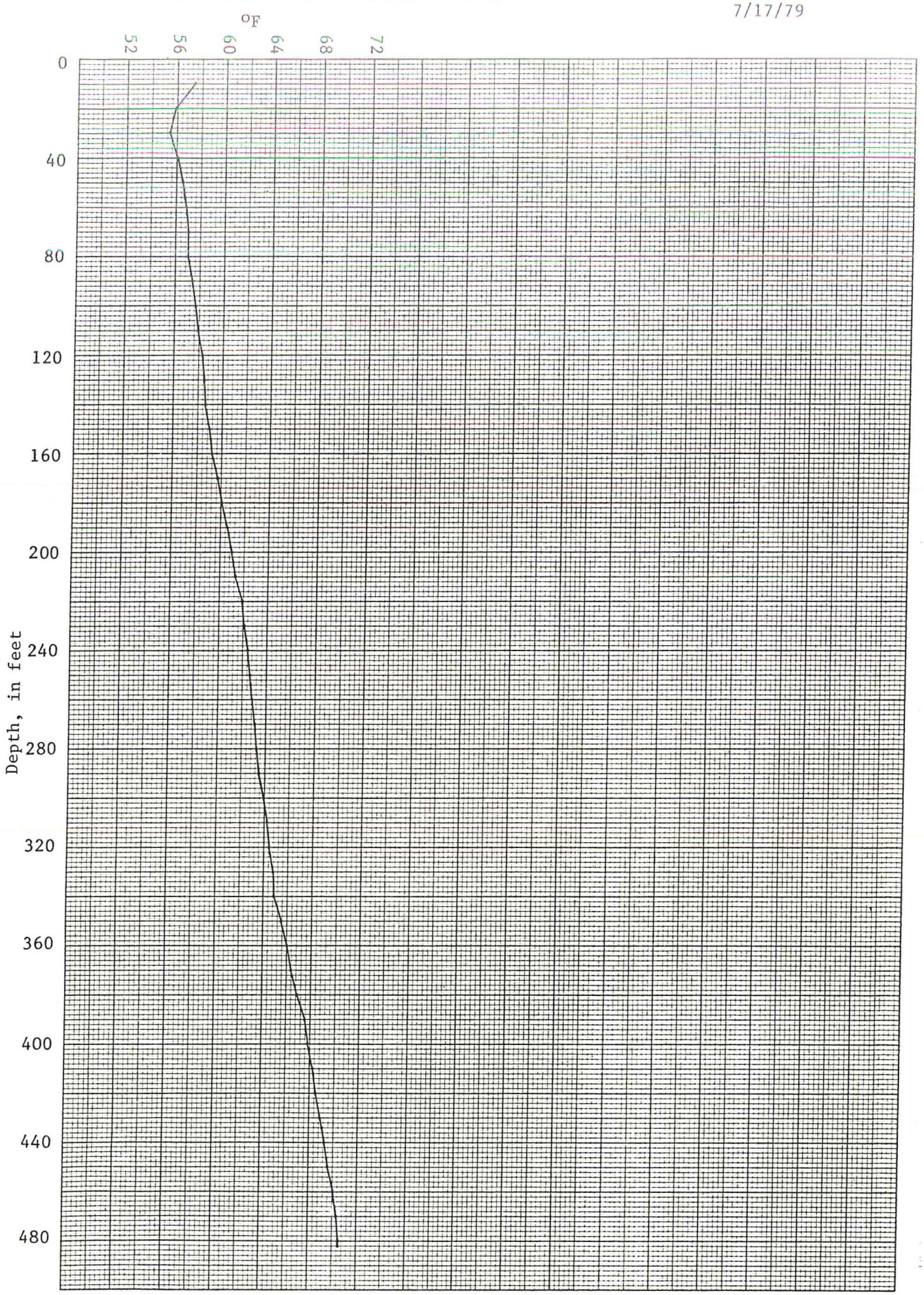
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-12
9/24/79



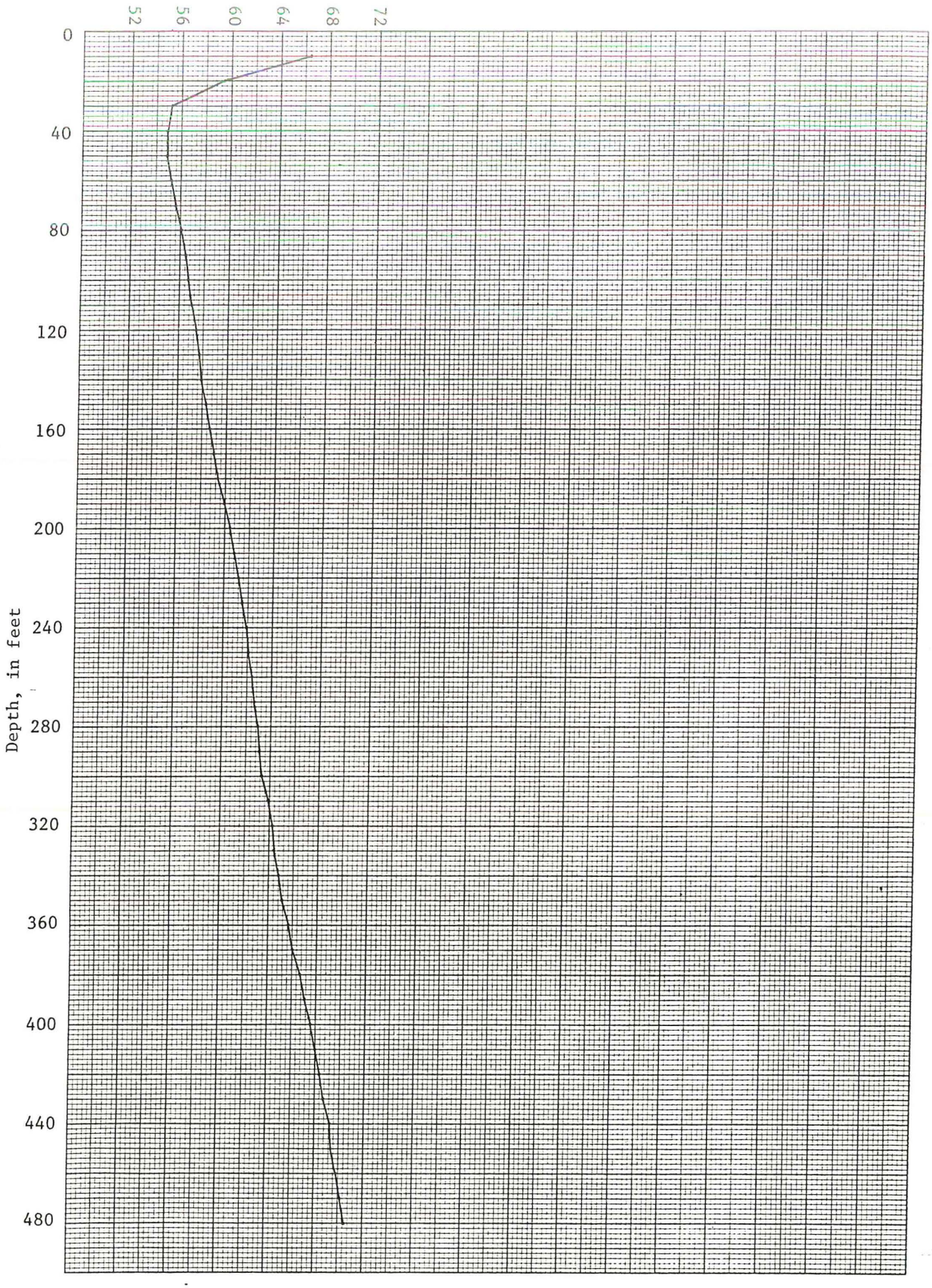
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-13
7/17/79



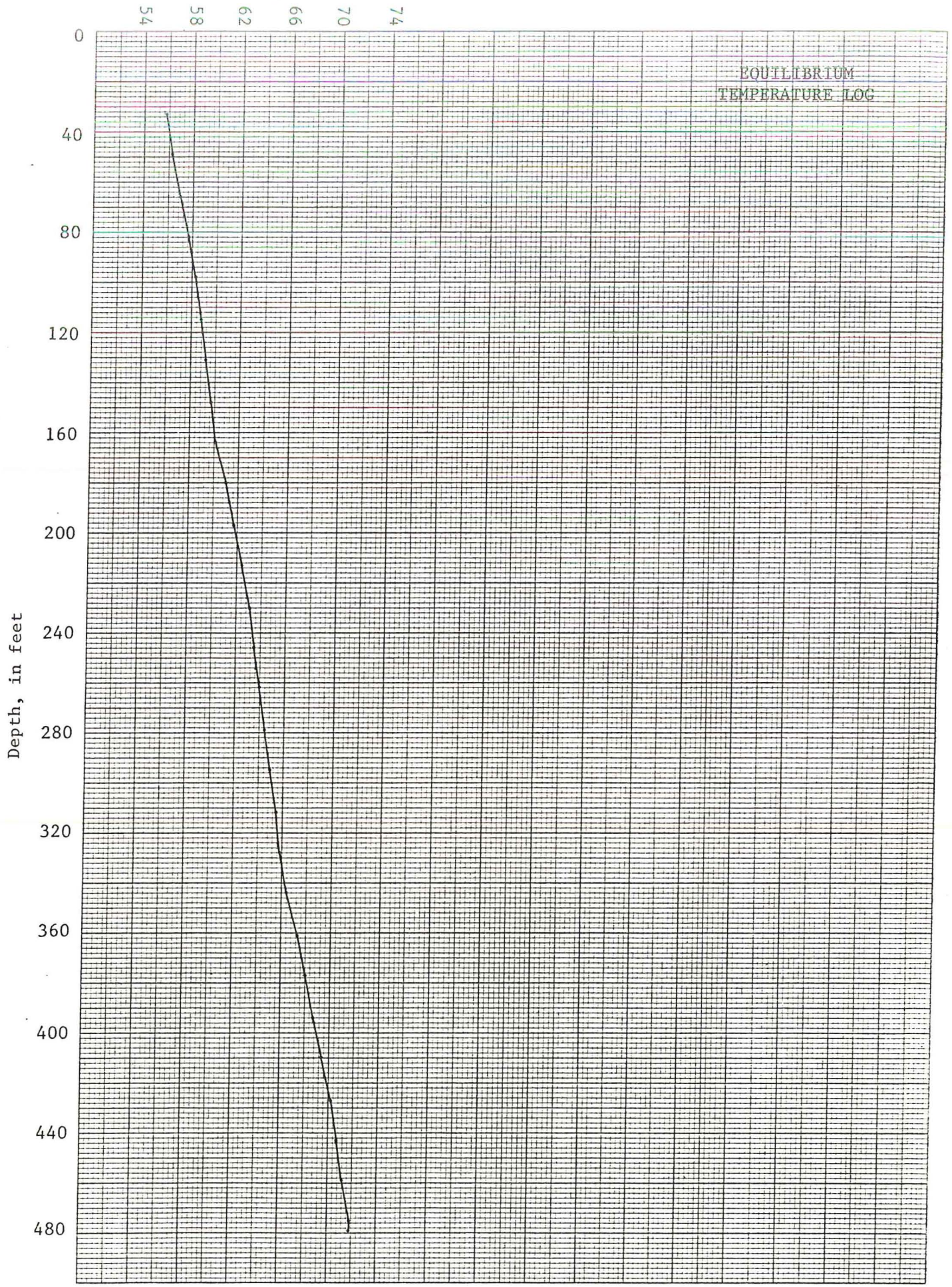
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-13
8/3/79



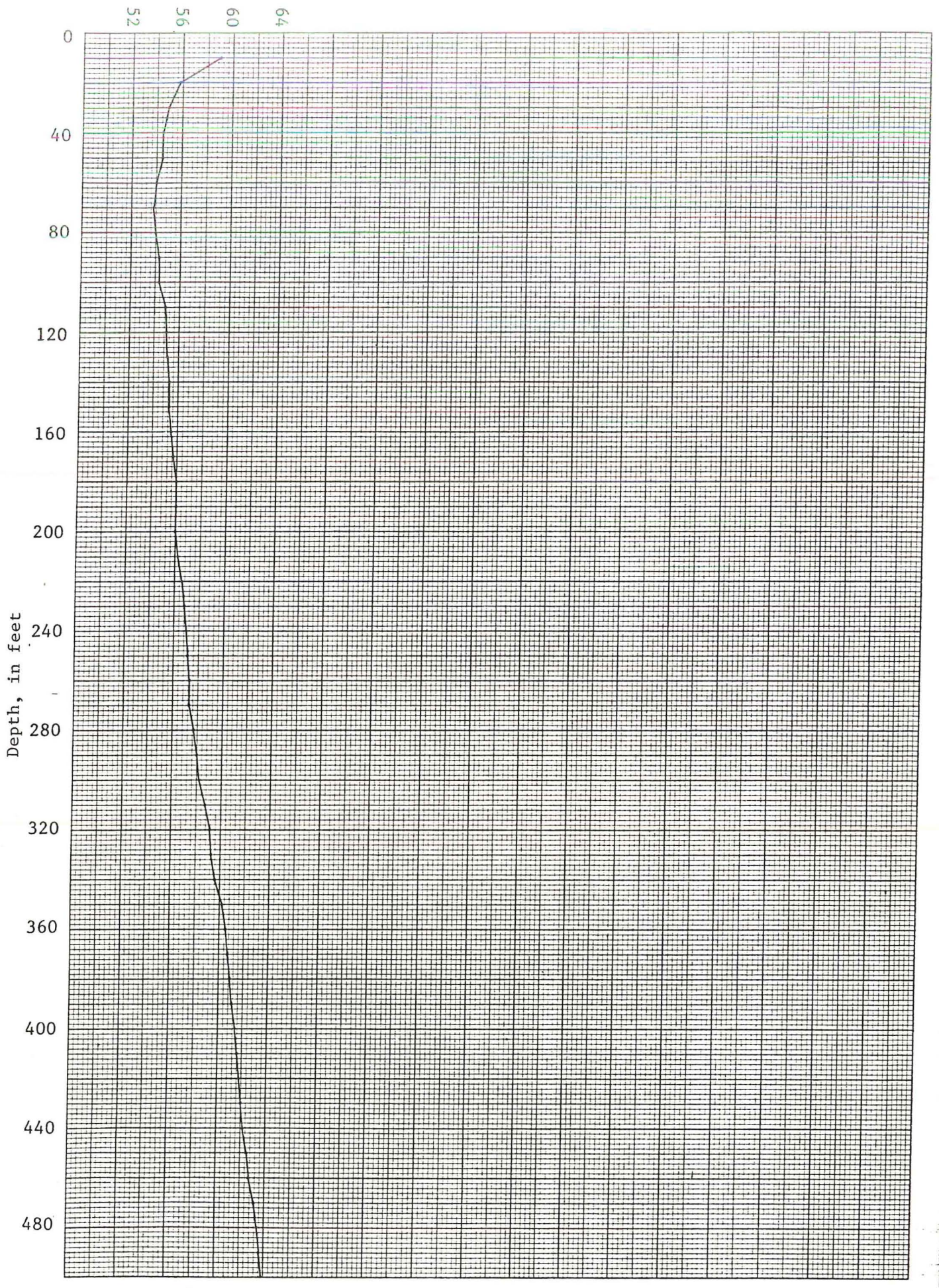
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-13
9/24/79



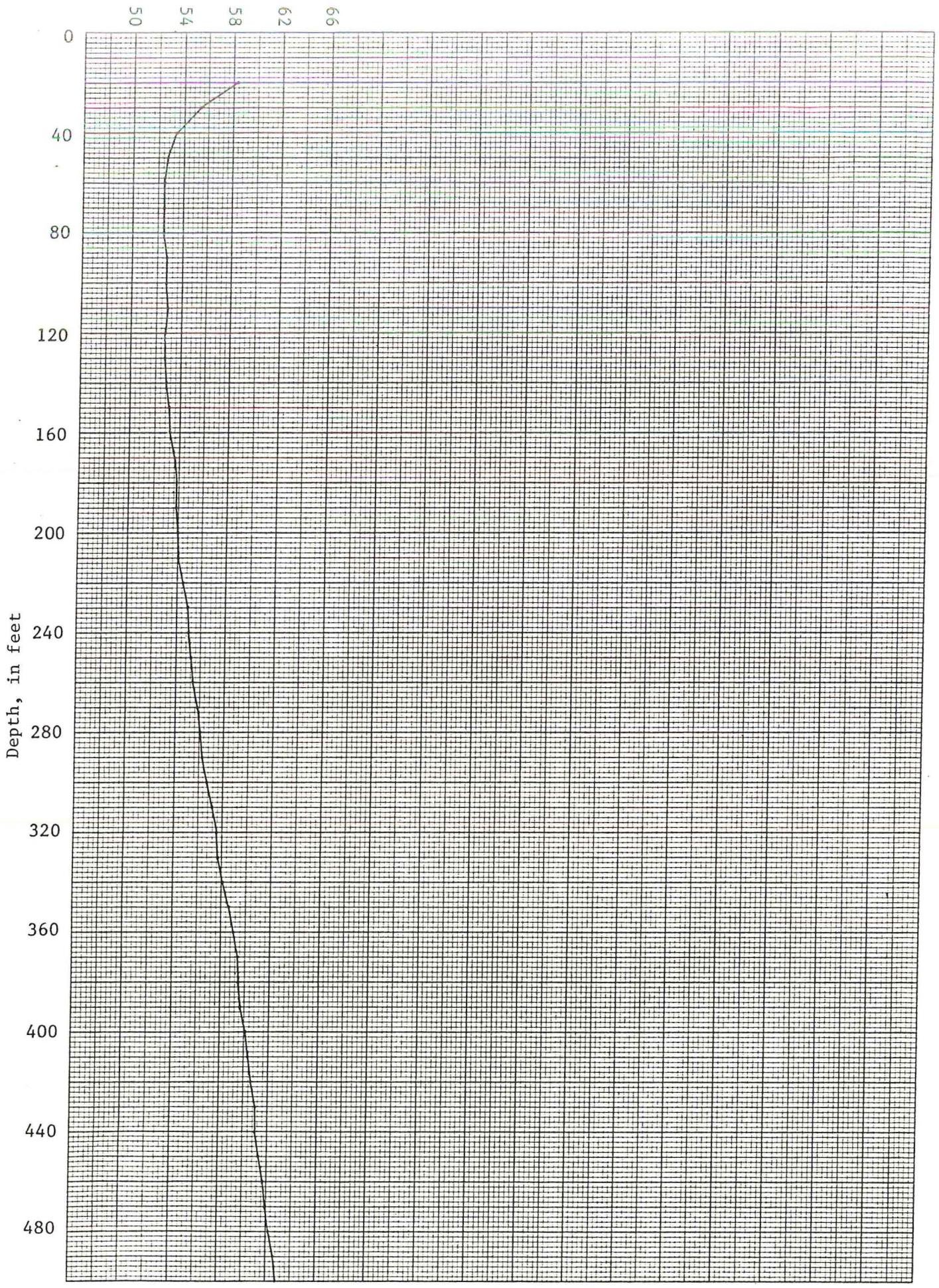
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-14
7/23/79



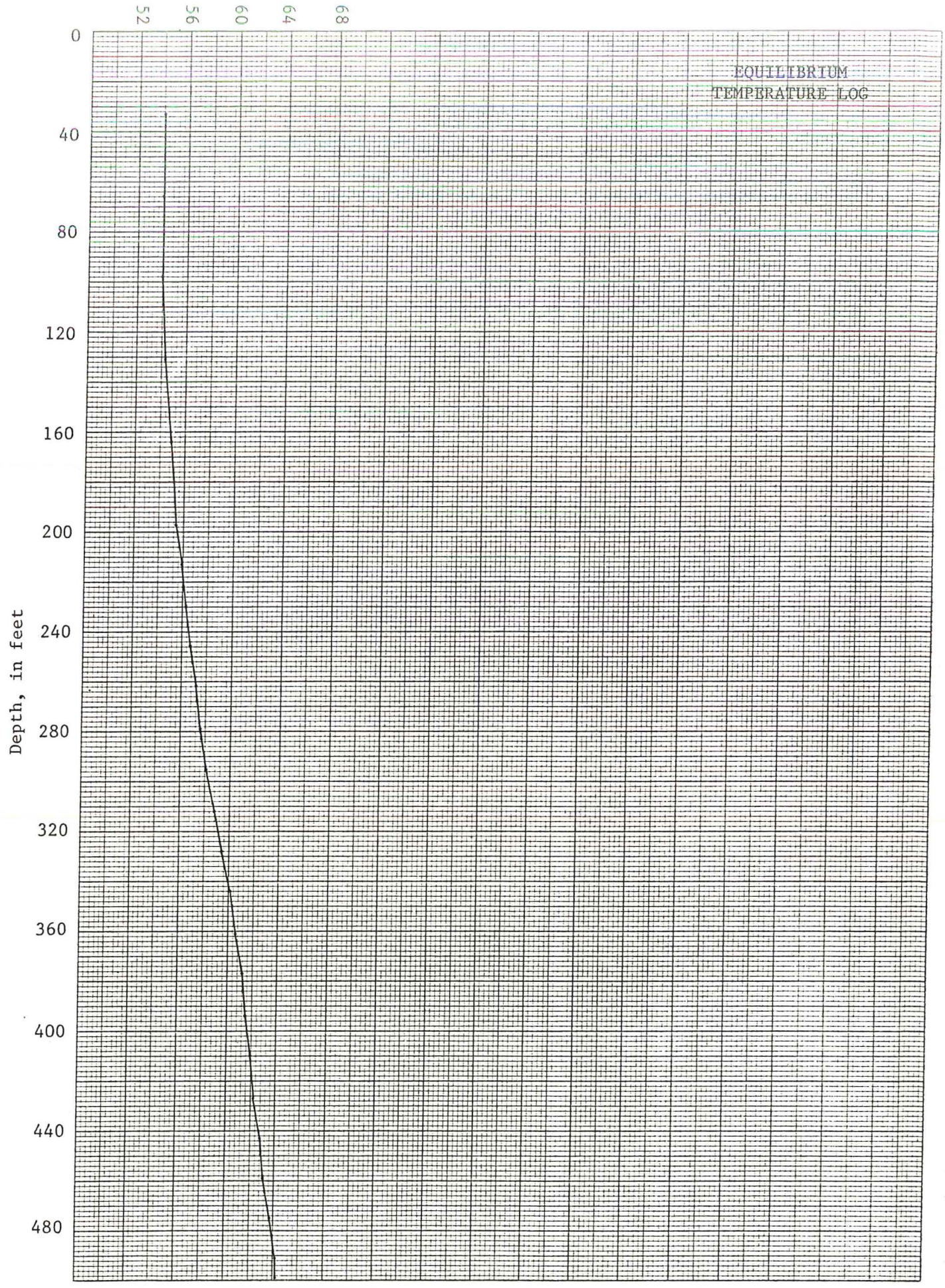
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-14
8/1/79



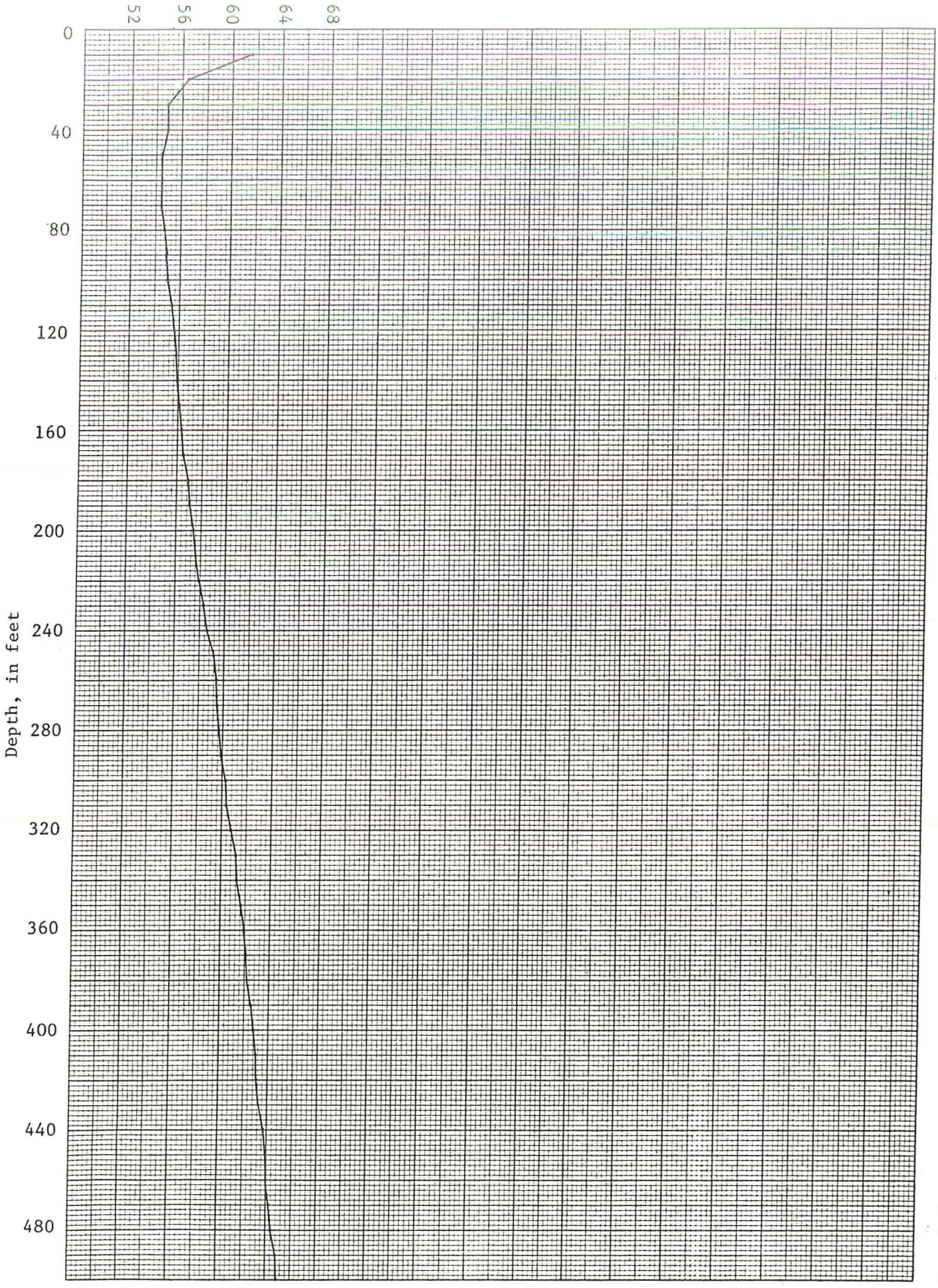
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-14
9/23/79



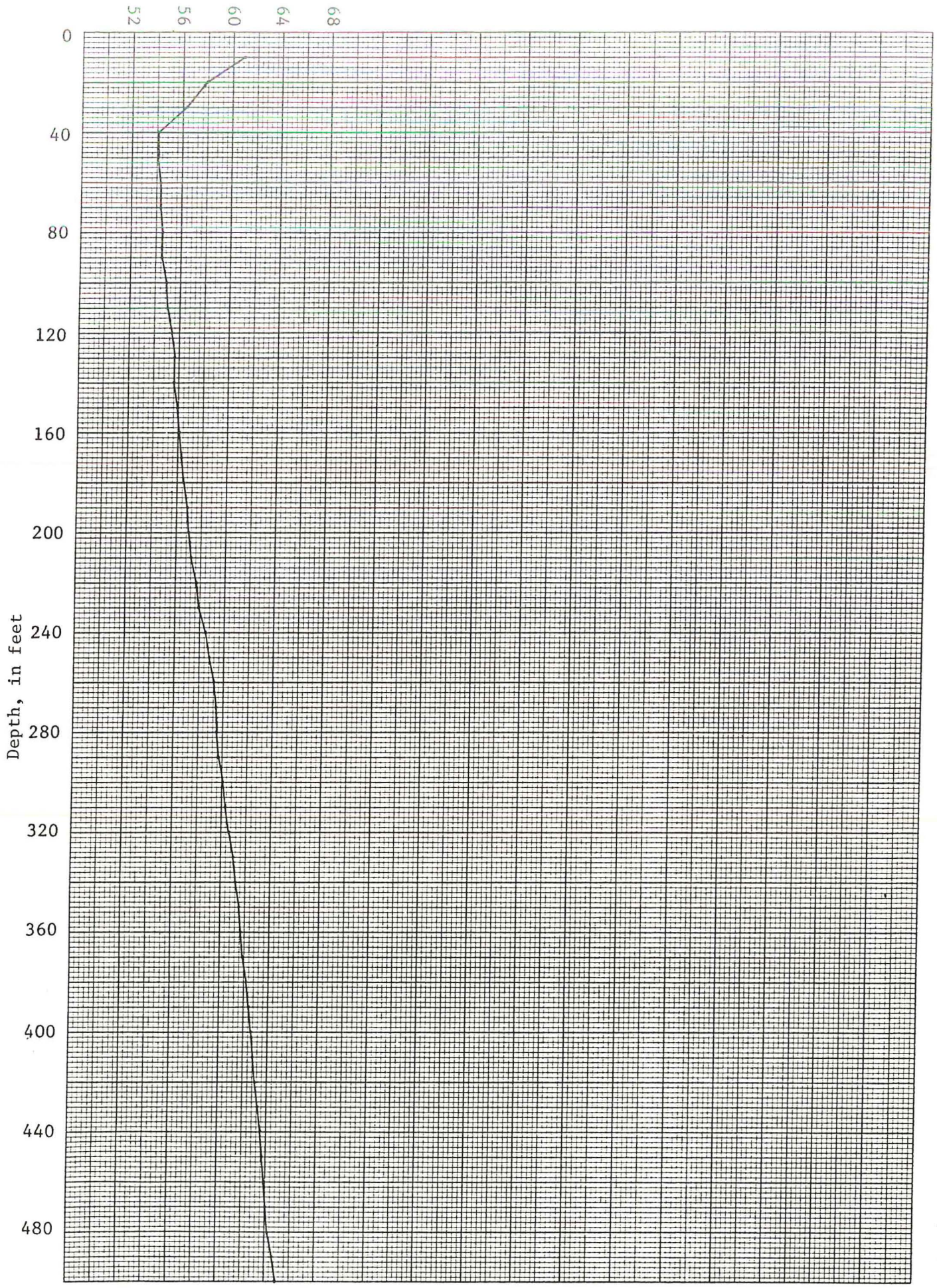
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-15
7/28/79



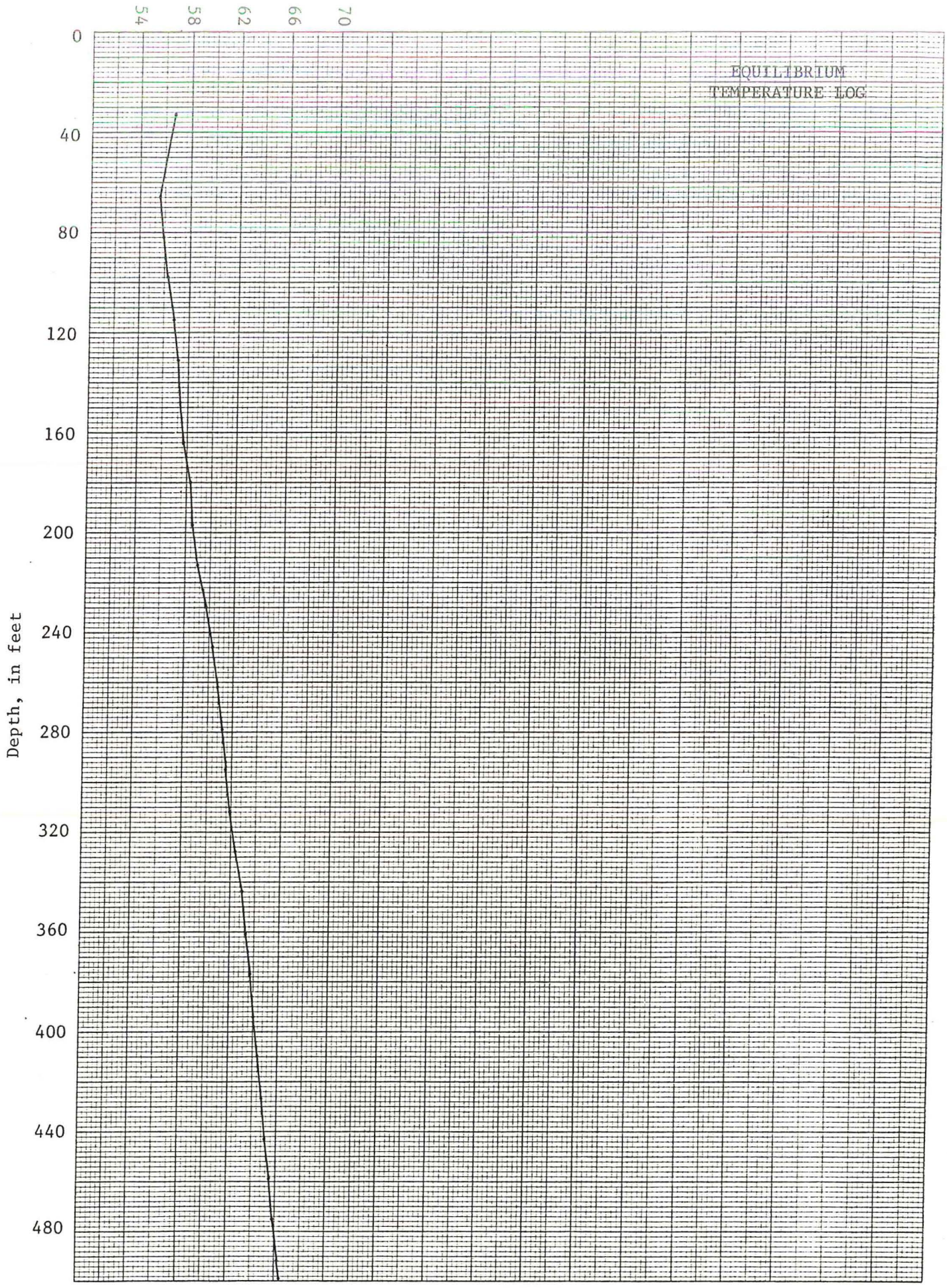
TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-15
8/3/79



TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-15
9/23/79



GeothermEx, Inc. 901 MENDOCINO AVE. BERKELEY, CA. 94707

JAMES B. KOENIG (415) 524-9242
MURRAY C. GARDNER (503) 482-2605

APPENDIX D.

Temperature logs of intermediate-depth (360-457 m) temperature-gradient holes.

TEMPERATURE LOG

S-GV-79-105

T. 31 N., R. 39 E., SW 1/4 of NW 1/4, Sec. 6

8/30/79 9:00 AM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
16	61.7	16.5	525	134.6	57.0
33	64.2	17.9	558	138.2	59.0
49	66.4	19.1	591	142.5	61.4
66	68.2	20.1	623	145.2	62.9
82	70.3	21.3	656	149.9	65.5
98	74.1	23.4	689	155.1	68.4
115	77.2	25.1	722	157.6	69.8
131	78.8	26.0	754	161.4	71.9
148	81.7	27.6	787	164.7	73.7
164	84.0	28.9	820	167.5	75.3
180	86.9	30.5	853	170.2	76.8
197	88.9	31.6	886	172.6	78.1
230	94.1	34.5	919	176.7	80.4
262	99.1	37.3	951	181.0	82.8
295	103.8	39.9	984	186.1	85.6
328	108.1	42.3	1,017	192.2	89.0
361	112.5	44.7	1,050	196.5	91.4
394	117.5	47.5	1,083	199.4	93.0
427	122.0	50.0	1,115	201.0	93.9
459	126.1	52.3	1,132	201.4	94.1
492	130.3	54.6	1,148	201.0	93.9

TEMPERATURE LOG

S-GV-79-105

T. 31 N., R. 39 E., SW 1/4 of NW 1/4, Sec. 6

9/6/79 11:30 AM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
33	63.1	17.3	754	162.4	72.5
66	67.5	19.7	787	165.6	74.2
82	69.4	20.8	820	168.5	75.8
98	72.7	22.6	853	171.1	77.3
131	78.0	25.6	869	172.5	78.1
164	83.0	28.3	886	173.9	78.8
197	88.5	31.4	902	176.0	80.0
230	93.5	34.1	919	178.2	81.2
262	98.7	37.1	935	180.5	82.5
295	103.6	39.8	951	182.8	83.8
328	108.2	42.4	968	185.2	85.1
361	113.1	45.0	984	187.7	86.5
394	117.8	47.7	1,001	190.3	87.9
427	122.5	50.3	1,017	193.1	89.5
459	126.8	52.7	1,033	195.3	90.7
492	131.3	55.1	1,050	197.5	92.0
525	135.6	57.5	1,066	199.0	92.8
558	139.0	59.4	1,083	200.2	93.5
591	143.0	61.7	1,099	201.3	94.1
623	146.3	63.5	1,115	201.6	94.2
656	151.1	66.2	1,132	201.7	94.3
689	156.0	68.9	1,148	201.6	94.2
722	158.6	70.4	1,158	201.6	94.2

TEMPERATURE LOG

S-GV-79-105

T. 31 N., R. 39 E., SW 1/4 of NW 1/4, Sec. 6

9/30/79 10:00 AM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C
66	66.2	19.0
98	71.1	21.7
131	77.0	25.0
164	81.9	27.7
197	87.6	30.9
230	93.0	33.9
262	98.2	36.8
295	103.3	39.6
328	108.0	42.2
361	112.8	44.9
394	117.9	47.7
427	122.5	50.3
459	127.0	52.8
492	131.5	55.3
525	136.0	57.8
558	139.5	59.7
591	143.1	61.7
623	147.0	63.9
656	151.9	66.6
689	156.7	69.3
722	159.4	70.8
755	163.6	73.1
787	166.5	74.7
820	169.3	76.3
853	171.9	77.7
886	174.9	79.4
919	178.9	81.6
951	183.9	84.4
984	189.1	87.3
1,017	194.4	90.2
1,050	198.7	92.6
1,066	200.1	93.4
1,083	201.0	93.9
1,099	202.1	94.5
1,115	202.5	94.7
1,132	202.1	94.5
1.145	201.4	94.1
1,158	201.4	94.1

TEMPERATURE LOG

S-GV-79-106

T. 31 N., R. 38 E., NW 1/4 of SE 1/4, Sec. 18

9/7/79 3:45 PM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
33	57.7	14.3	787	66.4	19.1
66	58.3	14.6	820	66.9	19.4
98	59.7	15.4	853	67.6	19.8
131	58.8	14.9	886	68.4	20.2
164	58.3	14.6	919	69.1	20.6
197	58.6	14.8	951	69.8	21.0
230	59.0	15.0	984	70.5	21.4
262	59.4	15.2	1,017	71.2	21.8
295	59.7	15.4	1,050	72.0	22.2
328	60.1	15.6	1,083	72.7	22.6
361	60.4	15.8	1,115	73.6	23.1
394	60.6	15.9	1,148	74.5	23.6
427	61.0	16.1	1,181	75.4	24.1
459	61.3	16.3	1,214	76.3	24.6
492	61.9	16.6	1,247	77.2	25.1
525	62.2	16.8	1,280	78.1	25.6
558	62.8	17.1	1,312	79.0	26.1
591	63.1	17.3	1,345	80.1	26.7
623	63.7	17.6	1,378	81.1	27.3
656	64.2	17.9	1,411	82.2	27.9
689	64.8	18.2	1,444	83.5	28.6
722	65.1	18.4	1,476	84.6	29.2
754	66.2	19.0	1,493	84.9	29.4

TEMPERATURE LOG

S-GV-79-106

T. 31 N., R. 38 E., NW 1/4 of SE 1/4, Sec. 18

9/13/79 1:15 PM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
33	55.0	12.8	787	66.0	18.9
66	55.8	13.2	820	66.6	19.2
98	56.5	13.6	853	67.5	19.7
131	57.6	14.2	886	68.4	20.2
164	56.7	13.7	919	69.3	20.7
197	57.0	13.9	951	69.8	21.0
230	57.6	14.2	984	70.5	21.4
262	57.9	14.4	1,017	71.4	21.9
295	58.3	14.6	1,050	72.1	22.3
328	58.8	14.9	1,083	73.0	22.8
361	59.4	15.2	1,115	73.9	23.3
394	59.5	15.3	1,181	74.8	23.8
427	60.1	15.6	1,214	75.0	23.9
459	60.4	15.8	1,247	76.6	24.8
492	61.0	16.1	1,280	77.5	25.3
525	61.3	16.3	1,312	79.5	26.4
558	61.9	16.6	1,345	80.6	27.0
591	62.4	16.9	1,378	81.7	27.6
623	63.1	17.3	1,411	82.8	28.2
656	63.5	17.5	1,444	83.8	28.8
689	64.2	17.9	1,476	85.1	29.5
722	64.8	18.2	1,493	85.1	29.5
755	65.3	18.5			

TEMPERATURE LOG

S-GV-79-106

T. 31 N., R. 38 E., NW 1/4 of SE 1/4, Sec. 18

9/30/79 7:45 AM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
66	54.9	12.7	820	66.7	19.3
98	55.4	13.0	853	67.6	19.8
131	55.8	13.2	886	68.5	20.3
164	56.1	13.4	919	69.3	20.7
197	56.7	13.7	951	70.0	21.1
230	57.0	13.9	984	70.7	21.5
262	57.6	14.2	1,017	71.6	22.0
295	57.9	14.4	1,050	72.3	22.4
328	58.6	14.8	1,083	73.2	22.9
361	59.0	15.0	1,115	74.1	23.4
394	59.4	15.2	1,148	75.0	23.9
427	59.9	15.5	1,181	75.9	24.4
459	60.3	15.7	1,214	76.6	24.8
492	60.8	16.0	1,247	77.7	25.4
525	61.3	16.3	1,280	78.8	26.0
558	61.9	16.6	1,312	79.7	26.5
591	62.2	16.8	1,345	80.8	27.1
623	63.0	17.2	1,378	81.9	27.7
656	63.5	17.5	1,411	82.9	28.3
689	64.0	17.8	1,444	84.2	29.0
722	64.6	18.1	1,476	85.3	29.6
755	65.3	18.5	1,493	85.3	29.6

TEMPERATURE LOG

S-GV-79-108

T. 31 N., R. 39 E., NE 1/4 of SW 1/4, Sec. 27

8/12/79 8:45 AM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
33	61.5	16.4	754	104.9	40.5
66	64.8	18.2	787	106.9	41.6
131	70.2	21.2	820	108.7	42.6
164	71.6	22.0	853	110.5	43.6
197	73.8	23.2	886	112.5	44.7
213	74.7	23.7	919	114.3	45.7
230	75.6	24.2	951	116.1	46.7
246	76.6	24.8	984	117.9	47.7
262	77.4	25.2	1,017	119.7	48.7
279	78.6	25.9	1,050	121.5	49.7
295	79.3	26.3	1,083	123.3	50.7
312	80.4	26.9	1,115	125.2	51.8
328	81.5	27.5	1,148	127.0	52.8
427	84.9	29.4	1,181	128.8	53.8
459	86.9	30.5	1,214	130.8	54.9
492	90.1	32.3	1,247	132.6	55.9
525	92.1	33.4	1,280	134.4	56.0
558	93.9	34.4	1,312	136.4	58.0
591	95.7	35.4	1,345	138.4	59.1
623	97.3	36.3	1,378	140.2	60.1
656	99.3	37.4	1,411	142.2	61.2
689	101.1	38.4	1,444	144.0	62.2
722	103.1	39.5	1,460	144.0	62.2

TEMPERATURE LOG

S-GV-79-108

T. 31 N., R. 39 E., NE 1/4 of SW 1/4, Sec. 27

8/18/79 4:00 PM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
66	62.8	17.1	591	95.7	35.4
82	65.1	18.4	623	97.7	36.5
98	66.0	18.9	656	99.5	37.5
115	67.8	19.9	689	101.5	38.6
131	69.1	20.6	722	103.3	39.6
148	69.8	21.0	754	105.3	40.7
164	70.9	21.6	787	107.1	41.7
180	71.8	22.1	820	109.0	42.8
197	72.7	22.6	853	110.8	43.8
213	73.8	23.2	886	112.6	44.8
230	74.7	23.7	919	114.6	45.9
262	76.8	24.9	951	116.4	46.9
279	77.9	25.5	984	118.2	47.9
295	78.8	26.0	1,017	120.0	48.9
312	79.9	26.6	1,050	121.8	49.9
328	81.0	27.2	1,083	123.8	51.0
344	81.7	27.6	1,115	125.6	52.0
361	82.8	28.2	1,148	127.4	53.0
377	84.0	28.9	1,181	129.2	54.0
394	84.9	29.4	1,214	131.2	55.1
410	85.5	29.7	1,247	133.0	56.1
427	86.4	30.2	1,280	134.8	57.1
459	88.3	31.3	1,312	136.8	58.2
492	90.1	32.3	1,345	138.6	59.2
509	91.0	32.8	1,378	140.5	60.3
525	91.8	33.2	1,411	142.3	61.3
558	93.9	34.4	1,444	144.1	62.3

TEMPERATURE LOG

S-GV-79-108

T. 31 N., R. 39 E., NE 1/4 of SW 1/4, Sec. 27

9/3/79 9:30 AM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
33	60.3	15.7	754	105.3	40.7
66	62.6	17.0	787	107.2	41.8
98	65.1	18.4	820	109.0	42.8
131	67.6	19.8	853	111.2	44.0
164	70.2	21.2	886	113.0	45.0
197	72.1	22.3	919	114.8	46.0
230	74.3	23.5	951	116.6	47.0
262	76.3	24.6	984	118.6	48.1
295	78.4	25.8	1,017	120.4	49.1
328	80.8	27.1	1,050	122.2	50.1
361	82.4	28.0	1,083	124.0	51.1
394	84.7	29.3	1,115	125.8	52.1
427	86.2	30.1	1,148	127.6	53.1
459	88.3	31.3	1,181	129.4	54.1
492	90.1	32.3	1,214	131.4	55.2
525	91.9	33.3	1,247	133.2	56.2
558	93.9	34.4	1,280	135.0	57.2
591	95.7	35.4	1,312	136.9	58.3
623	97.8	36.6	1,345	138.7	59.3
656	99.7	37.6	1,378	140.5	60.3
689	101.5	38.6	1,411	142.3	61.3
722	103.5	39.7	1,444	144.1	62.3

TEMPERATURE LOG

S-GV-79-108

T. 31 N., R. 39 E., NE 1/4 of SW 1/4, Sec. 27

9/20/79 2:30 PM
Logged by GeothermEx, Inc.

Depth, in feet	°F	°C	Depth, in feet	°F	°C
33	59.9	15.5	755	105.4	40.8
66	62.2	16.8	787	107.4	41.9
98	64.6	18.1	820	109.2	42.9
131	67.6	19.8	853	111.2	44.0
164	69.8	21.0	886	113.0	45.0
197	72.0	22.2	919	114.8	46.0
230	74.1	23.4	951	116.8	47.1
262	76.3	24.6	984	118.6	48.1
295	78.3	25.7	1,017	120.6	49.2
328	80.6	27.0	1,050	122.4	50.2
361	82.4	28.0	1,083	124.2	51.2
394	84.7	29.3	1,115	126.0	52.2
427	86.2	30.1	1,148	127.8	53.2
459	88.2	31.2	1,181	129.6	54.2
492	90.0	32.2	1,214	131.4	55.2
525	91.9	33.3	1,247	133.3	56.3
558	93.9	34.4	1,280	135.1	57.3
591	95.9	35.5	1,312	137.1	58.4
623	97.9	36.6	1,345	138.9	59.4
656	99.7	37.6	1,375	140.7	60.4
689	101.7	38.7	1,411	142.5	61.4
722	103.5	39.7	1,444	144.1	62.3

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-105
9/6/79

°F

62 66 70 74 78 82 86 90 94 98 102 106 110 114 118 122 126 130

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160

120 124 128 132 136 140 144 148 152 156 160 164 168 172 176 180

182 186 190 194 198 202

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-105
9/30/79

°F

64 68 72 76 80 84 88 92 96 100 104 108 112 116 120 124 128 132

EQUILIBRIUM TEMPERATURE LOG

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160

128 132 136 140 144 148 152 156 160 164 168 172 176 180 184 188

180 184 188 192 196 200 204

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-105
8/30/79

°F

60 64 68 72 76 80 84 88 92 96 100 104 108 112 116 120 124 128

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160

124 128 132 136 140 144 148 152 156 160 164 168 172 176 180 184

180 184 188 192 196 200 204

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-106
9/7/79

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-106
9/13/79

T_p

52 56 60 64 68 72 76 80 84 88

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160 1,200 1,240 1,280 1,320 1,360 1,400 1,440 1,480

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-106
9/30/79

°F

52 56 60 64 68 72 76 80 84 88

EQUILIBRIUM TEMPERATURE LOG

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160 1,200 1,240 1,280 1,320 1,360 1,400 1,440 1,480

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-108
8/12/79

°F

60 64 68 72 76 80 84 88 92 96 100 104 108 112 116 120 124 128

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160 1,200 1,240 1,280 1,320 1,360 1,400 1,440 1,480

124 128 132 136 140 144

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-108
8/18/79

°F

62 66 70 74 78 82 86 90 94 98 102 106 110 114 118 122 126 130

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160 1,200 1,240 1,280 1,320 1,360 1,400 1,440 1,480

126 130 134 138 142 146

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-108
9/3/79

°F

60 64 68 72 76 80 84 88 92 96 100 104 108 112 116 120 124 128

Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160 1,200 1,240 1,280 1,320 1,360 1,400 1,440 1,480

124 128 132 136 140 144 148

TEMPERATURE LOG - SUNEDCO - GRASS VALLEY

S-GV-79-108
9/20/79

°F

58 62 66 70 74 78 82 84 90 94 98 102 106 110 114 118 122 126

EQUILIBRIUM TEMPERATURE LOG

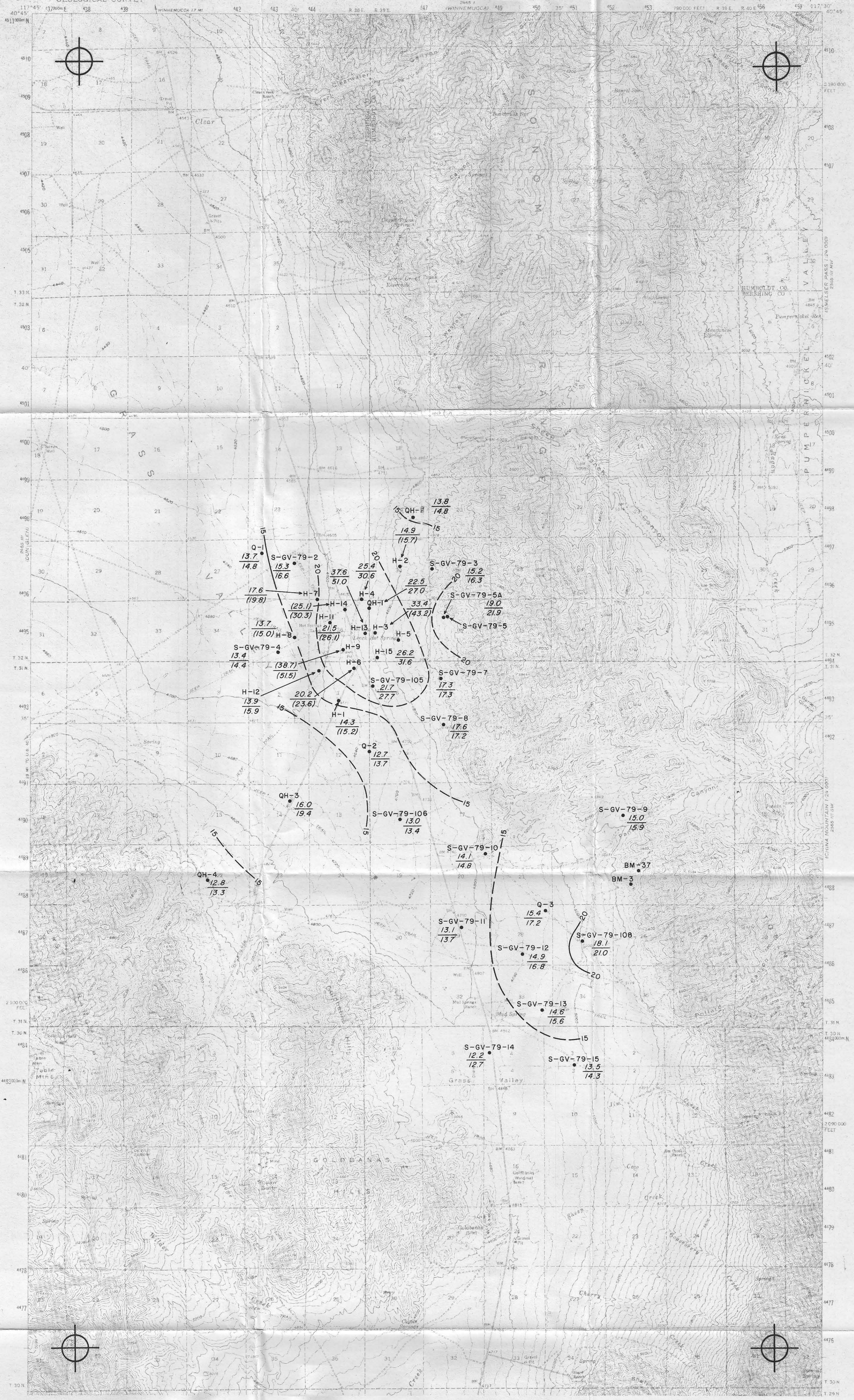
Depth, in feet

0 40 80 120 160 200 240 280 320 360 400 440 480 520 560 600 640 680 720 760 800 840 880 920 960 1,000 1,040 1,080 1,120 1,160 1,200 1,240 1,280 1,320 1,360 1,400 1,440 1,480

126 130 134 138 142 146

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LEACH HOT SPRINGS QUADRANGLE
NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)



Explanation

S-GV-79-15	Sunedco-Grass Valley project holes
Q-3, QH-4	Heat-flow and heat-flow-hydrologic test holes
H-1	Shallow hydrologic test wells
BM-37	Hole used by Sass et al. (1971) for heat flow determinations
15.3 / 16.6	Temperature, in °C, at 30m / Temperature, in °C, at 50m
	Parentheses indicate value extrapolated from slightly shallower depths
———	Contour on temperature at 50m, in °C

PLATE I. Temperatures observed at shallow depths (30 and 50m) in the Grass Valley area.

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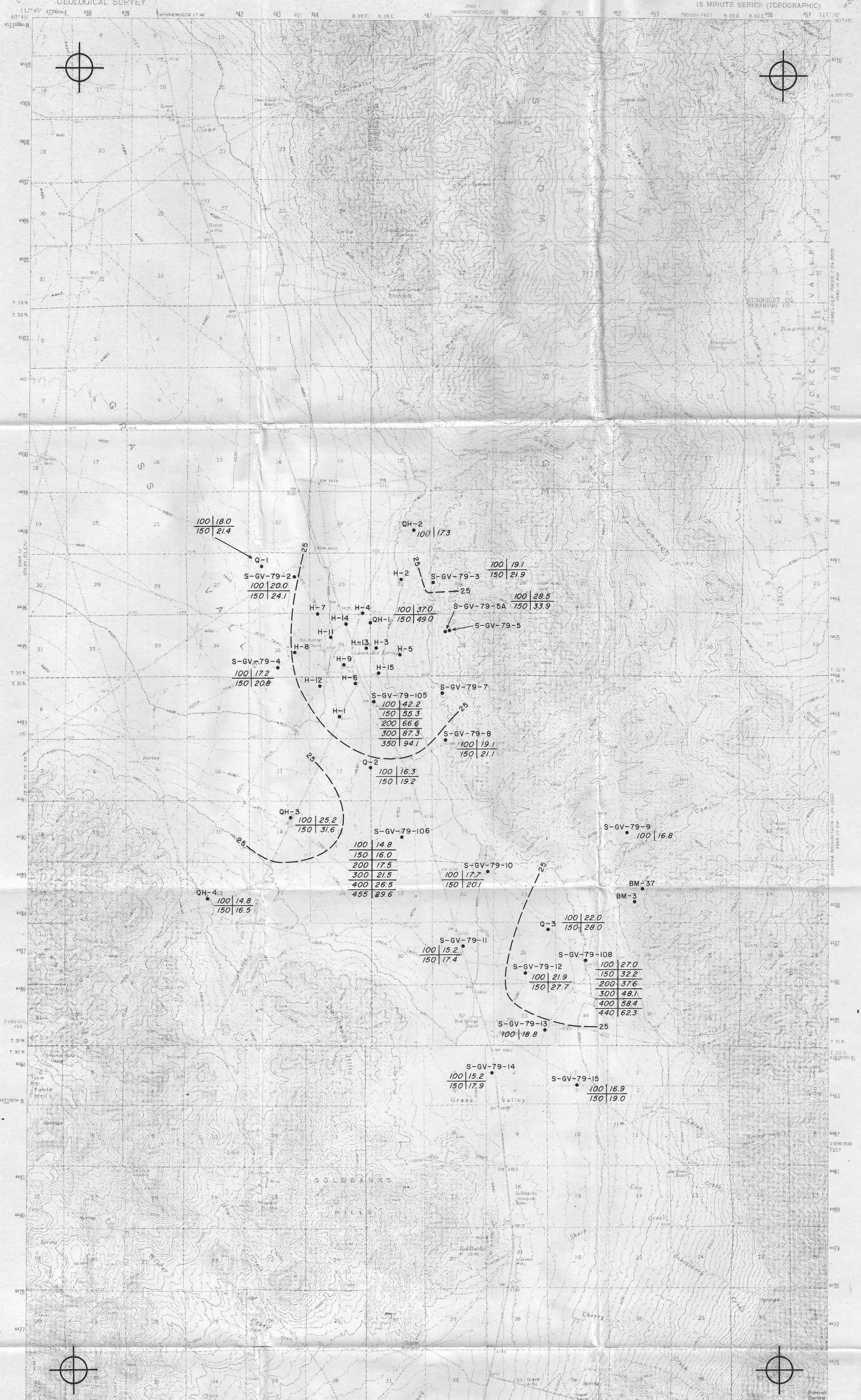
GEOLOGICAL SURVEY

LEACH HOT SPRINGS QUADRANGLE
NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)



Explanation

S-GV-79-15	Sunedco—Grass Valley project holes
Q-3, QH-4	Heat flow and heat flow hydrologic test holes
H-1	Shallow hydrologic test wells
BM-37	Hole used by Sass et al. (1971) in heat-flow determinations
100 | 18.8	Depth, in meters | Temperature, in °C
— — — —	Contour on temperature at 150m depth, in °C

PLATE 2. Temperatures observed at intermediate (100 and 150m) and deep (greater than 150m) levels in the Grass Valley area.

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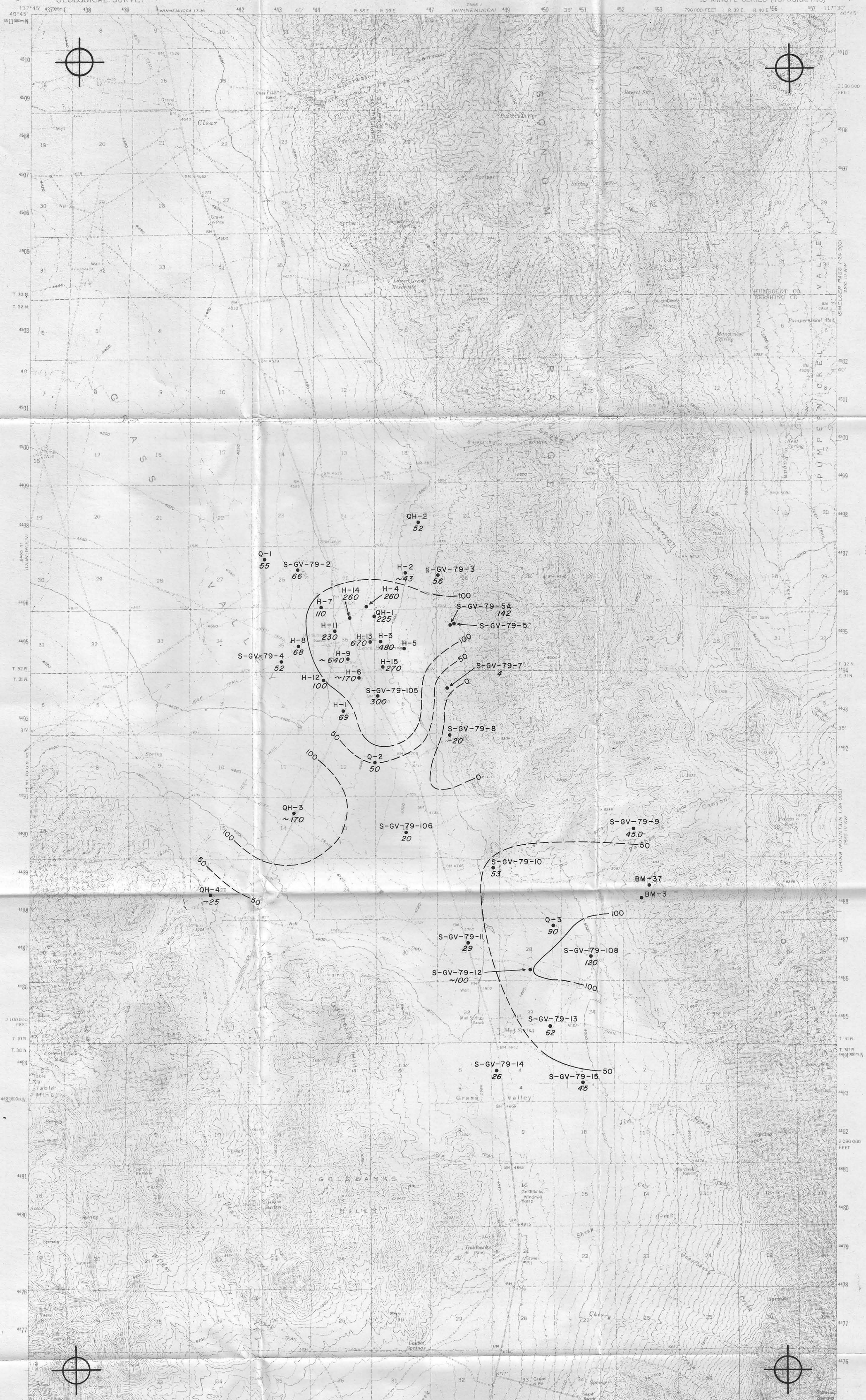
LEACH HOT SPRINGS QUADRANGLE
NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)



Explanation

S-GV-79-15	Sunedco—Grass Valley project holes
Q-3, QH-4	Heat-flow and heat-flow-hydrologic test holes
H-1	Shallow hydrologic test wells
BM-37	Hole used by Sass et al. (1971) in heat-flow determinations
53	Calculated temperature gradient, in °C/km. A ~ indicates approximate values — the temperature profile shows some irregularity through this depth interval.
———	Contours on temperature gradients at 0, 50 and 100°C/km

PLATE 3. Temperature gradients at shallow depths (30 to 50m) in the Grass Valley area.

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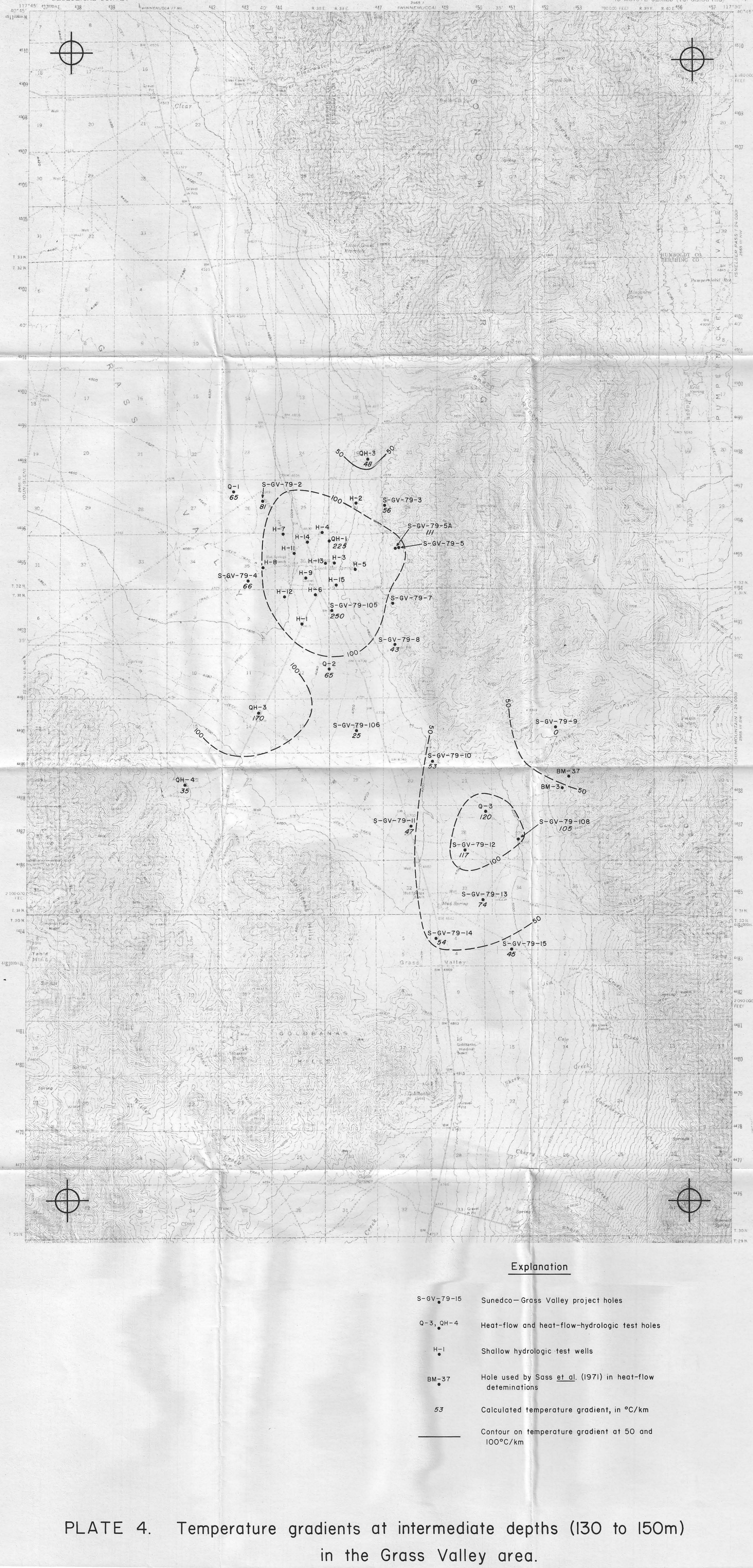
LEACH HOT SPRINGS QUADRANGLE
NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)



Explanation

S-GV-79-15	Sunedco—Grass Valley project holes
Q-3, QH-4	Heat-flow and heat-flow-hydrologic test holes
H-1	Shallow hydrologic test wells
BM-37	Hole used by Sass et al. (1971) in heat-flow deteminations
53	Calculated temperature gradient, in °C/km
———	Contour on temperature gradient at 50 and 100°C/km

PLATE 4. Temperature gradients at intermediate depths (130 to 150m) in the Grass Valley area.

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NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)

230	160 – 210m
158	230 – 270m
290	290 – 310m
reverse gradient	340 – 353m

44.5	230 – 340m
46.6	340 – 370m
60.0	370 – 450m

108	150 – 230m
104	230 – 340m
110	340 – 440m

Explanation

- S-GV-79-15 — Sunedco—Grass Valley project holes
- Q-3, QH-4 — Heat-flow and heat-flow-hydrologic test holes
- H-1 — Shallow hydrologic test wells
- BM-37 — Hole used by Sass et al. (1971) in heat-flow determinations
- 230 | 160-210m — Temperature gradient, in °C/km | Depth interval, in m

PLATE 5. Temperature gradients at deep levels (greater than 150m) in the Grass Valley area.

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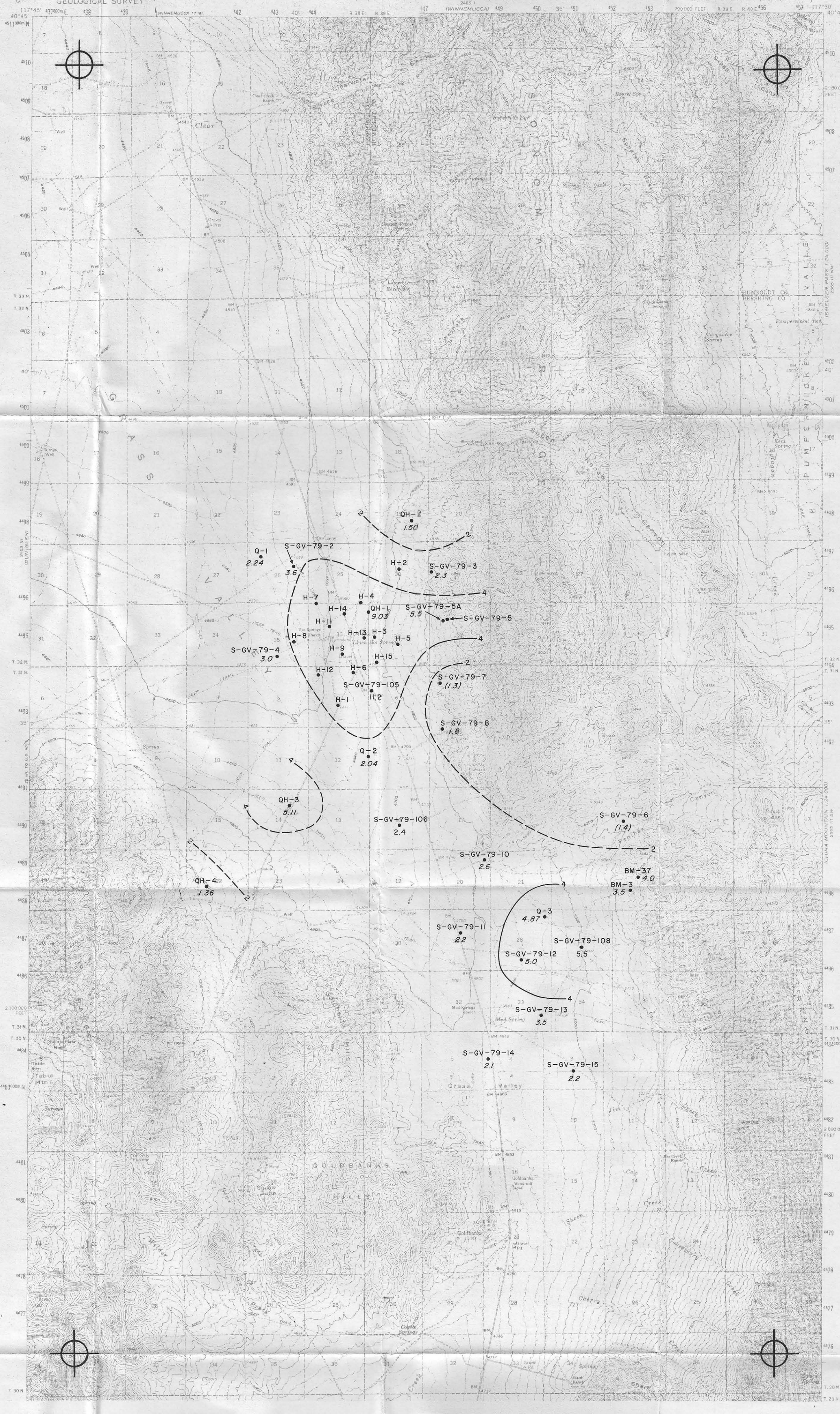
LEACH HOT SPRINGS QUADRANGLE
NEVADA
15 MINUTE SERIES (TOPOGRAPHIC)



Explanation

S-GV-79-15	Sunedco—Grass Valley project holes
Q-3, QH-4	Heat-flow and heat-flow-hydrologic test holes
H-1	Shallow hydrologic test wells
BM-37	Hole used by Sass et al. (1971) in heat flow determinations
2.6	Heat flow (in 10^{-6} cal/cm^2-sec, or HFU) from 100–150m depth interval. Parentheses indicate value from slightly shallower depth. Sunedco's holes represented by average of values computed for maximum and minimum porosity conditions. Published values shown as reported.
2.4	Heat-flow (in HFU) from 300–450m depth interval. Average of values computed for minimum and maximum porosity conditions.
———	Contours on heat flow values at 2 and 4 HFU. Based chiefly on values from 100–150m interval, but also reflecting values from deeper interval.

PLATE 6. Heat flow in the Grass Valley area.