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University of Nevada
Reno, Nevada

NASA CR 101793

MACKAY SCHOOL OF MINES

UNIVERSITY OF NEVADA

RENO, NEVADA

J. P. L. MICROWAVE EXPERIMENT SUPPORT

by

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Prepared for the
National Aeronautics and Space Administration

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INTRODUCTION

A cooperative study by the University of Nevada and Jet Propulsion Laboratories was conducted between July 9 and July 19, 1968 to study the effects of various geologic parameters on microwave radiometer responses. Ground based radiometer data was generated by a 9.2 GHz portable microwave instrument designed, built and manned by J. P. L. and the Aerojet General van on special subcontract to J. P. L. operating at 1.4, 13.7, 37.0, and 94.0 GHz. Field experiments were conducted to determine the effects of look angle, grain size, soil moisture, density and to establish the depth of penetration of different microwave frequencies. A variety of materials were observed at several different test nodes selected by the University of Nevada.

The following technical letter discusses the "ground truth" measurements made by the University of Nevada ground data team and the J. P. L. 9.2 GHz portable radiometer data. Included in the ground data are measurements made at the Aerojet General test nodes, though their radiometer data is not presented here.

"GROUND TRUTH" MEASUREMENTS

The following five items are descriptions of the methods employed in measuring various important "ground truth" parameters which influence the microwave signal. Information on albedo, chemical composition and relative thermal diffusivities which contribute to the microwave signal has been compiled in earlier papers and is not repeated here.

Soil Moisture

The following soil moisture determinations were made in the lab from field samples sealed in steel cans. The 100 to 150 gram samples were opened, weighed, dehydrated by roasting for 2-1/2 hours at 105°C and re-weighed for moisture loss. The cans were cleaned, weighed and their weight subtracted from the wet and dry weights before weight percent was calculated. All of the samples reported here were processed within 72 hours after having been taken.

Samples N981 - N1009 were taken at Mono Lake; N1012 - N1040 and J. P. L. I - V at the Reno Gravel Pit and N1043 - N1055 at the Mt. Lassen cinder pit site. See Tables 1, 4 and 8.

Particle Size

Particle size analysis was done mechanically with a square-root of two set of screens ranging from 16mm to 1/16mm sieve openings. The weight percent in each sieve was calculated and plotted against gram size on bar graphs. Material greater than 16mm and less than 1/16 mm was noted but not plotted on the bar graphs. Only one sample N1027 (Reno site #3) contained grains greater than 22mm in diameter. Most samples had small amounts of material less than 1/16mm in diameter (usually less than 1%). Only two

samples N983 (Mono site #1 4") and N984 (Mono site #1 6") had significant amounts of very fine material, 9.4% and 12.6% respectively.

Radiometric Temperatures

Surface temperatures of target materials were monitored at the various sites using a Barnes PRT-4 infrared radiometer. The 8-14μ radiometer is calibrated to materials with a .9 emissivity. This radiometric data is probably the closest measurement to true surface temperatured attainable. All infrared radiometer readings are presented in degrees Celsius.

Temperature Profiles

Subsurface temperatures were monitored during various microwave experiments at Mono Lake and at Mt. Lassen. At the cinder pit site of Mt. Lassen a continuous temperature profile was run for 28 hours using a self-recording thermister probe instrument with probes buried at depths up to three feet.

Density and Porosity

In situ bulk density, porosity and moisture measurements are made with a gamma-neutron probe, which integrates the density and moisture content of approximately the first half foot. The neutron probe is sensitive to water content and the gamma probe to material density. The raw readings from each site may be converted to pounds per cubic foot on a simple calibration chart. A simple computer program in PDP-8 Fortran may be used to further convert these readings to wet density in gms/cm^3, dry density in gms/cm^3, percent water moisture and percent porosity, assuming an average mineral density of 2.56 gm/cm^3 (160 lbs/ft^3).

DENSITY AND POROSITY PDP-8 FORTRAN PROGRAM

```
1;ACCEPT 2,INO,W1,W2,W3,W4,D1,D2,D3,D4
2;FORMAT (I,E,E,E,E,E,E,E,E)
 ;BARM=(W1+W2+W3+W4)/4.0
 ;BARD+(D1+D2+D3+D4)/4.0
 ;TD=BARM+BARD
 ;WD=TD/62.4
 ;DD+BARD/62.4
 ;PW=(TD-BARD)/TD
 ;P=1.-(BARD/160.)
 ;TYPE 4,INO,WD,DD,PW,P
4;FORMAT (/,I,/,E,E,E,E)
 ;GO TO 1
 ;END
```

BARM = Wt. of moisture average of 4 readings in lbs/ft^3

BARD = Density of material average of 4 readings in lbs/ft^3

TD = Total wet density in lbs/ft^3

WD = Wet density in gms/cm^3

DD = Dry density in gms/cm^3

PW = Weight percent moisture

P = Percent porosity

J. P. L. MICROWAVE RADIOMETER

A 9.2 GHz portable microwave radiometer, built by Jet Propulsion Laboratories, was operated at Mono Lake, Reno Gravel Site, Mt. Lassen cinder pit and during flights 4 and 5 of mission 76 on the test site. This suitcase-sized radiometer operates at approximately the same frequency as the X-band system aboard the NASA 926-CV240 aircraft. All of the data presented in this technical letter was generated with the radiometer in a boom mounted mode. Figures 1 and 2 show the radiometer both boom mounted and stand mounted.

Temperature versus look-angle plots

Temperature/look-angle plots are a very effective graphic method of portraying changes in antenna temperature due to emissivity differences with look-angle and polarization. Each look-angle plot includes three curves; vertical polarization, horizontal polarization and vertical polarization minus horizontal polarization.

Theoretically for specular targets, vertical polarization temperatures (emissivities) rise slowly to the Brewster Angle and fall sharply to 0°K at 90° look-angle. In the case of less ideal targets such as typical rocks and soils reported in this technical letter the two polarizations move closer in temperature to each other with increasing roughness at all look-angles and drop off to the approximate microwave temperature of the sky near the horizon at 90° look-angle.

The curves presented here are greatly idealized. Each curve has been generated using only four or five points and the base behavior of the curves between points and beyond the points have been formulated using the following assumptions: 1) the vertical and horizontal polarization temperatures tend to converge near look-angles of 0° and 90°; 2) the horizontal polarization temperature decreases in some regular fashion with increasing look-angle; 3) the vertical polarized temperature curve lies above the horizontal polarized temperature curve. The exact points used in the generation of the curves may be seen in partially reduced data tables appearing a few pages in front of the curves.



Figure 1. Jet Propulsion Laboratories portable 9.2 GHz microwave radiometer mounted on boom truck.

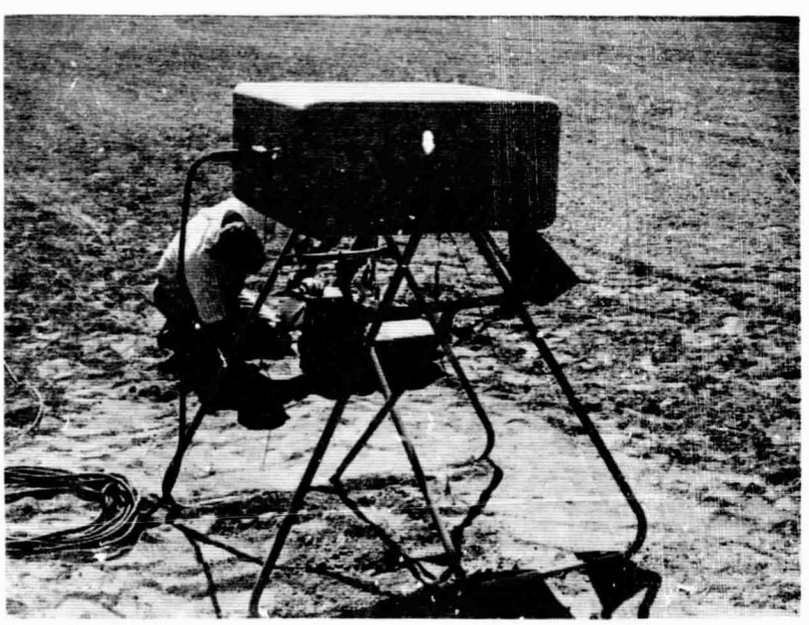


Figure 2. Jet Propulsion Laboratories portable 9.2 GHz microwave radiometer on lightweight stand.

Depth of penetration curves

One of the primary purposes of this microwave study was to determine depths of penetration of various microwave frequencies in particulate materials. This report contains only microwave data collected by the 9.2 GHz J. P. L. radiometer. The experiment was performed by burying an aluminum plate (reflectivity almost 1) at various depths in loose material and recording the microwave temperatures.

The microwave temperatures recorded in such a manner are the sum of two principle sources, the material covering the plate and a component of sky temperature reflected by the plate. If we make several nearly true assumptions, 1) the emissivity of the plate is 0.0, 2) the emissivity of the target material viewed near the vertical is 1.0, and 3) the microwave temperature of the sky is a uniform 5°K, a greatly simplified equation for antenna temperature may be arrived at:

$$Ta = (P_t * T_t) + [(1-P_t) * 5.0]$$

Ta = target reading

T_t = temperature of target material

P_t = fractional contribution of target material to signal

From this simplified equation the percent contribution of any layer may be solved for because Ta and T_t are known. The interval reflection components are neglected in this equation because they are relatively small at nearly vertical look-angle.

For purposes of comparing depths of penetration the term *optical depth* is commonly used. Several different definitions of optical depth are unfortunately in current usage. In this technical letter the half-power point is used. The half-power point is that depth where 50% of the signal comes from above and 50% from below, i.e. $P_t = (1-P_t)$.

The plotted curves show the variation in antenna temperature with various depths of burial for each material. The optical depth is marked on each curve.

Computer Reduction of Data

For the rapid processing of large quantities of raw radiometer data a PDP-8 Frotran program was written by Peter E. Chapman and Peter A. Brennan of the University of Nevada. With this program it is possible to reduce radiometer output to antenna temperatures and various instrument parameters on the same day that the data are taken.

The six computer outputs reproduced in the reduced radiometer data section are as follows:

TIME - Time of reading
$T_3(R)$ - Antenna temperature in degrees Kelvin
T_1 = Absolute temperature of the reference load
α = instrument gain in degrees per volt
$\bar{X}$ = Base line reading in volts corresponding to T_1
ΔTB = Temperature drift between base checks.

The following program has three options. Option 1 is for processing calibration data. The input data for option 1 are as follows: 1) time, 2) sky reading, 3) conical black body reading, 4) base check, 5) reference load reading, 6) sky reading, 7) estimated absolute sky temperature, 8) absolute temperature of conical black body, 9) absolute temperature of reference load box. Option 2 requires two calibration parameters (output of option 1) plus the following target information: 1) time, 2) base check, 3) reference load reading, 4) target reading, 5) base check, 6) absolute temperature of reference load box. Option 3 carries the calibration parameters from the previous calculation and requires only the target information in the same form as option 2.

PDP-8 FORTRAN J. P. L. RADIOMETER DATA REDUCTION PROGRAM

```
    ;TYPE 8Ø
  8Ø;FORMAT(/"TYPE (1) FOR CALIB., (2) FOR DATA.")
    ;TYPE 1Ø1
 1Ø1;FORMAT ("(3) FOR DATA WITH TB(COR) AND TCAL",/)
  84;TYPE 23
  23;FORMAT ("INPUT (1),(2) OR (3)")
    ;ACCEPT 9Ø,N
```

```
90;FORMAT(I)
  ;IF(2-N)83,82,81
81;TYPE 20
20;FORMAT(/,"CALIBRATION DATA",/,/,"INPUT TIME=")
  ;ACCEPT 21,T
  ;TYPE 22
22;FORMAT(/,"X1=")
  ;ACCEPT 21,X1
  ;TYPE 24
24;FORMAT(/,"X2=")
  ;ACCEPT 21,X2
  ;TYPE 26
26;FORMAT(/,"X3=")
  ;ACCEPT 21,X3
  ;TYPE 28
28;FORMAT(/,"X4=")
  ;ACCEPT 21,X4
  ;TYPE 30
30;FORMAT(/,"X5=")
  ;ACCEPT 21,X5
  ;TYPE 32
32;FORMAT(/,"T1=")
  ;ACCEPT 21,T1
  ;TYPE 34
34;FORMAT(/,"T2")
  ;ACCEPT 21,T2
  ;TYPE 36
36;FORMAT(/,"T3C=")
  ;ACCEPT21,T3C
  ;XBR=(X1+X5)/2.0
  ;IF(X1-X5) 12, 13, 13
12;DXB=(X5-X1)/2.0
  ;GO TO 14
13;DXB=(X1-X5)/2.0
14;A=(T2-T1)/(X2-XBR)
  :T3R=A*(X3-XBR)+T1
  ;T4C=A*(X4-XBR)+T1
  ;TB=T3C-T3R
  ;TCL=T4C-T3R
  ;DT=A*DXB
  ;TYPE 2, T
  ;TYPE 3, T3R, T4C, T3C
  ;TYPE 7, TB, TCL, A
  ;TYPE 8, XBR, DT
  ;GO TO 84
82;TYPE 85
85;FORMAT(/,"TB(COR)=")
  ;ACCEPT 21, TB
  ;TYPE 86
86;FORMAT(/,"T(CAL)=")
  ;ACCEPT 21, TCL
  ;TYPE 86
86;FORMAT(/,"T(CAL)=")
  ;ACCEPT 21,TCL
```

```
83;TYPE 38
38;FORMAT(/,/,/,"DATA",/,/,"TIME=")
  ;ACCEPT 21,TM
  ;TYPE 40
40;FORMAT(/,"X1=")
  ;ACCEPT 21,XA
  ;TYPE 42
42;FORMAT(/,"X2=")
  ;ACCEPT 21,XB
  ;TYPE 44
44;FORMAT(/,"X3=")
  ;ACCEPT 21,XC
  ;TYPE 46
46;FORMAT(/,"X4=")
  ;ACCEPT 21,XD
  ;TYPE 48
48;FORMAT(/,"T1=")
  ;ACCEPT 21,TA
  ;XBAR=(XA+XD)/2.0
  ;IF(XA-XD)15,16,16
15;DXBA=(XD-XA)/2.0
  ;GO TO 17
16;DXBA=(XA-XD)/2.0
17;AL=TCL/(XB-XBAR)
  ;TTR=AL*(XC-XBAR)+(TA-TB)
  ;DTBB=AL*DXBA
  ;TYPE5, IM
  ;TYPE6, TTR, TA, AL
  ;TYPE9,XBAR, DTBB
  ;GO TO 84
21;FORMAT(E)
 2;FORMAT(/,"MICROWAVE CALIBRATION   TIME=",E,/)
 5;FORMAT(/,"MICROWAVE RADIOMETER DATA   TIME=",E,/)
 3;FORMAT("T3(R)    =",E,/,"T4(C)   =",E,/,"T3(C)    =",E,/)
 7;FORMAT("TB(COR)  =",E,/,"T(CAL)  =",E,/,"ALPHA    =",E,/)
 8;FORMAT("XBAR     =",E,/,"DELTA TB=",E,/,/)
 6;FORMAT(,"T3(R)   =",E,/,"T1      =",E,/,"ALPHA    =",E,/)
 9;FORMAT("XBAR     =",E,/,"DELTA TB=",E,/,/,)
  ;END
```

MONO LAKE SITE

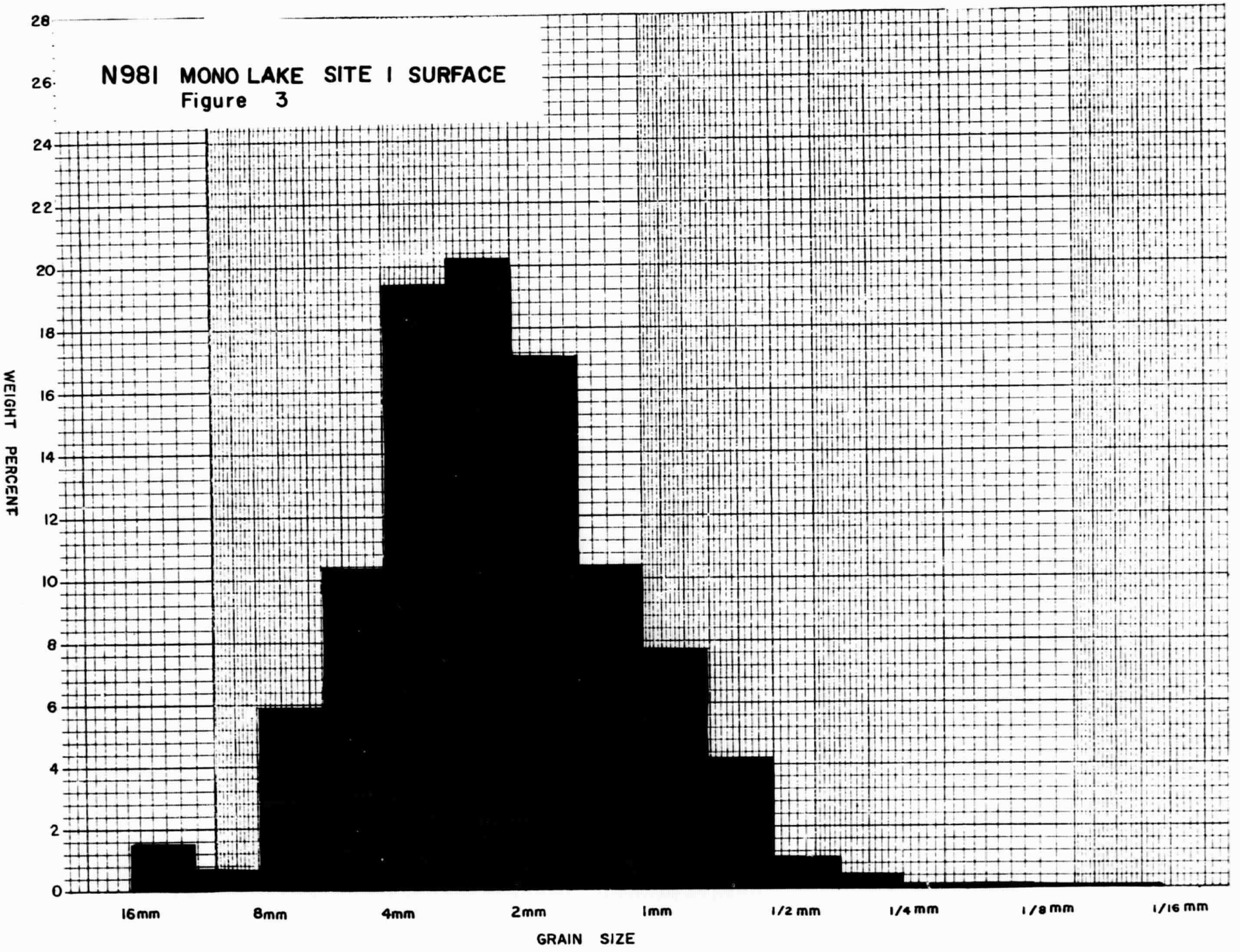
July 9 & 10, 1968

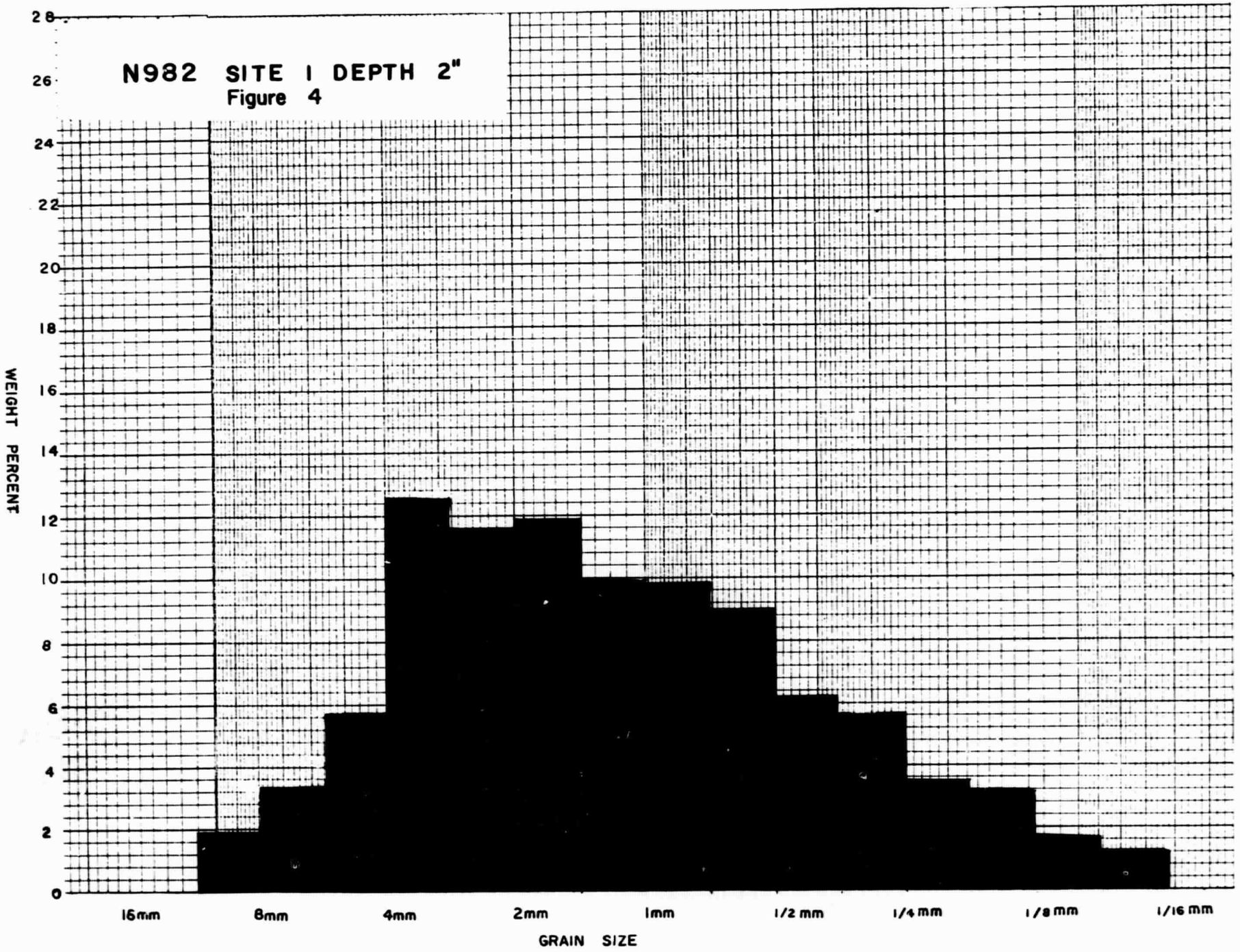
TABLE I

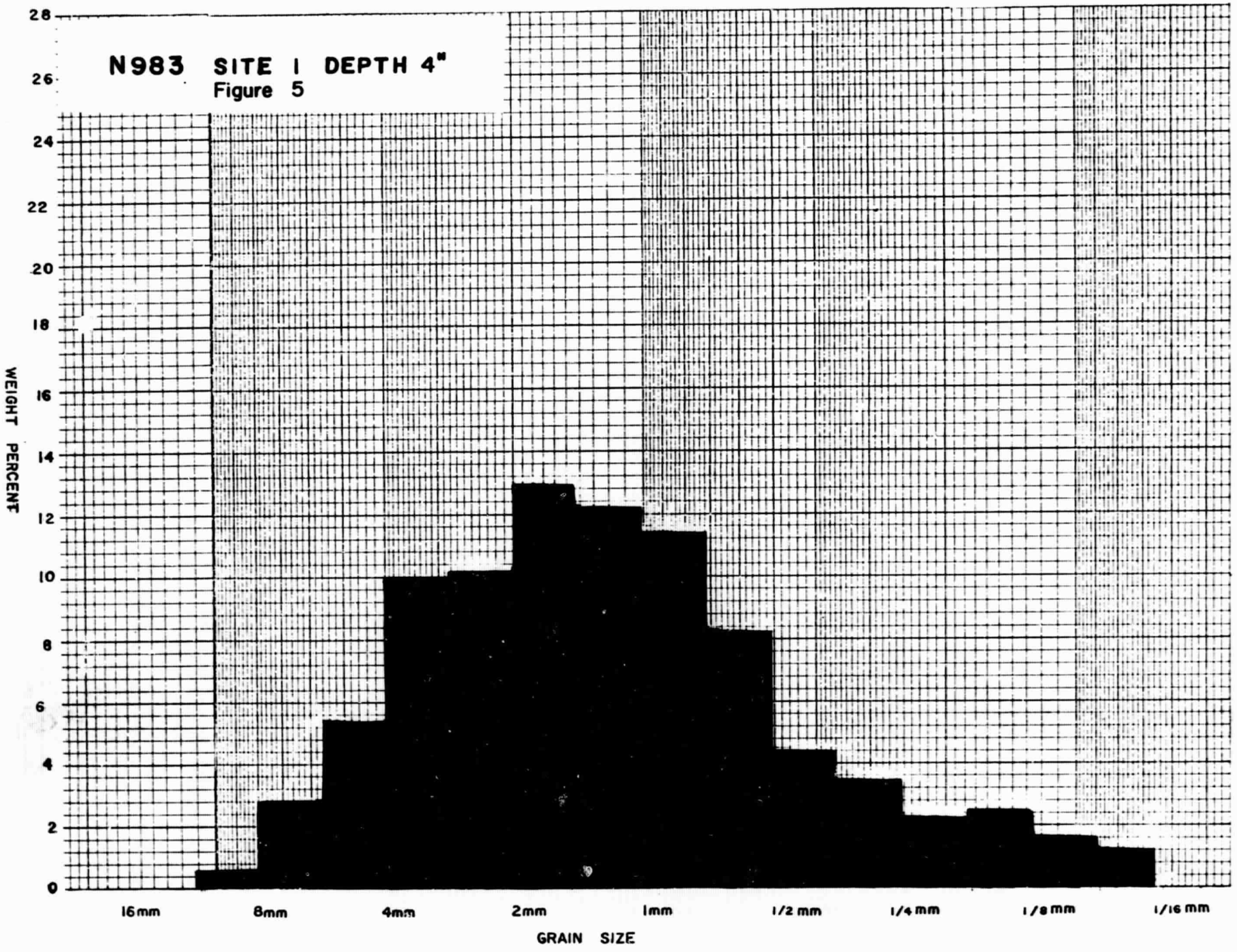
SOIL MOISTURE

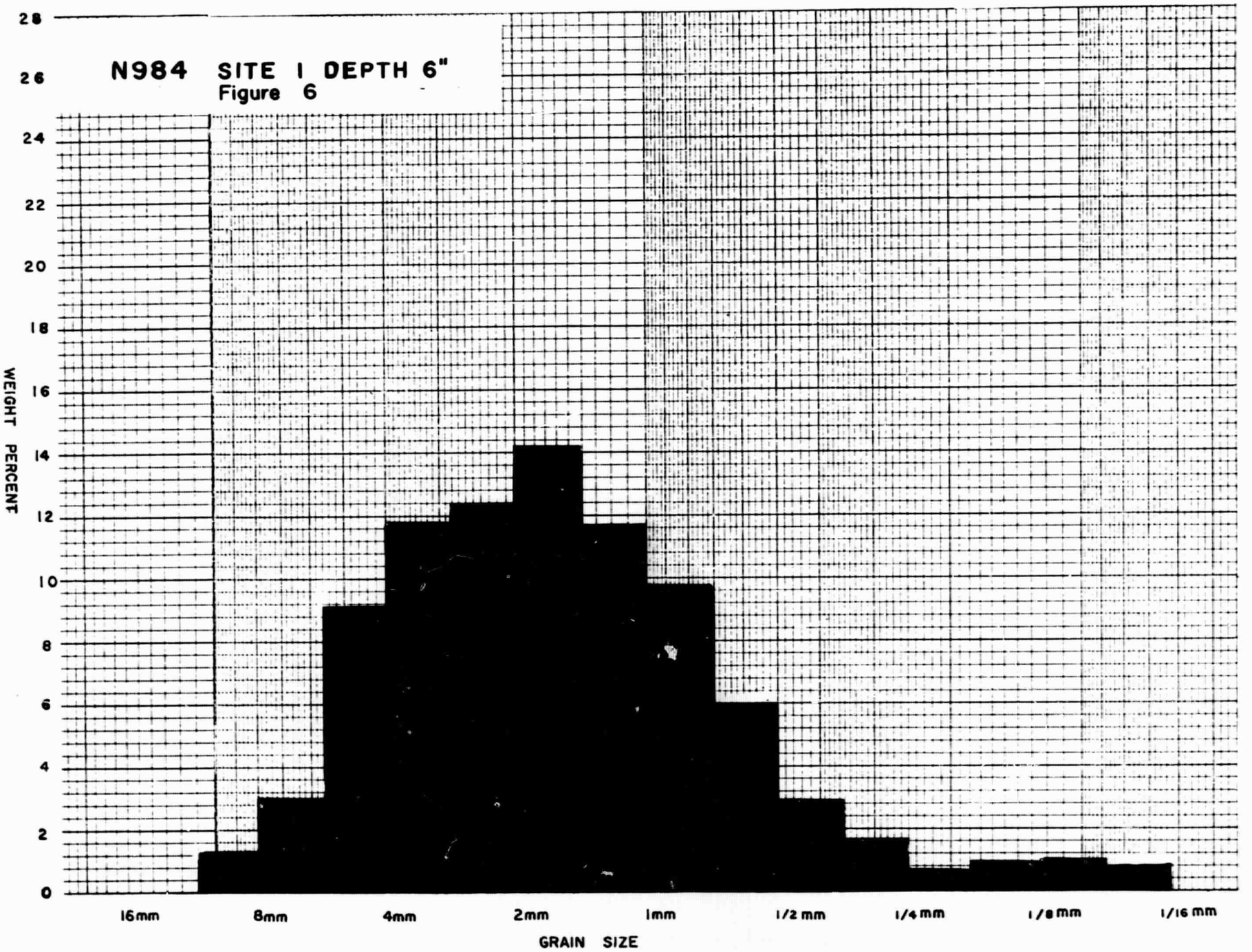
Mono Lake
July 9-10, 1968

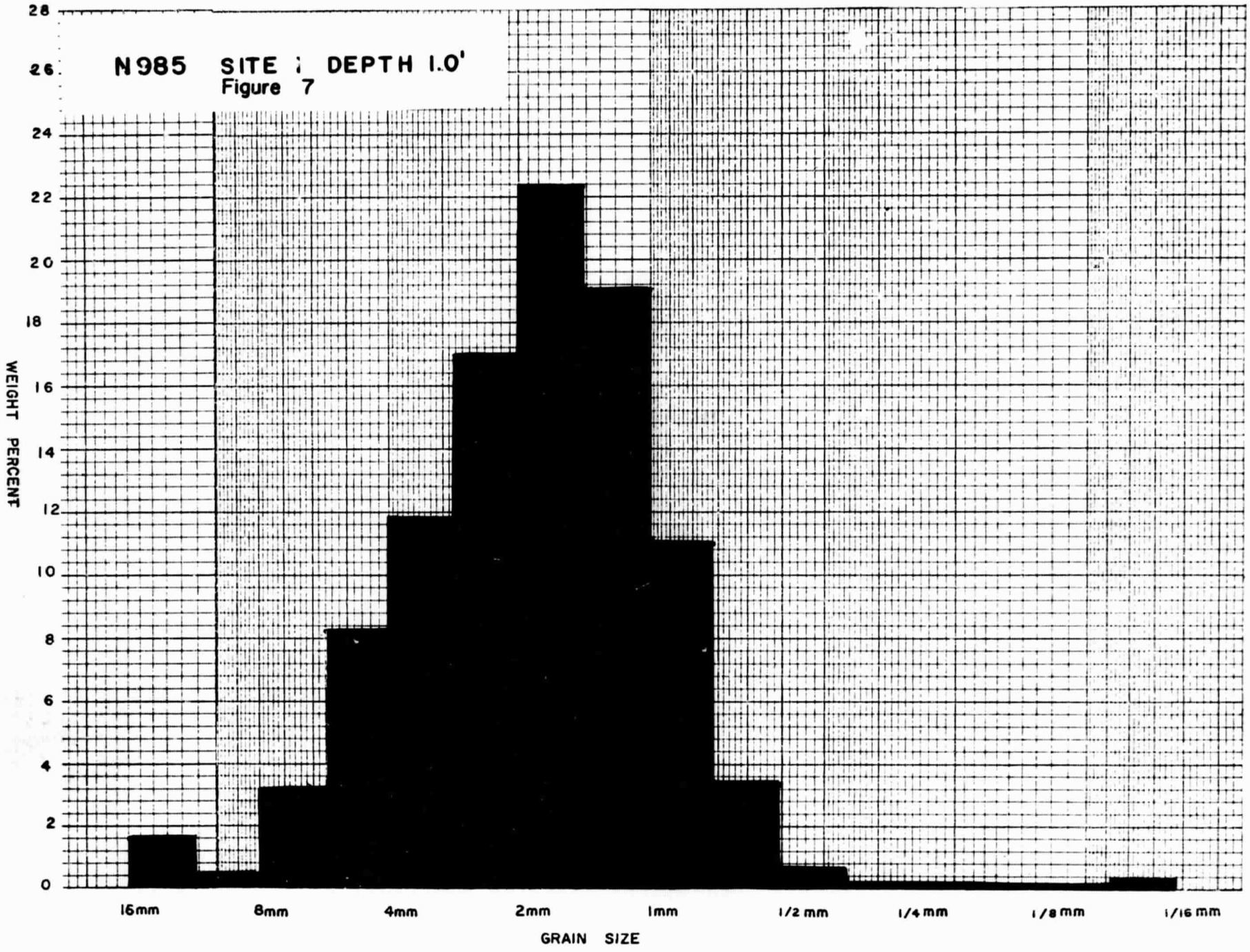
Sample No.		Wt. Percent Moisture	
N981	(Site #1-surface)	0.10	
N982	(Site #1-2")	3.25	
N983	(Site #1-4")	6.12	
N984	(Site #1-6")	6.54	
N985	(Site #1-1')	5.86	
N986	(Site #1-1.5')	7.01	
N987	(Site #1-2')	5.91	
N988	(Site #1 Alum 1)	0.40	
N989	(Site #1 Alum 1)	0.25	Average 0.27%
N990	(Site #1 Alum 1)	0.15	
N991	(Site #1 JPL-Al	2.44	
N992	(Site #1 JPL-Al)	1.08	Average 1.74%
N993	(Site #1 JPL-Al)	1.72	
N996	(Site #2 Plate 2 SG 13 Material)	0.54	
N997	(Site #2 Plate 2 SG 13 Material)	0.78	Average 0.67%
N998	(Site #2 Plate 2 SG 13 Material)	0.69	
N999	(Site #2 SG 13 Wet)	11.97	
N1000	(Site #2 SG 13 Wet)	14.48	Average 13.23%
N1002	(Site #2 ML SG Beach Surface)	0.74	
N1003	(Site #2 ML SG Beach 2")	0.50	
N1004	(Site #2 ML SG Beach 4")	1.42	
N1005	(Site #2 ML SG Beach 6")	4.94	
N1006	(Site #2 ML SG Beach 1')	6.88	
N1007	(Site #2 ML SG Beach 2')	8.94	
N1008	(Site #2 Wet L Al Band)	14.50	
N1009	(Site #2 Wet L Al Band)	13.15	

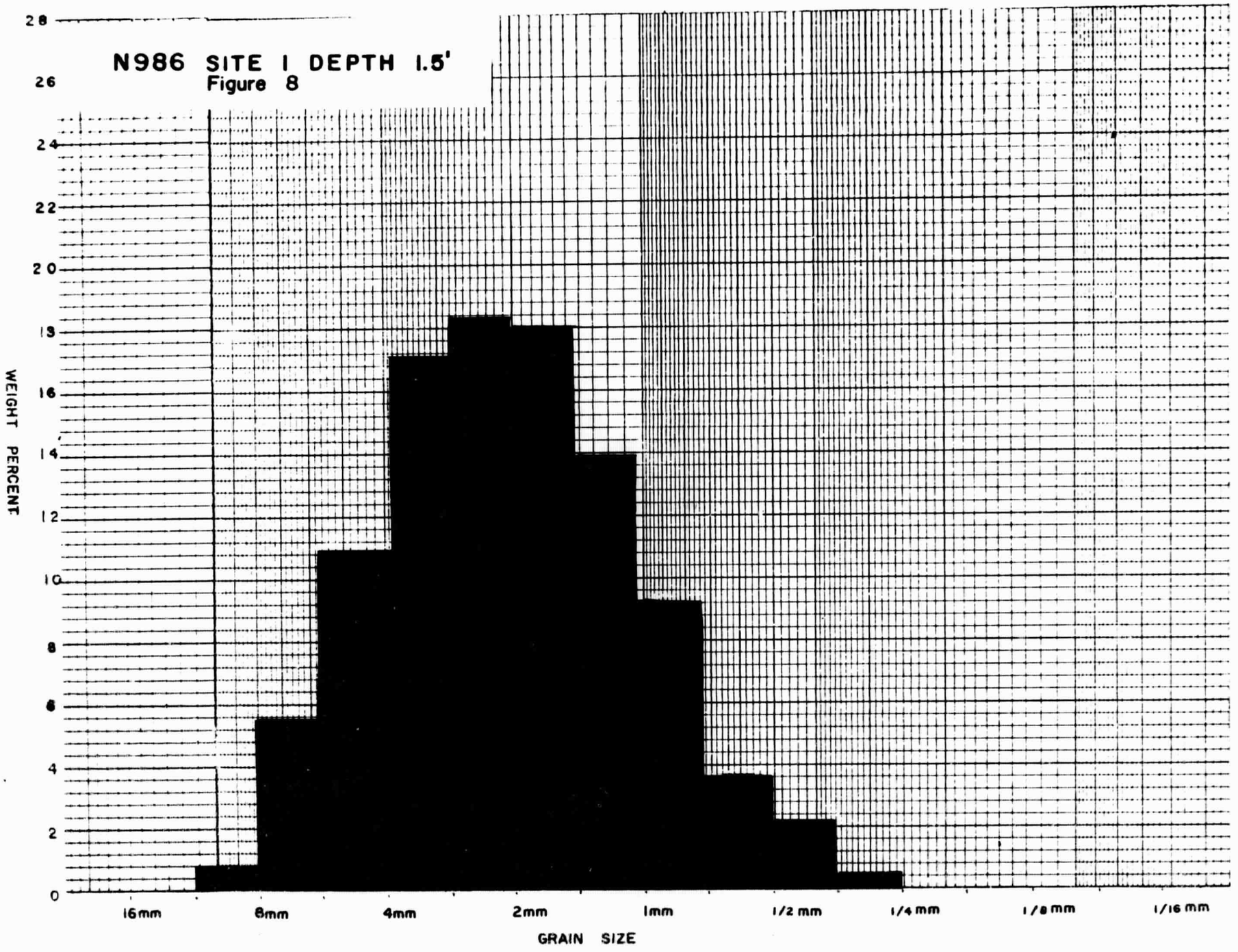

N981 MONO LAKE SITE I SURFACE
Figure 3
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

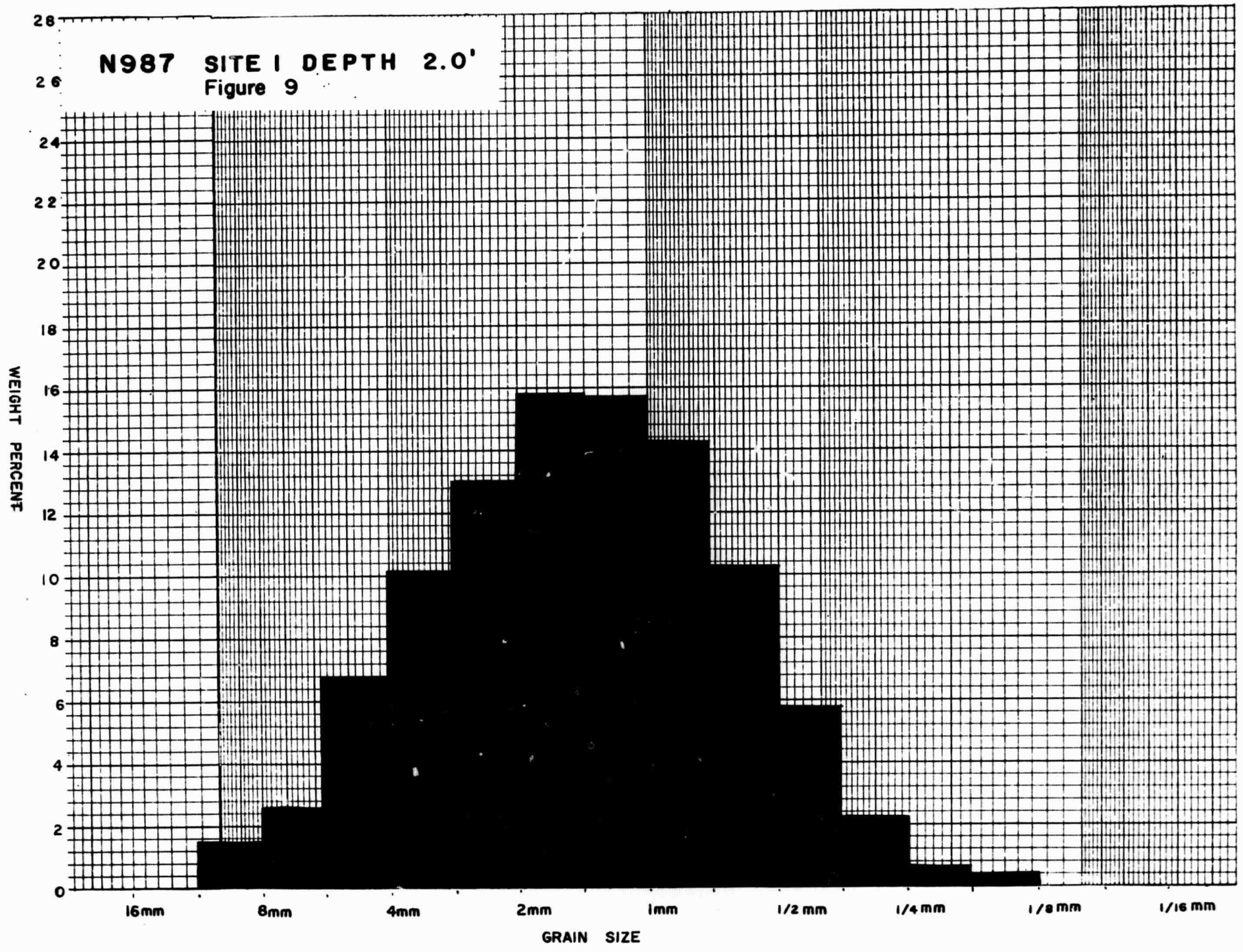

N982 SITE 1 DEPTH 2"
Figure 4
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

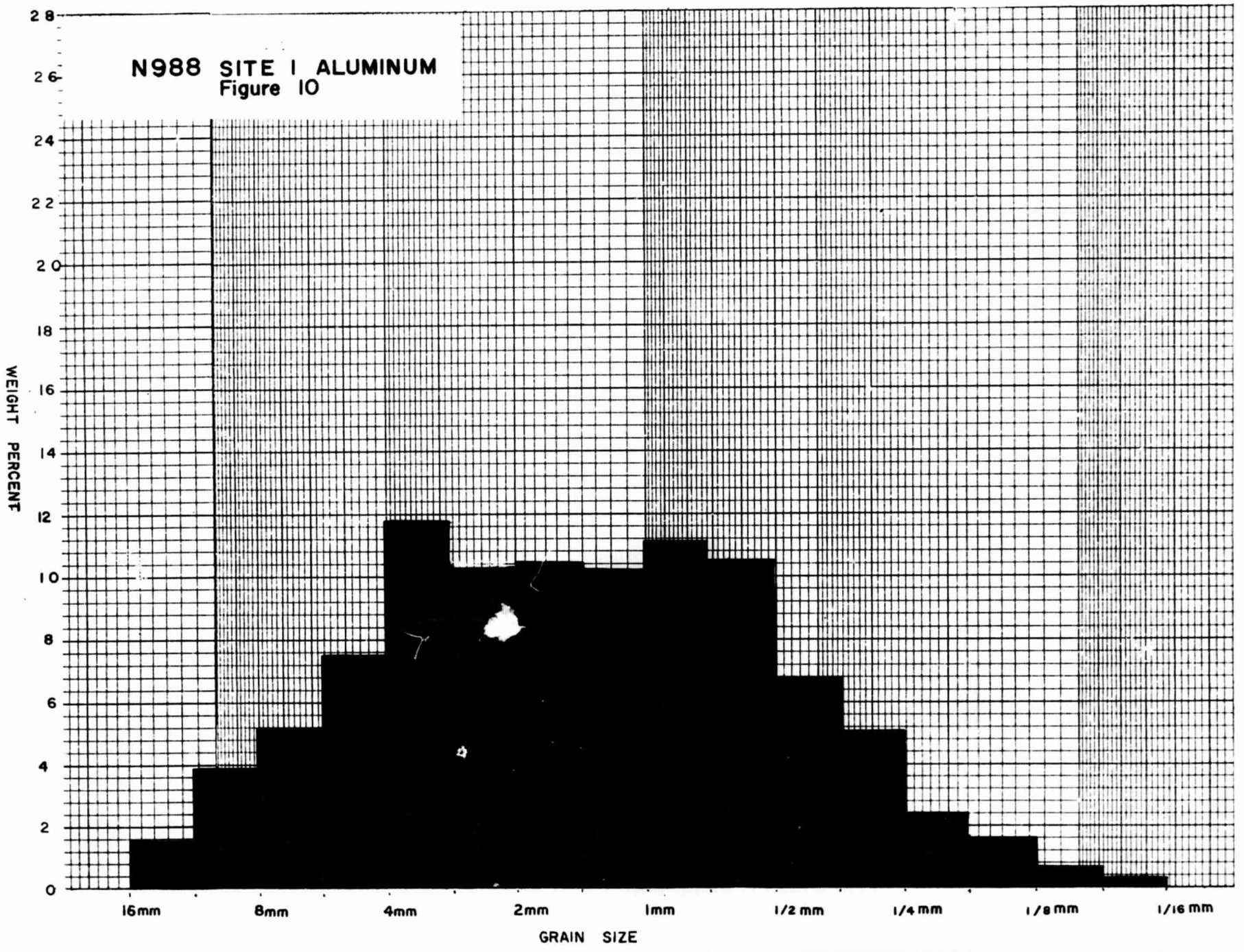

N983 SITE I DEPTH 4"
Figure 5
WEIGHT PERCENT
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

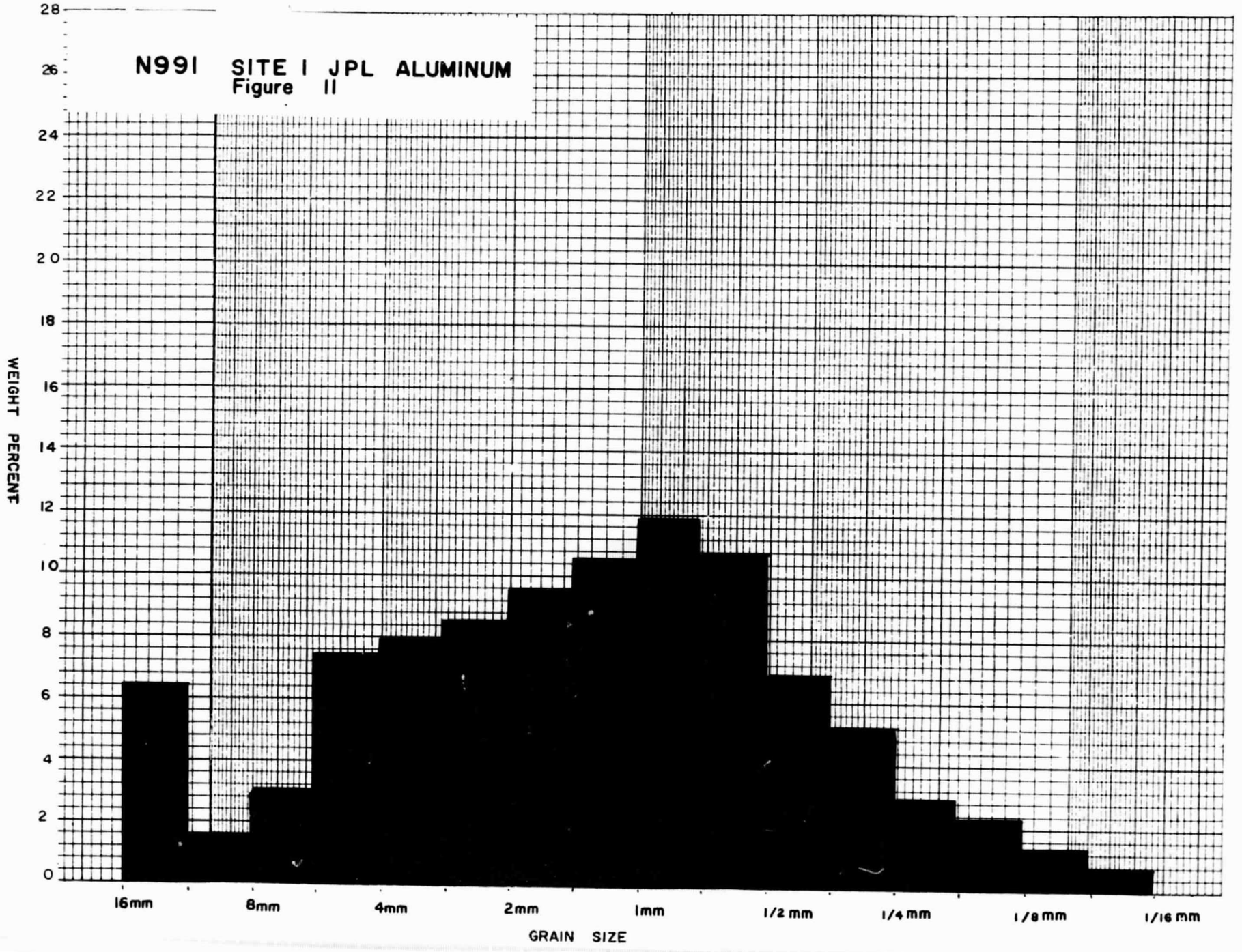

N984 SITE 1 DEPTH 6"
Figure 6
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

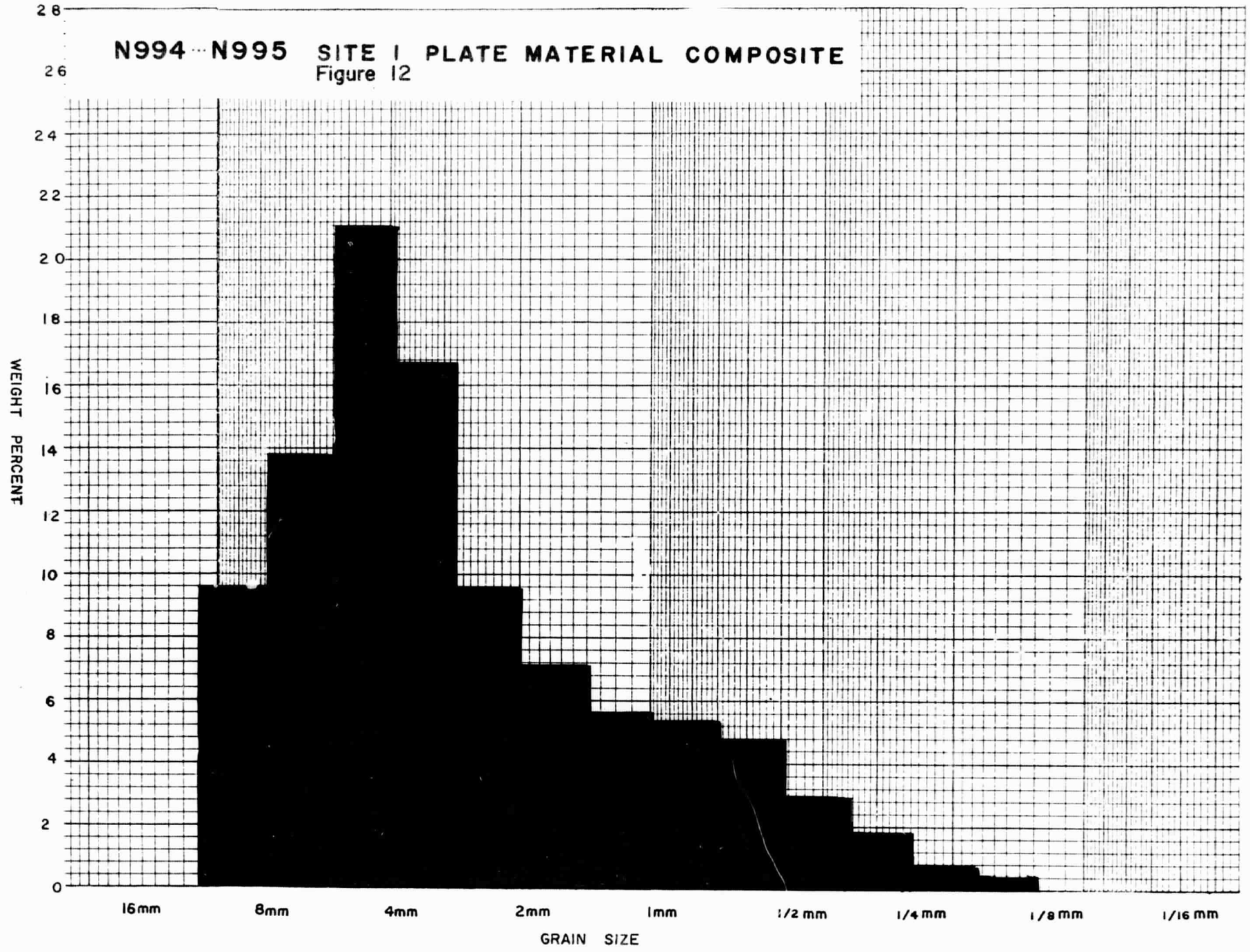

N985 SITE 1 DEPTH 1.0'
Figure 7
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

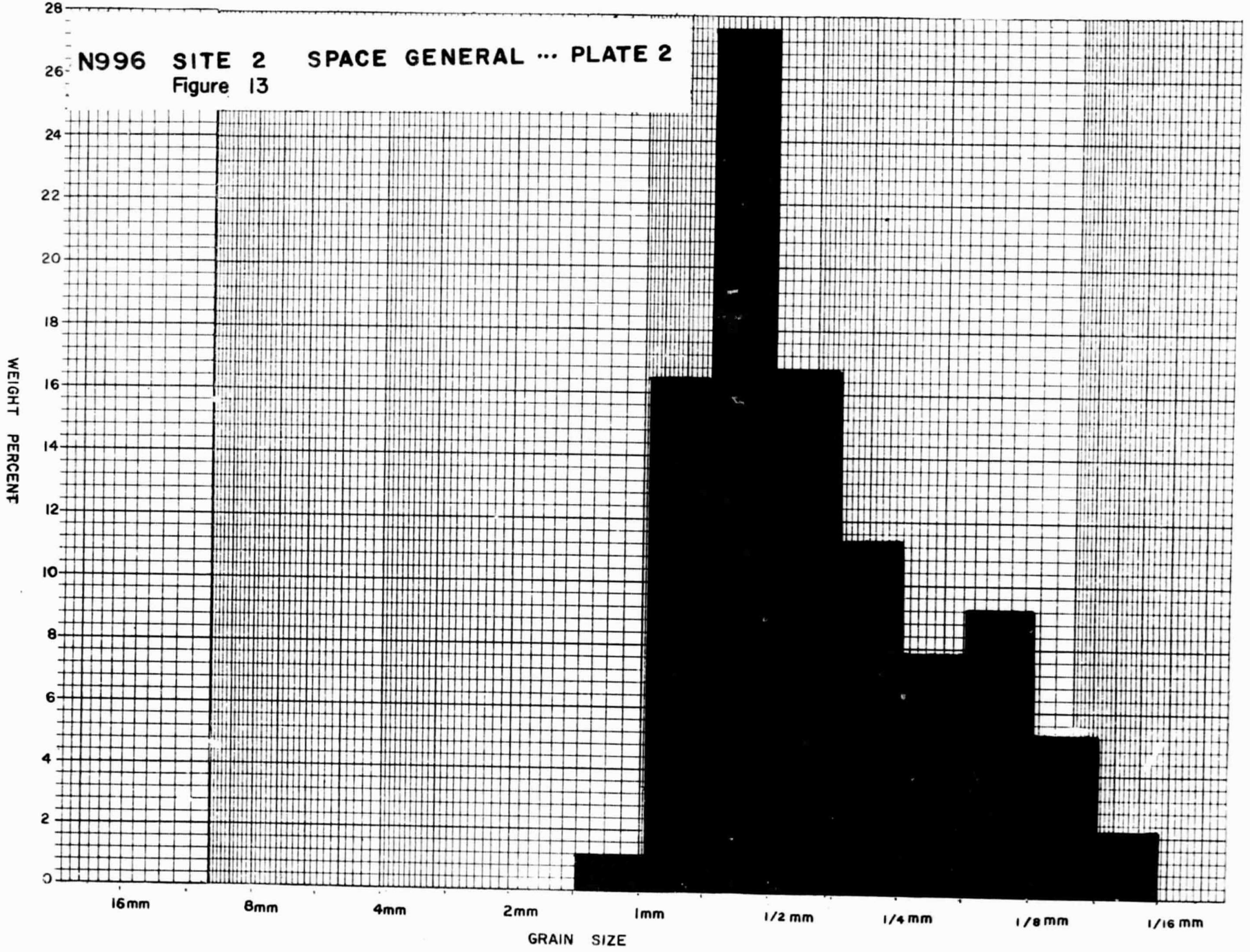

N986 SITE 1 DEPTH 1.5'
Figure 8
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

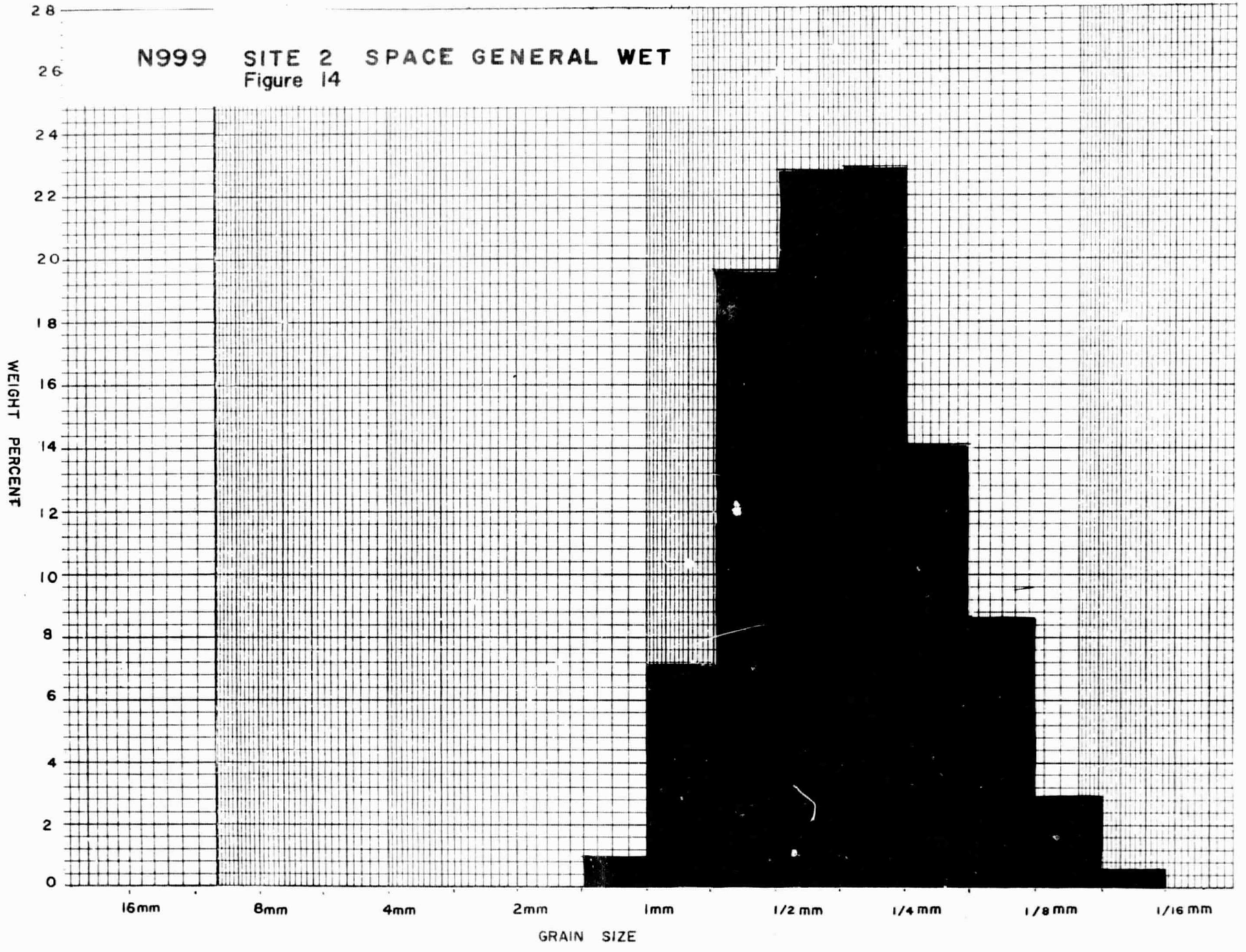

N987 SITE I DEPTH 2.0'
Figure 9
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

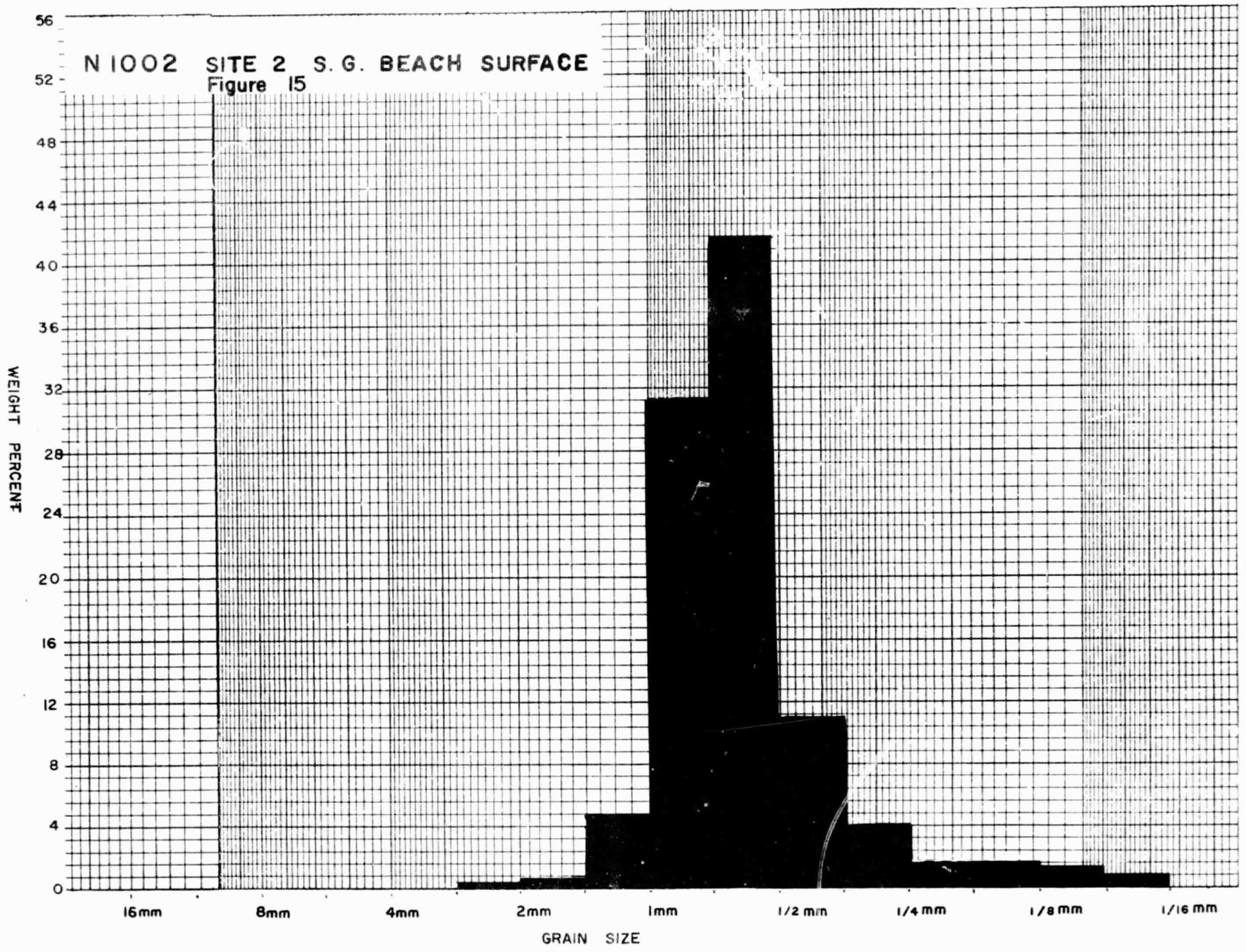

N988 SITE I ALUMINUM
Figure 10
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

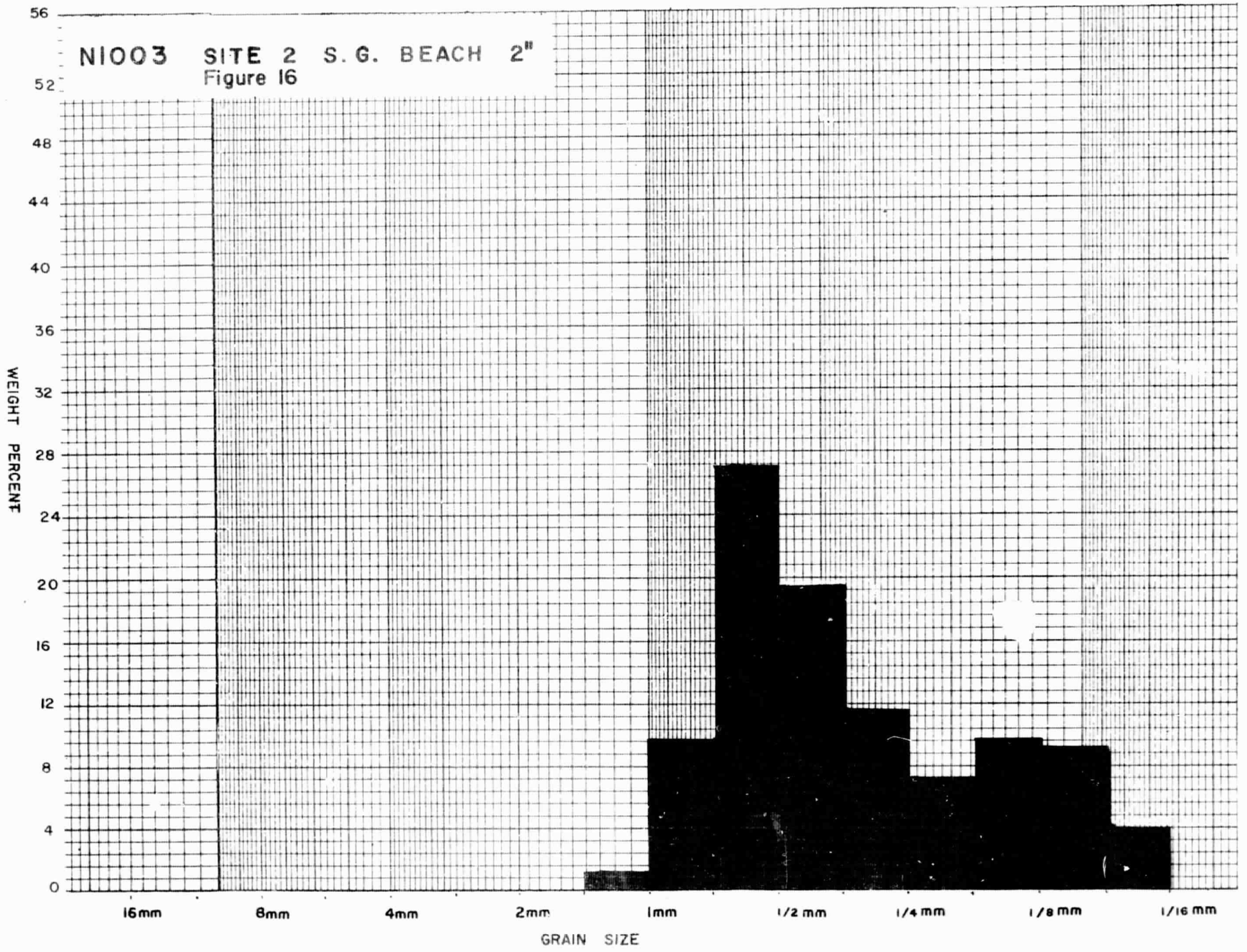

N991 SITE I JPL ALUMINUM
Figure II
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

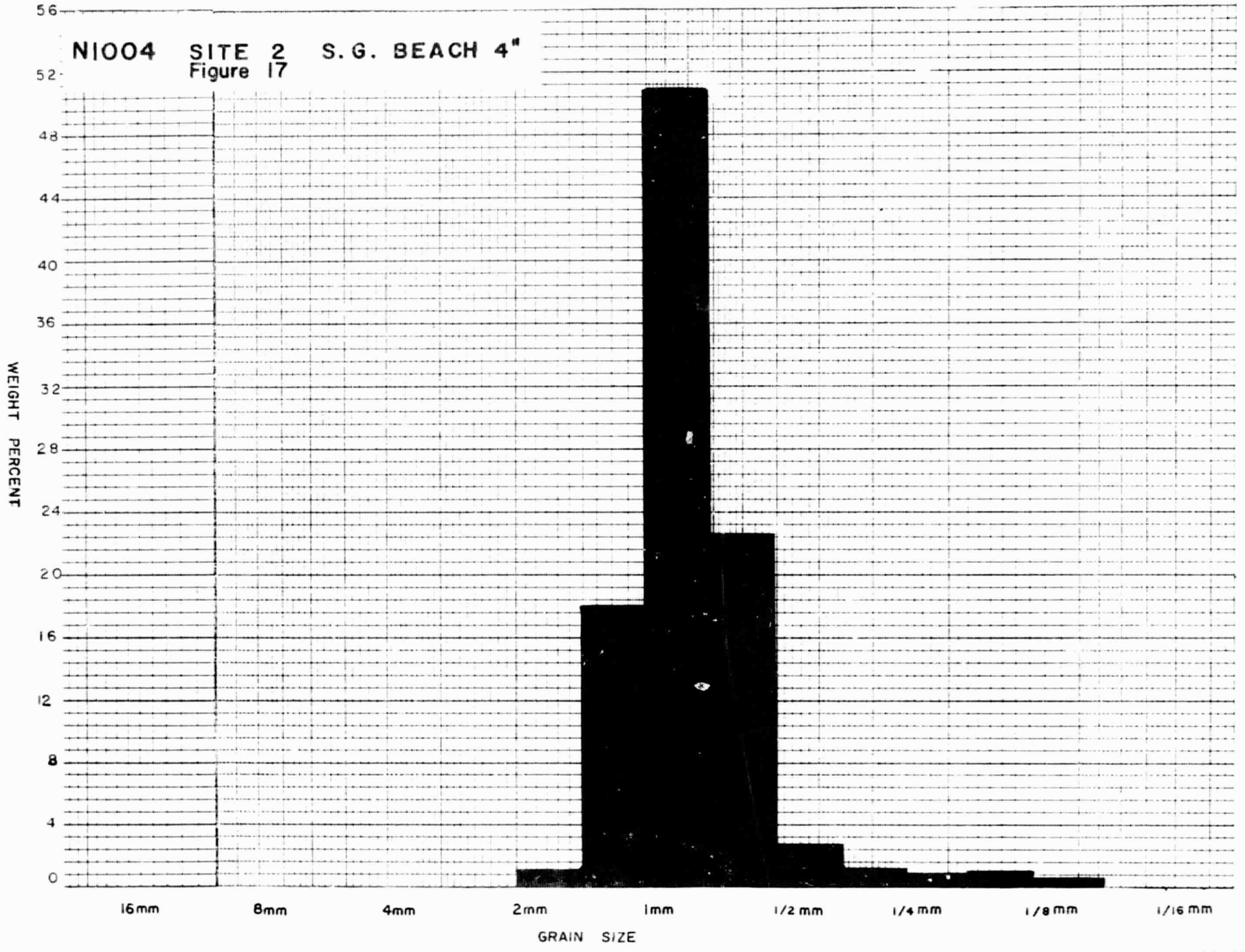

N994 ··· N995 SITE I PLATE MATERIAL COMPOSITE
Figure 12
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

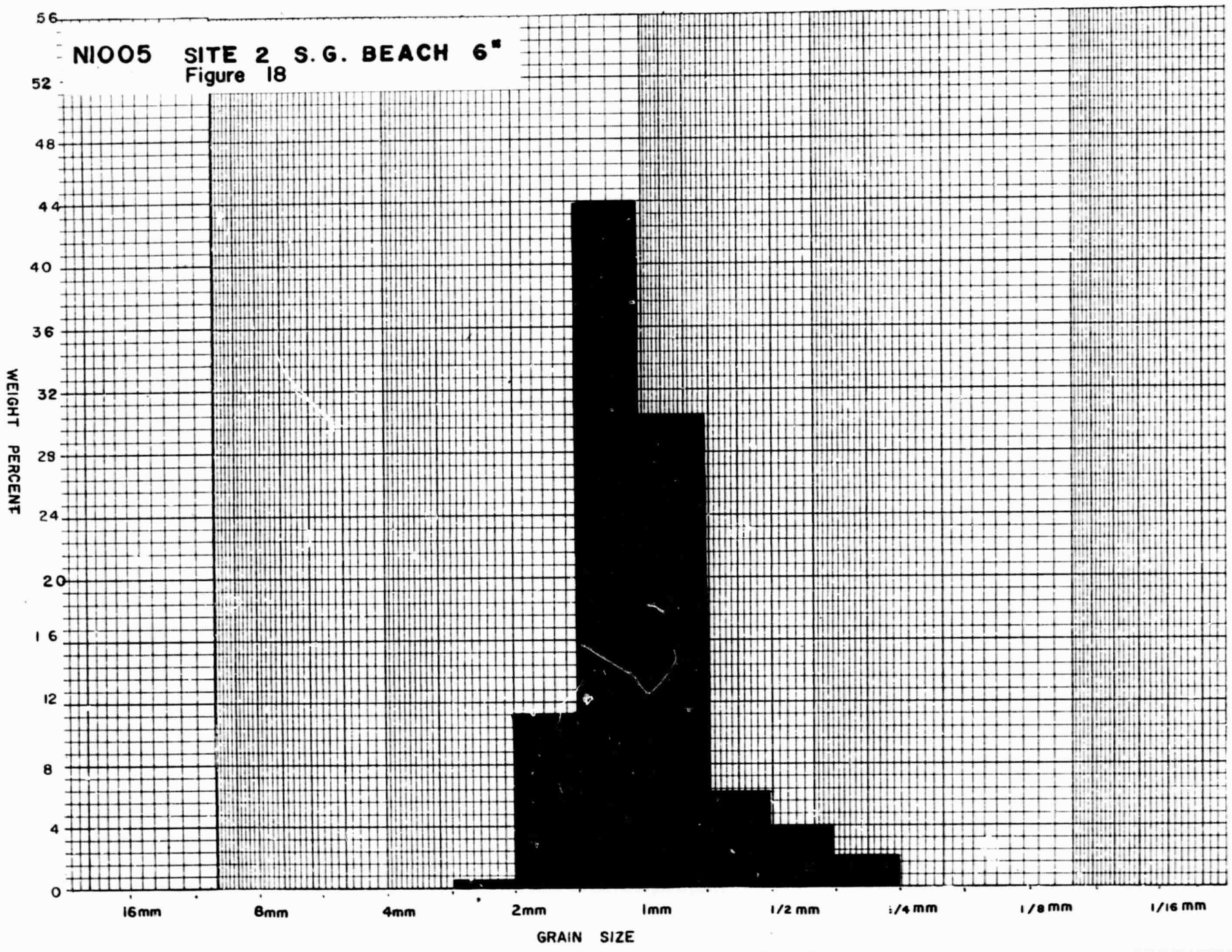

N996 SITE 2 SPACE GENERAL ... PLATE 2
Figure 13
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

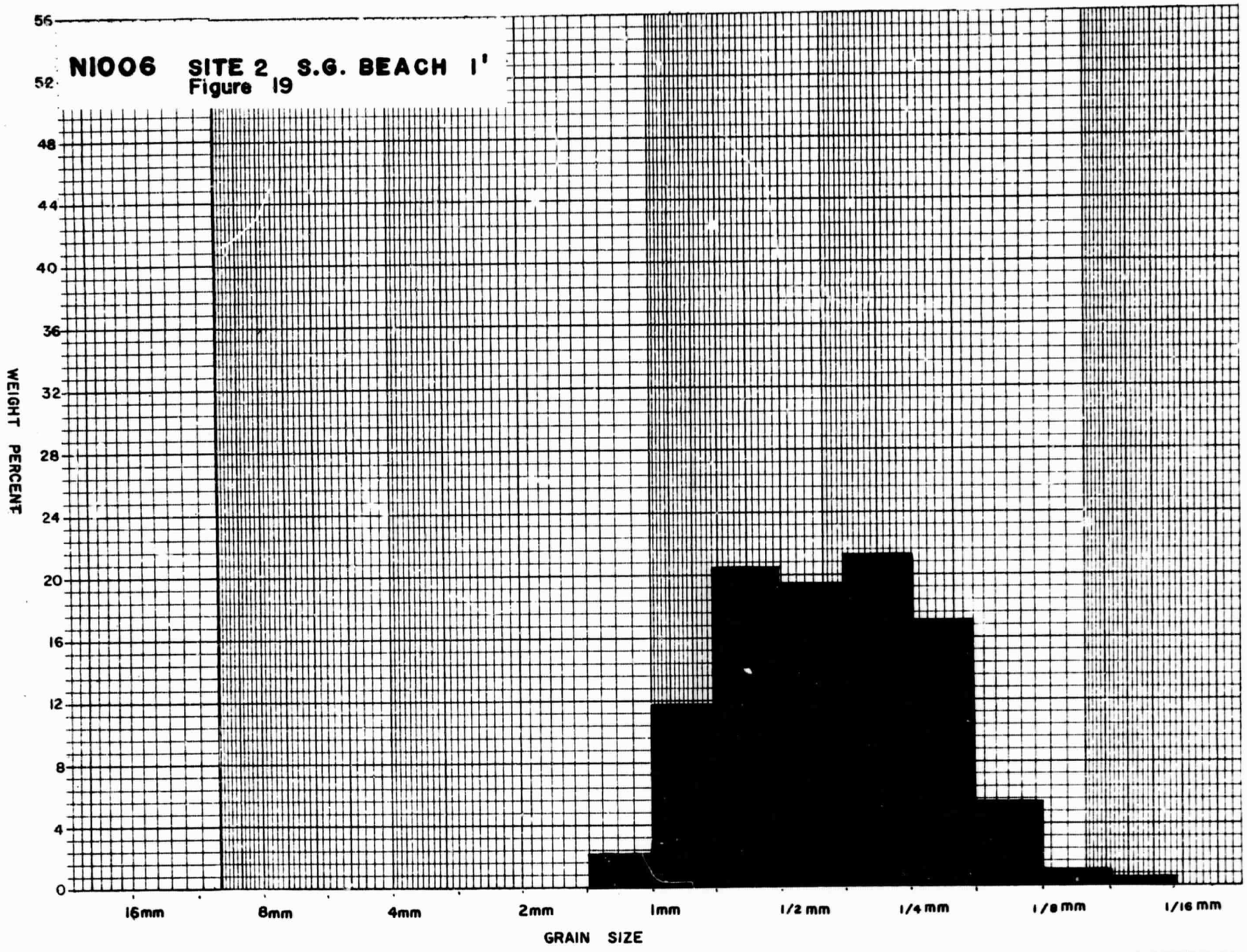

N999 SITE 2 SPACE GENERAL WET
Figure 14
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

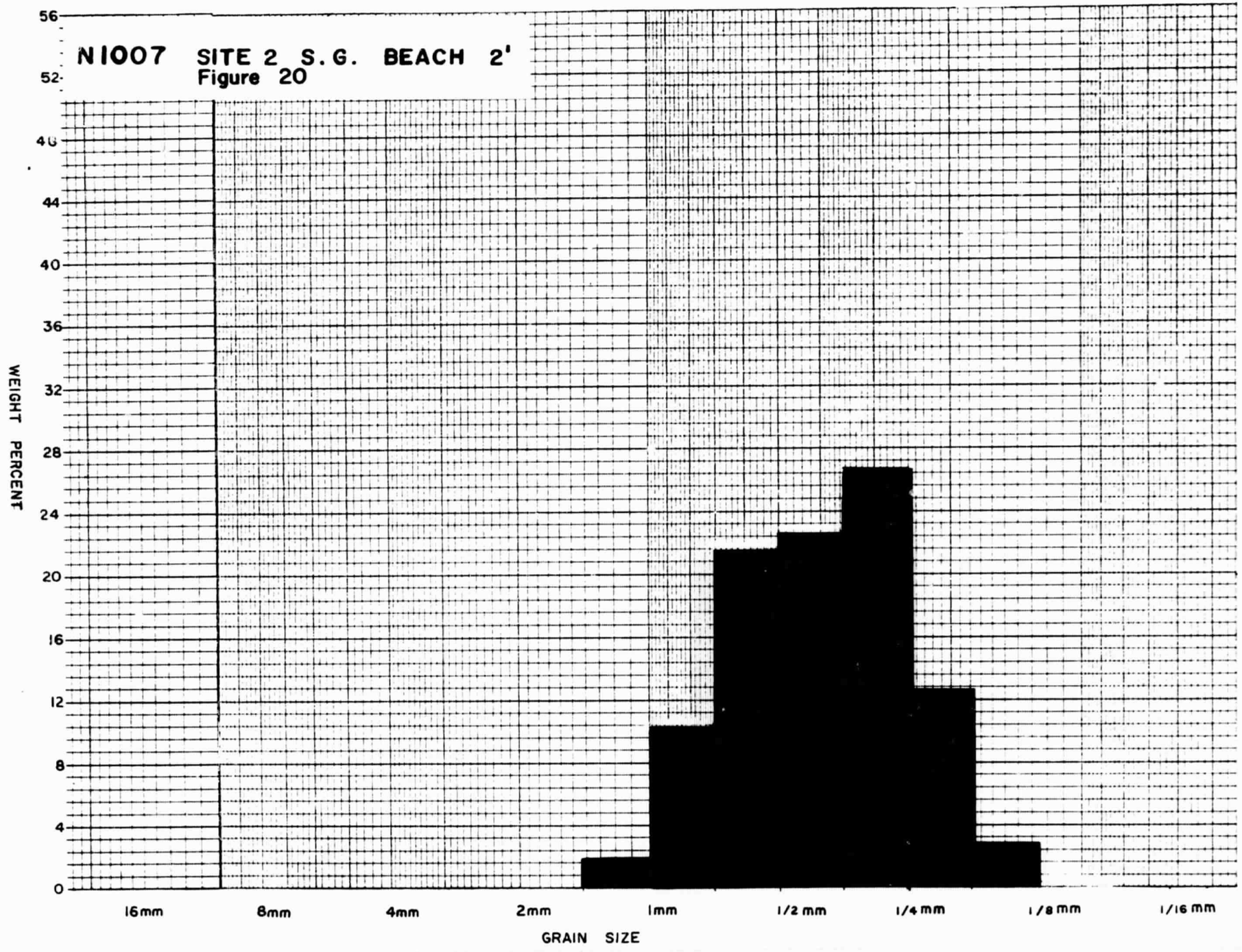

N1002 SITE 2 S.G. BEACH SURFACE
Figure 15
WEIGHT PERCENT
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1003 SITE 2 S.G. BEACH 2"
Figure 16
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1004 SITE 2 S.G. BEACH 4"
Figure 17
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1005 SITE 2 S.G. BEACH 6"
Figure 18
56
52
48
44
40
36
32
29
24
20
16
12
8
4
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1006 SITE 2 S.G. BEACH 1'
Figure 19
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1007 SITE 2 S.G. BEACH 2'
Figure 20
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

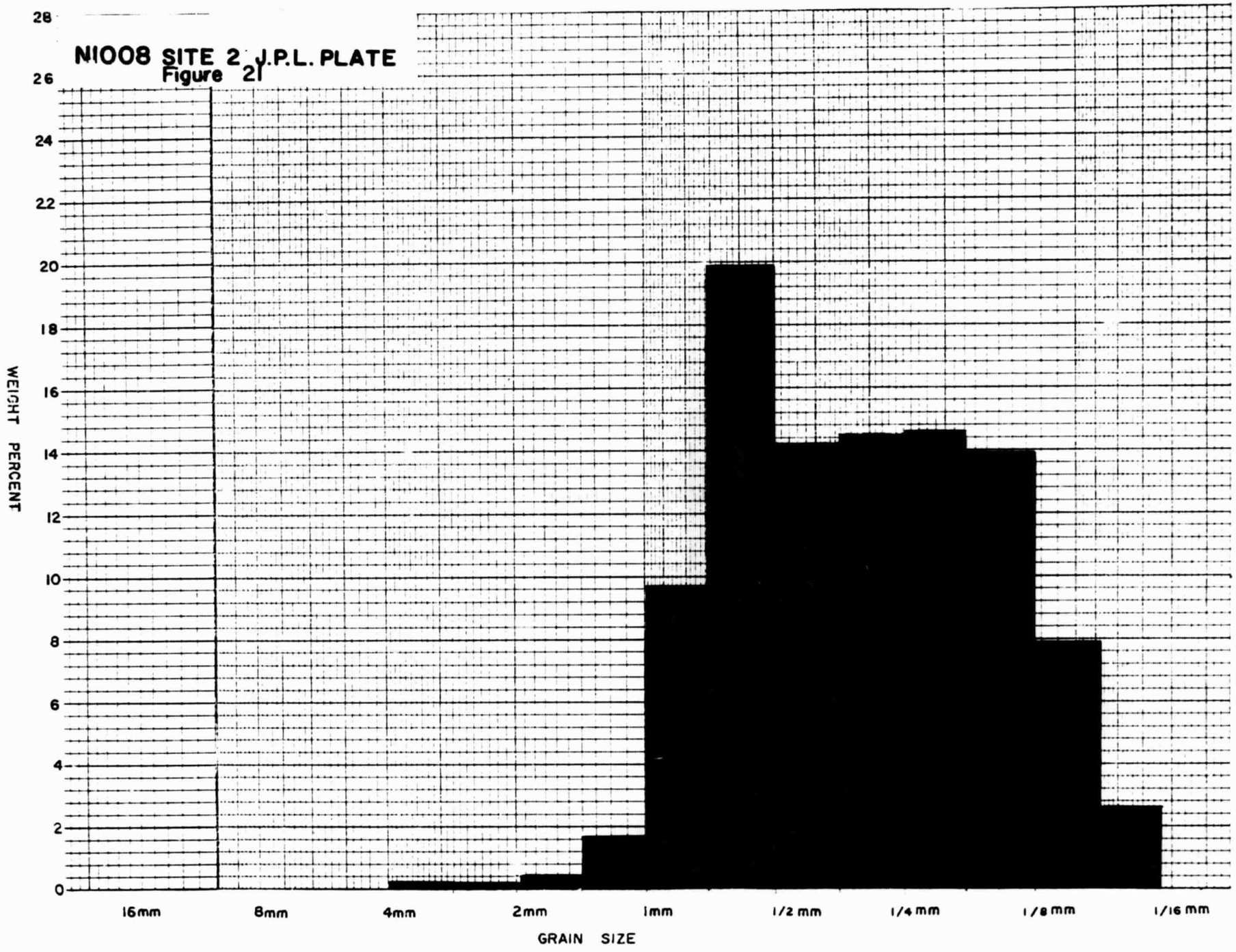

N1008 SITE 2 J.P.L. PLATE
Figure 21
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

TABLE 2

DENSITY AND POROSITY

Mono Lake - Pumice Sand Flat

d in lb/ft^3	d in g/cm^3	% porosity
74.0	1.19	57.5%
71.5	1.15	58.9%
71.3	1.14	59.3%

Table 3

Reduced Radiometer Data

Mono Pumice Flat

July 9, 1968

TB(COR)= -.574
T(CAL)=29.48

SITE	TIME	T_3(R)	T_1	α	$\bar{X}$	ΔTB	COMMENTS
#1	12:50	281.77	314.00	92.36	.288	.332	
#1	12:53	281.12	314.00	93.10	.292	.070	
#1	12:56	281.49	314.00	92.01	.292	.046	
#2	13:00	285.56	314.00	91.84	.293	.138	
#2	13:02	285.47	314.00	92.54	.292	.042	
#2	13:04	286.77	314.00	91.06	.287	.059	
#2	13:05	286.52	314.00	91.64	.287	.192	
#2	13:07	286.14	314.00	91.35	.285	.000	
#2	13:10	285.73	314.00	92.05	.285	.014	
#3	13:13	289.65	313.80	91.11	.282	.014	
#3	13:15	289.80	313.80	92.30	.285	.000	
#3	13:17	289.40	313.80	90.78	.282	.050	
#3	13:19	289.72	313.80	91.78	.285	.000	
#3	13:21	288.77	313.80	92.10	.285	.018	
#4	13:35	283.36	312.00	90.89	.279	.177	
#4	13:37	283.75	312.00	91.47	.278	.119	
#4	13:39	283.56	312.00	92.41	.279	.037	
#4	13:40	284.00	312.00	91.74	.276	.023	
#4	13:42	283.46	312.00	92.34	.279	.060	
#5	13:46	285.78	312.00	92.01	.278	.046	
#5	13:48	285.86	312.00	91.72	.278	.101	
			July 10, 1968				
			Plate Measurements				Polar=Vertical
	10:05	80.66	316.90	87.71	.251	.061	0"
	10:11	87.98	317.30	89.55	.265	.143	1/8-1/4"
	10:16	118.06	317.60	89.73	.259	.175	1/2"

Table 3 (Cont'd.)

SITE	TIME	T_3(R)	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	10:22	156.24	317.80	89.89	.255	.031	1"
	10:28	210.92	317.80	89.60	.254	.018	2"
	10:35	272.36	318.00	89.75	.246	.211	4"
	10:42	285.28	318.10	91.00	.244	.205	8"
	10:48	281.84	317.90	91.14	.250	.205	12" (Damper Sand)
	10:54	286.35	317.90	91.47	.251	.091	No Plate - Undisturbed Sand
				Mono Lake Sand July 10, 1968			
	1:00	288.75	317.10	90.06	.263	.041	2°V
	1:03	287.12	316.69	91.55	.265	.018	10°V
	1:05	284.20	316.50	91.43	.266	.059	20°V
	1:07	287.98	316.30	91.07	.268	.100	30°V
	1:09	293.25	316.30	91.45	.270	.069	40°V
	1:11	294.46	316.60	91.68	.269	.096	50°V
	1:13	295.91	316.90	91.44	.269	.101	60°V
	1:15	286.21	317.30	91.84	.272	.119	70°V
	1:18	252.85	317.50	93.83	.274	.047	80°V
	1:20	-2.43	317.80	94.25	.274	.085	160°V
	1:27	6.01	317.30	93.87	.278	.023	160°H
	1:29	182.23	316.90	93.84	.276	.277	80°H
	1:32	200.70	317.00	93.00	.273	.056	70°H
	1:34	241.32	317.20	92.53	.271	.120	60°H
	1:36	255.17	317.30	92.02	.269	.060	50°H
	1:38	278.30	317.80	90.68	.266	.021	40°H
	1:40	282.72	318.30	90.39	.262	.015	30°H
	1:43	285.07	318.80	90.17	.256	.356	20°H
	1:45	289.28	318.90	91.64	.255	.202	10°H
	1:46	290.29	319.00	91.82	.256	.087	0°H

Table 3 (Cont'd.)

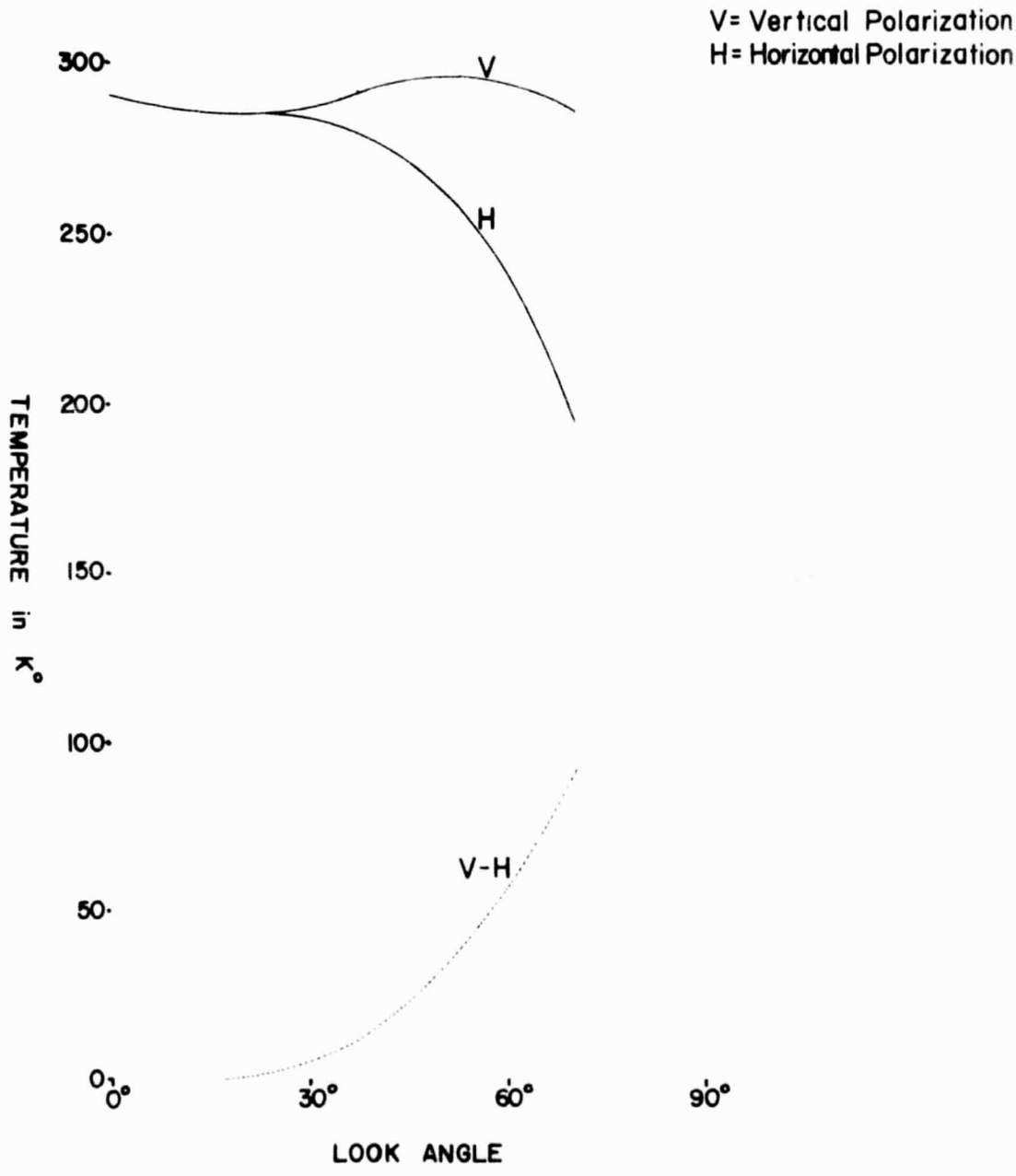
Mono Road
July 10, 1968

SITE	TIME	$T_3(R)$	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	2:25	286.38	317.70	93.14	.243	.020	0°V
	2:27	284.79	317.70	94.02	.246	.042	10°V
	2:28	286.23	317.70	92.50	.245	.102	20°V
	2:29	288.96	317.80	92.94	.247	.242	30°V
	2:30	292.63	317.90	93.81	.250	.070	40°V
	2:31	294.73	318.00	94.32	.251	.061	50°V
	2:33	295.04	318.20	93.54	.253	.261	60°V
	2:35	282.28	318.40	93.35	.253	.261	70°V
	2:38	-3.41	318.60	96.06	.260	.000	160°V
	2:45	+8.94	318.40	93.31	.254	.233	160°H
	2:48	206.08	318.20	95.45	.255	.081	70°H
	2:49	237.11	318.20	95.19	.257	.086	60°H
	2:50	257.10	318.20	94.73	2.584	.085	50°H
	2:52	270.23	318.50	92.89	2.582	.098	40°H
	2:54	280.19	318.80	92.41	2.560	.139	30°H
	2:56	284.68	319.00	92.30	2.548	.028	20°H
	2:57	287.92	319.20	92.62	2.562	.101	10°H
	2:59	291.42	319.40	93.53	2.578	.047	0°H

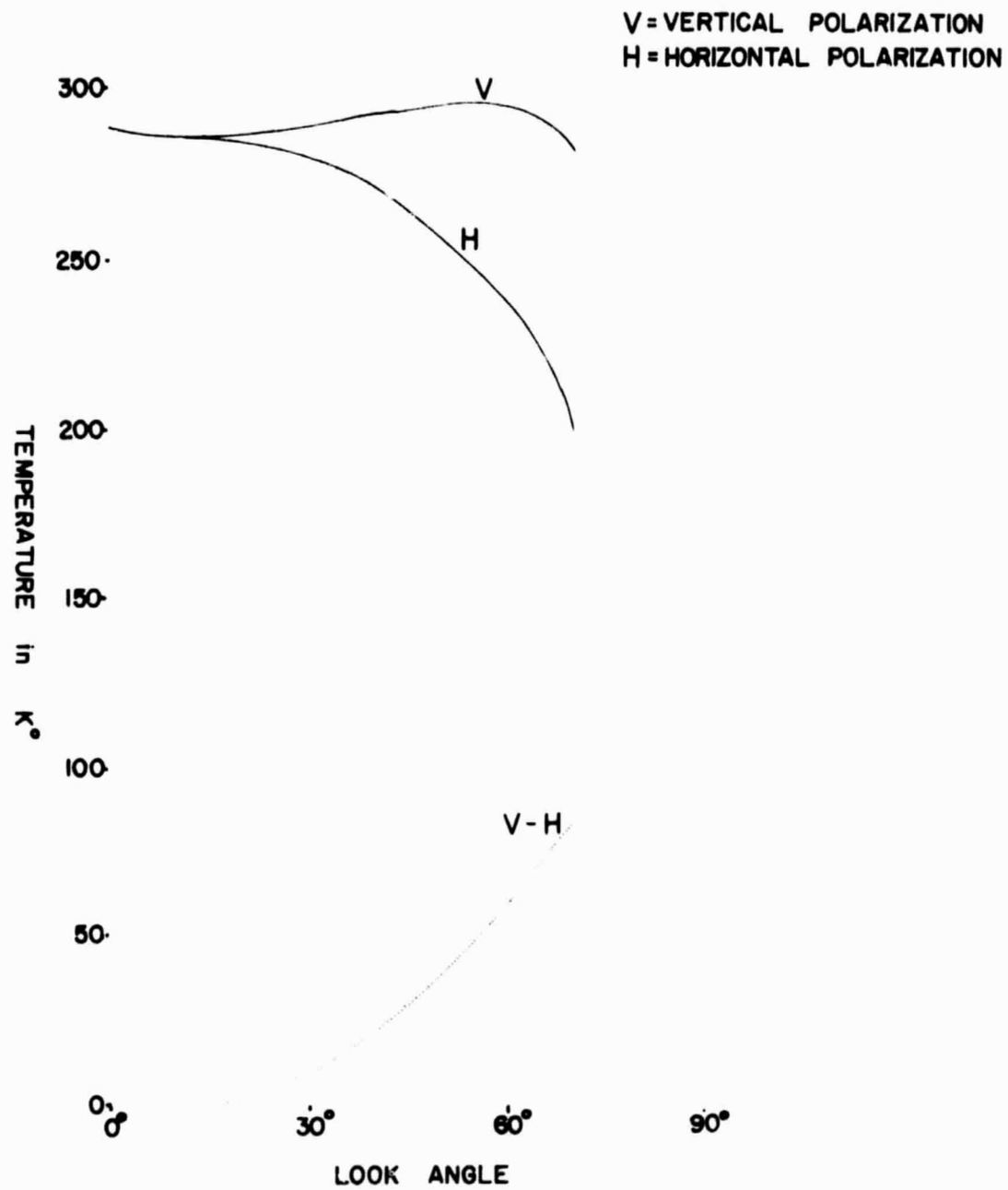
Mono Lake Shores
July 10, 1968

3:40	263.21	317.30	93.78	.250	.211	3" wet sand & plate 15°V
3:45	263.37	317.50	94.70	.247	.038	2" wet sand - sand top=25°C
3:49	264.41	317.80	95.28	.249	.143	1" wet sand - sand top=25.3°C
3:53	261.49	317.80	94.13	.249	.085	1/2" wet sand - sand top=26.5°C
3:57	243.88	317.90	93.57	.247	.332	1/4" wet sand - sand top=26.25°C
4:00	89.88	318.00	94.36	.243	.217	0" Bare Plates
4:05	127.26	318.10	94.04	.245	.028	1/2" dry sand 31.8°C sand top
4:09	166.46	318.20	94.65	.247	.184	1" dry sand
4:13	205.95	318.30	95.12	.252	.171	2" dry sand - sand temp 32.0°C
4:16	263.01	318.30	94.51	.254	.019	4" dry sand - sand temp 32.8°C
4:20	284.06	318.30	94.14	.252	.005	8" dry sand - sand temp 32.4°C
4:27	286.82	318.30	94.27	.257	.161	12" dry sand

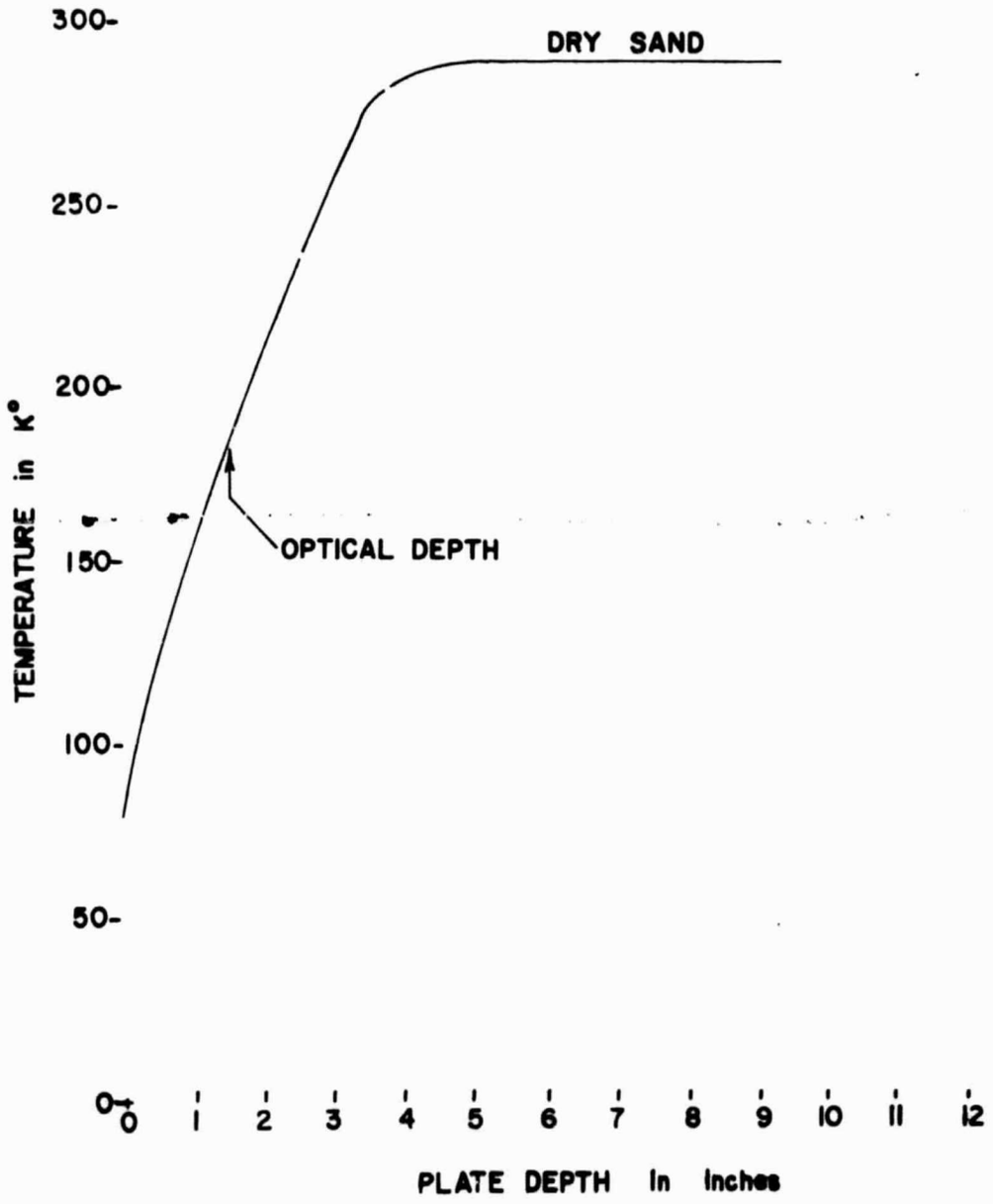
9.2 GHz MICROWAVE TEMPERATURES
SAND - MONO LAKE
0100 JULY 10, 1968
Figure 22



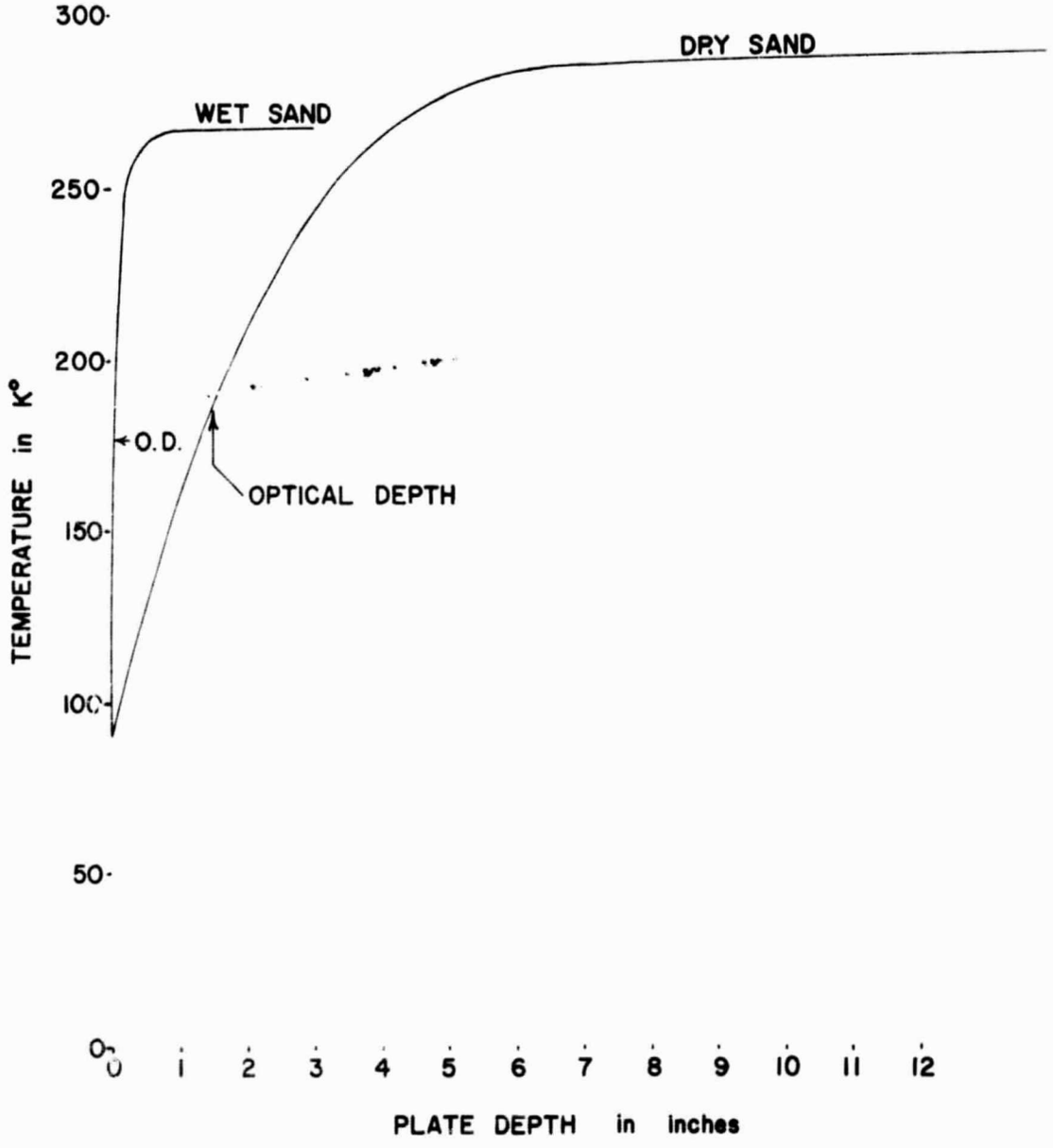
9.2 GHz MICROWAVE TEMPERATURES
PUMICE FLAT - MONO LAKE
0230 JULY 10, 1968
Figure 23



9.2 GHz MICROWAVE TEMPERATURES
PUMICE FLAT-MONO LAKE
1005 JULY 10, 1968
Figure 24



9.2 GHz MICROWAVE TEMPERATURES
MONO LAKE SAND
0400 JULY 10,1968
Figure 25



RENO GRAVEL PIT SITE

July 11 & 12, 1968

Table 4

SOIL MOISTURE

Reno Site

July 11, 1968

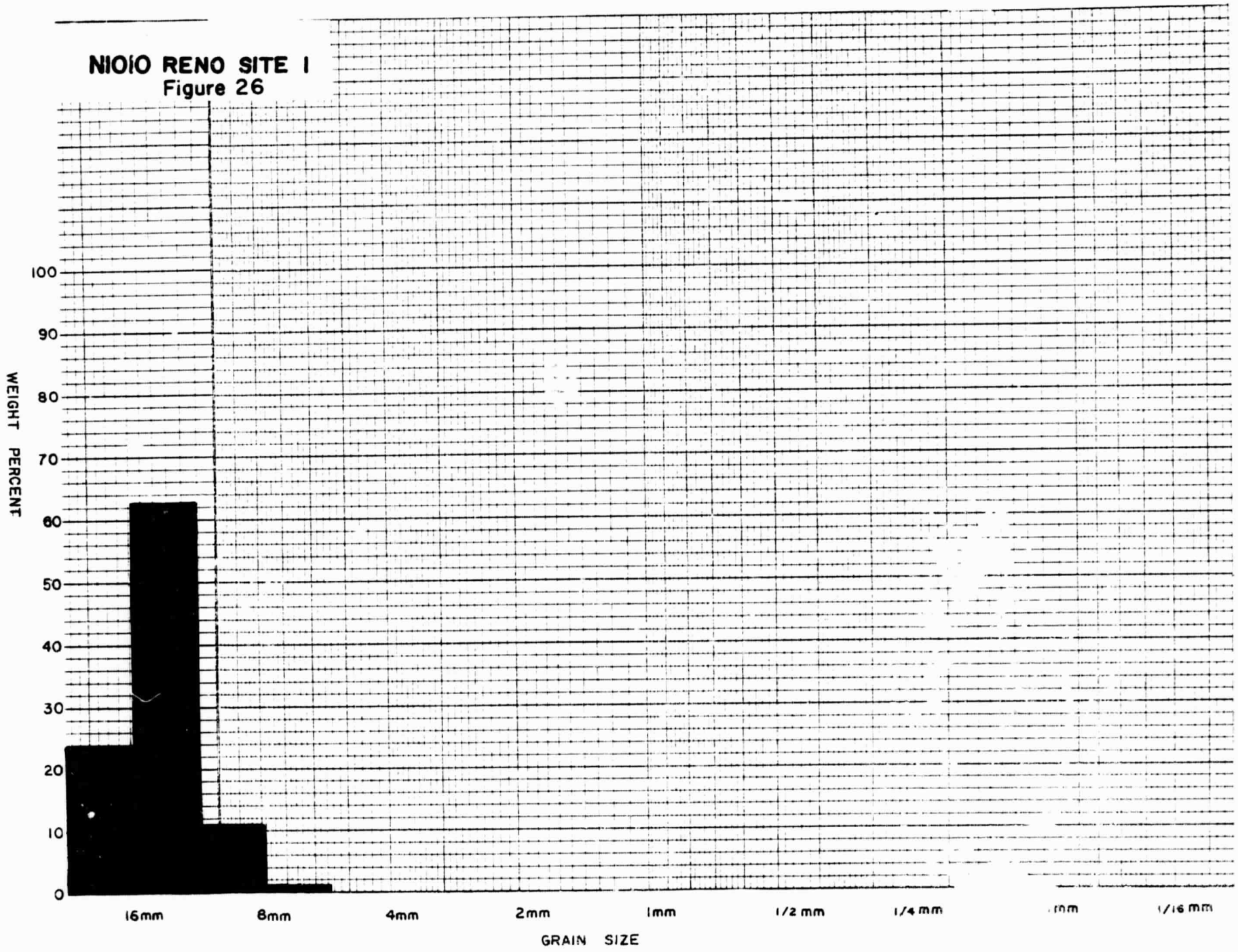
Sample No.		Wt. Percent Moisture	
N1012	(Site #1 Reno)	0.08	
N1013	(Site #1 Reno)	0.13	Average 0.11%
N1016	(Site #2 Reno - Surface)	0.32	
N1017	(Site #2 Reno - 1")	1.79	
N1018	(Site #2 Reno - 2")	5.04	
N1019	(Site #2 Reno - 6")	4.98	
N1020	(Site #2 Reno - 12")	5.55	

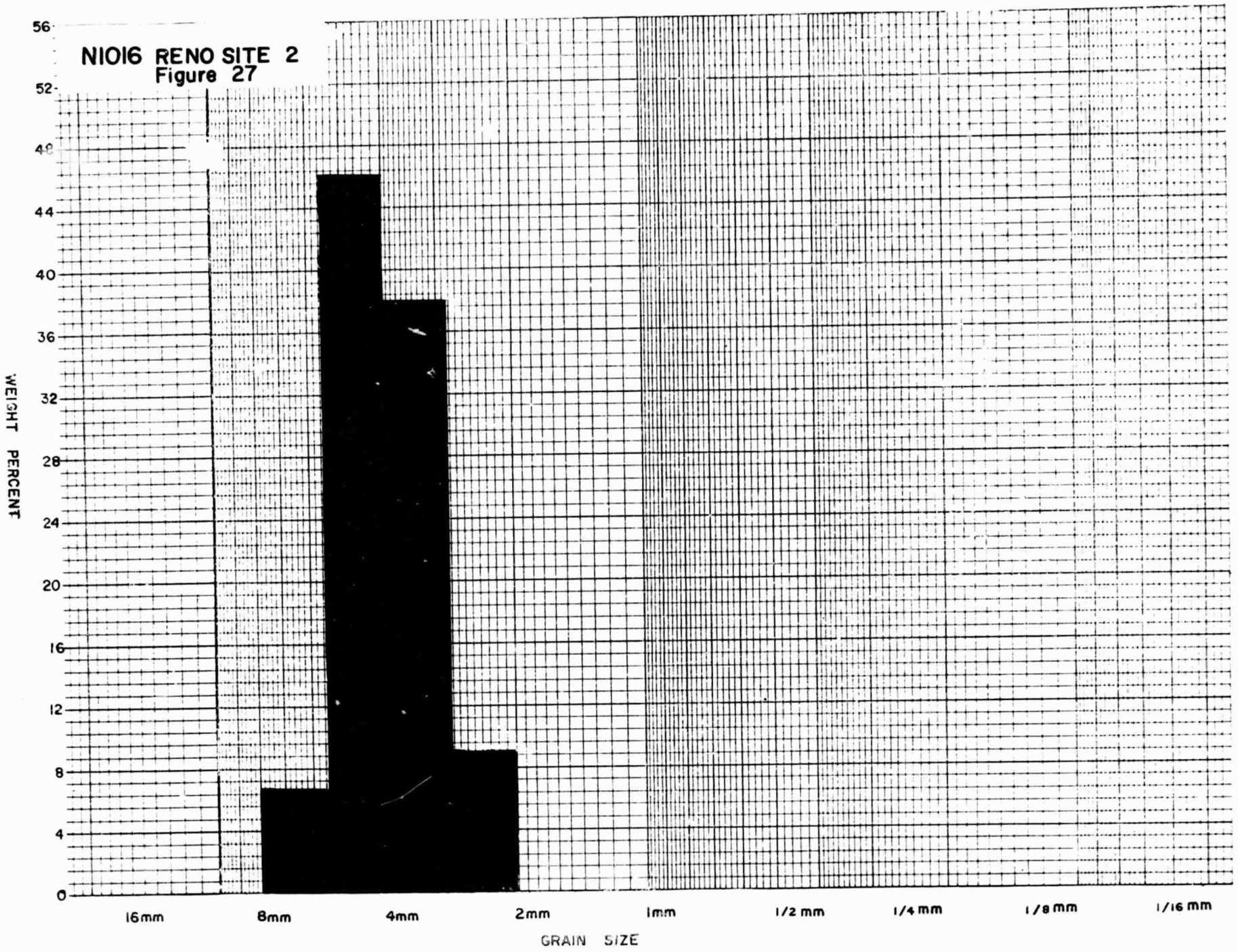
July 12, 1968

N1021	(Site #2 Reno SG Plate)	0.74	
N1022	(Site #2 Reno SG Plate)	0.84	Average 0.84%
N1023	(Site #2 Reno SG Plate)	1.02	
N1024	(Site #2 Reno JPL Plate)	1.09	
N1025	(Site #2 Reno JPL Plate)	0.87	Average 0.92%
N1026	(Site #2 Reno JPL Plate)	0.81	
N1031	(Site #4 Reno Surface)	0.64	
N1032	(Site #4 Reno 3")	1.08	
N1033	(Site #4 Reno 6")	1.81	
N1034	(Site #4 Reno 12")	2.09	
N1035	(Site #4 Reno Plate)	0.57	
N1036	(Site #4 Reno Plate)	0.71	Average 0.67%
N1037	(Site #4 Reno Plate)	0. 2	
N1038	(Site #2 JPL Wet Plate)	6.16	
N1039	(Site #2 JPL Wet Plate)	6.62	Average 6.53%
N1040	(Site #2 JPL Wet Plate)	6.81	

Reno Gravel Site
JPL - Glass Bottles
July 12, 1968

Lab. No.	Field No.	Wt. Percent Moisture
I	(Reno Pit Site 2 Plate Dry)	0.42%
II	(Reno Pit Site 2 .5" Wet)	5.03%
III	(Reno Pit Site 2 1.0" Wet)	5.15%
IV	(Reno Pit Site 1.5" Wet)	5.56%
V	(Reno Pit Site 2.0" Wet)	5.68%


NIOIO RENO SITE I
Figure 26
WEIGHT PERCENT
100
90
80
70
60
50
40
30
20
10
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/16 mm
GRAIN SIZE


N1016 RENO SITE 2
Figure 27
56
52
48
44
40
36
32
28
24
20
16
12
8
4
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

NIOZO RENO SITE 4
Figure 28

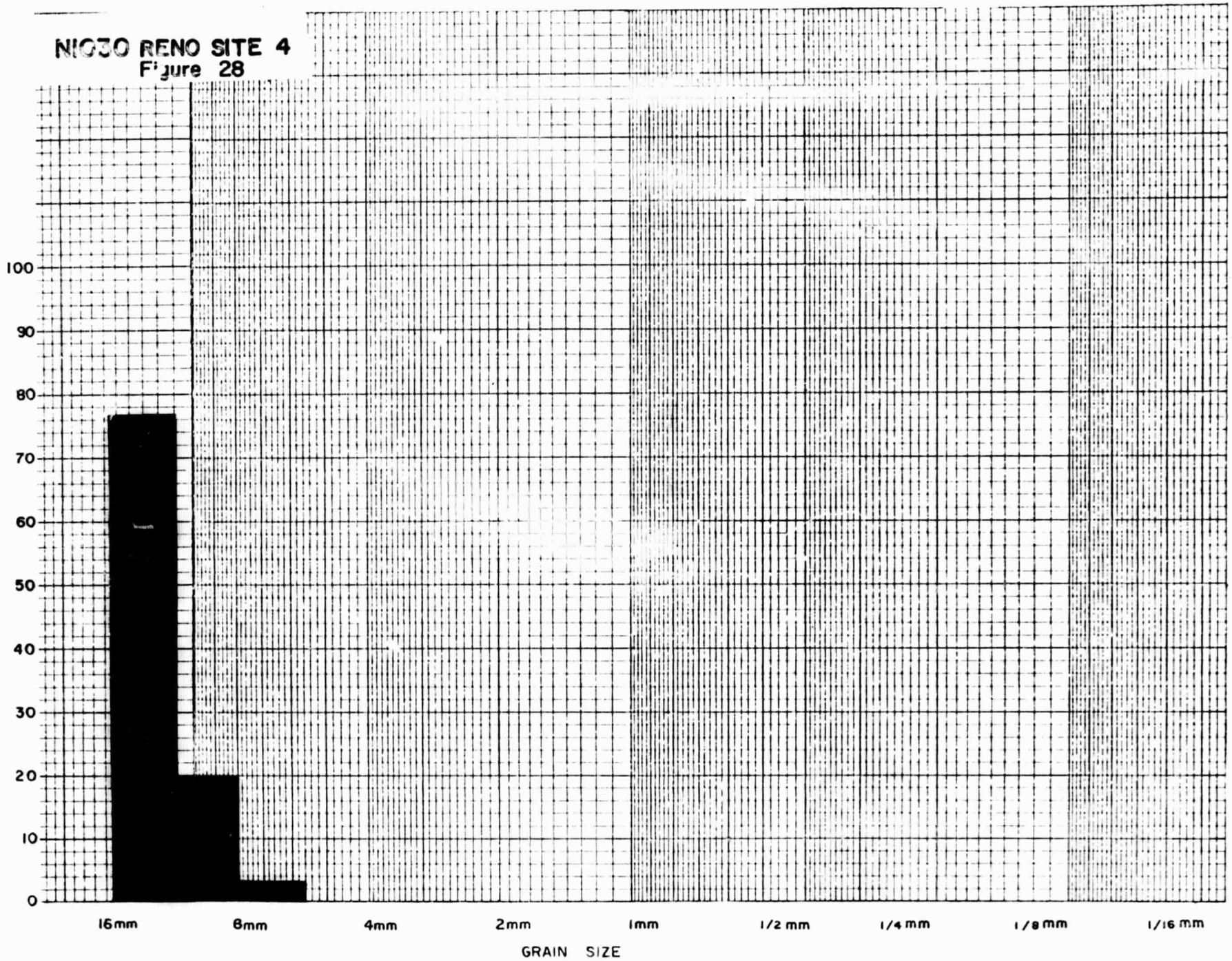


Table 5

RADIOMETRIC TEMPERATURES

Reno Gravel Pit Site

July 12, 1968

Radiometric temperatures during plate experiment, surface temperatures as material is being added to the top of the plate at the Aerojet General sites.

Site #2 1000	
1/2" cover	35.5°C
1" cover	34.4°C
2" cover	33.3°C
4" cover	38.8°C
8" cover	31.9°C
Site #4 1230	
surface	43.3°C
1" cover	42.5°C
2" cover	36.0°C
4" cover	34.9°C
12" cover	33.3°C
Site #2 1300	
1/4" dry cover	40.5°C
1/2" dry cover	39.9°C
1/4" wet cover	29.4°C
Site #1 1340	
2" cover	33.8°C
4" cover	33.2°C
Site #1 1430	
2" cover	36.5°C
12" cover	36.5°C

Table 6

DENSITY AND POROSITY

Reno Gravel Pit Site

Site	d in lb/ft^3	d in g/cm^3	% porosity
#1	91.0	1.46	47.9%
	55.0	.88	68.5%
#2	93.5	1.49	46.8%
	94.0	1.51	46.1%
#3	59.9	.96	65.7%
	62.0	.99	64.5%
#4	85.5	1.37	51.1%
	90.0	1.44	48.6%
	83.0	1.33	52.5%

Table 7

Reduced Radiometer Data

ABC Gravel
July 11, 1968

T(CAL)=29.48
TB(COR)=-.574

3/4" Pumice, Reno Site #1

SITE	TIME	$T_3(R)$	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	11:10	15.12	315.60	89.50	.225	.290	Bare Plate
	11:17	15.69	315.70	89.18	.232	.102	Bare Plate
	11:22	167.61	315.80	89.05	.233	.067	1" 20°V
	11:31	255.88	316.63	89.13	.229	.050	2"
	11:42	274.29	316.59	89.14	.227	.116	5"
	11:52	276.08	316.90	89.96	.225	.045	10"
	12:00	280.45	317.10	90.08	.218	.085	10" over again

Site #2 1/4" Aggregate

	13:01	293.65	316.10	91.68	225	.293	20°V
	13:03	293.97	316.00	91.14	.227	.041	20°V
	13:05	294.22	315.90	90.86	.229	.159	20°V
	13:07	293.93	315.90	91.73	.233	.096	20°V
	13:15	291.76	315.80	91.25	.234	.032	20°H
	13:17	292.06	315.80	91.12	.234	.091	20°H
	13:19	291.52	315.70	91.42	.235	.005	20°H
	13:37	274.13	315.10	91.73	.242	.096	45°H
	13:39	274.52	315.20	91.41	.241	.109	45°H
	13:43	274.21	315.30	91.90	.238	.133	45°H
	13:49	294.28	316.20	90.65	.235	.226	45°V
	13:52	293.81	316.30	91.07	.233	.073	45°V
	13:55	293.64	316.40	91.35	.232	.009	45°V
	14:00	293.73	316.90	91.60	.239	.174	45°V
	14:10	291.90	317.10	91.86	.237	.046	60°V
	14:13	292.11	317.10	92.21	.234	.083	60°V
	14:15	292.52	317.10	92.06	.236	.027	60°H - Cone1 behind aggregate
	14:21	256.08	317.30	92.47	.234	.009	60°H
	14:23	256.83	317.30	91.60	.234	.109	60°H
	14:27	256.74	317.30	92.12	.229	.175	60°H

Table 7 (Cont'd.)

1" Aggregate Site #3

SITE	TIME	$T_3(R)$	T_1	α	$\overline{X}$	ΔTB	COMMENTS
	15:09	5.51	314.20	93.82	.221	.037	160°H
	15:11	6.73	315.20	93.26	.222	.075	160°H
	15:16	287.15	315.90	90.90	.223	.163	20°H
	15:18	287.57	316.20	90.53	.221	.014	20°H
	15:22	281.39	316.60	91.78	.225	.000	35°H
	15:24	281.18	316.70	91.67	.223	.137	35°H
	15:27	277.10	316.80	91.80	.218	.096	45°H
	15:28	277.23	316.80	91.71	.217	.014	45°H
	15:32	260.60	316.90	91.70	.216	.018	60°H
	15:45	281.96	317.20	92.02	.211	.161	60°V
	15:46	281.31	317.30	93.20	.214	.009	60°V
	15:49	284.86	317.50	93.00	.212	.046	45°V
	15:51	285.13	317.60	92.47	.212	.074	45°V
	15:54	286.02	317.70	92.52	.213	.079	35°V
	15:55	285.98	317.70	92.01	.212	.037	35°V
	15:57	286.91	317.70	91.62	.211	.050	20°V
	15:59	286.78	317.60	91.55	.211	.055	20°V
	16:02	1.63	317.60	94.21	.213	.085	160°V
	16:04	2.89	317.50	93.86	.212	.038	160°V

July 12, 1968 Site #1

	9:50	269.28	315.70	88.90	.251	.062	20°V
	9:57	268.60	315.70	88.77	.252	.027	20°H
	9:58	268.59	315.80	88.85	.251	.213	20°H
	10:05	265.78	316.00	89.05	.251	.022	45°H (42°)
	10:07	265.98	316.10	89.33	.251	.009	45°H
	10:11	269.47	316.30	89.41	.252	.063	45°V
	10:13	269.57	316.40	89.89	.253	.004	45°V
	10:20	269.77	316.60	90.85	.253	.036	60°V RFI
	10:21	262.08	316.70	90.69	.249	.177	60°V RFI (best)?
	10:25	261.92	316.90	91.23	.246	.014	60°V
	10:30	252.36	317.00	91.24	.246	.283	60°H RFI
	10:33	254.10	317.10	90.71	.243	.009	60°H RFI
	10:34	250.08	317.10	90.02	.244	.155	60°H RFI (good)?

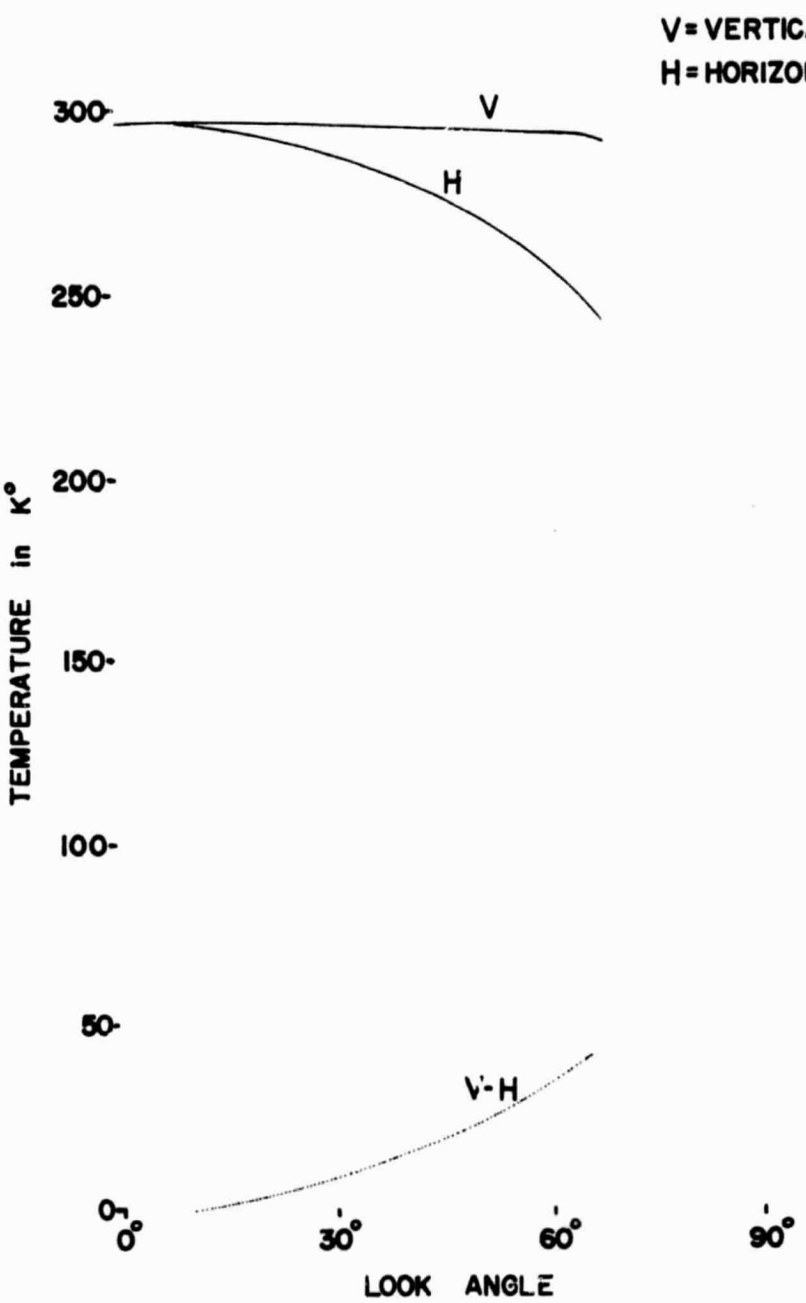
Table 7 (Cont'd.)
Site #4 1/4" Granite Gravel
July 12, 1968

SITE	TIME	$T_3(R)$	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	11:13	286.00	316.60	90.21	.239	.027	0°H
	11:14	286.59	316.80	89.25	.238	.062	0°H
	11:20	287.13	317.00	90.08	.236	.068	10°H
	11:23	287.30	317.20	90.02	.233	.045	20°H RFI
	11:26	284.14	317.40	90.44	.234	.122	30°H RFI
	11:28	281.46	317.50	91.06	.235	.005	40°H
	11:31	277.23	317.50	90.28	.231	.149	45°H
	11:33	273.28	317.50	91.72	.233	.183	50°H
	11:37	259.42	317.60	91.38	.235	.192	60°H Boom Lowered
	11:39	233.32	317.70	91.31	.237	.059	70°H
	11:43	-.11	317.80	93.01	.240	.041	160°H
	11:48	-3.06	317.90	93.11	.240	.093	160°V
	11:50	259.33	317.90	91.99	.240	.018	70°V
	11:52	276.25	317.90	91.44	.240	.027	60°V
	11:55	283.98	317.90	89.92	.239	.148	50°V Boom Raised
	11:57	284.40	317.90	91.14	.239	.077	45°V
	11:59	285.31	317.90	91.31	.237	.041	40°V
	12:00	285.85	317.80	91.16	.235	.036	30°V
	12:03	288.07	317.80	92.27	.237	.028	20°V RFI?
	12:05	287.11	317.80	90.79	.237	.163	10°V
	12:07	286.67	317.70	91.82	.237	.014	20°V Re-do
	12:09	286.70	317.70	90.82	.238	.000	0°V
				Large Boulders July 12, 1968			
	12:34	284.29	315.80	91.24	.240	.055	0°V
	12:38	284.84	316.00	91.87	.240	.147	10°V
	12:40	285.92	316.20	90.67	.240	.159	20°V
	12:42	286.02	316.40	91.65	.239	.005	30°V
	12:45	284.54	316.62	91.55	.237	.009	40°V
	12:48	284.10	316.80	93.14	.237	.009	45°V Boom Lowered
	12:49	284.35	316.90	92.74	.237	.042	50°V
	12:53	279.49	317.00	92.73	.236	.139	60°V Boom Lowered
	12:54	268.80	31[illegible].10	92.95	.237	.051	70°V
	12:56	2.34	317.00	93.45	.236	.266	140°V Sun at 10° (150°=31500)

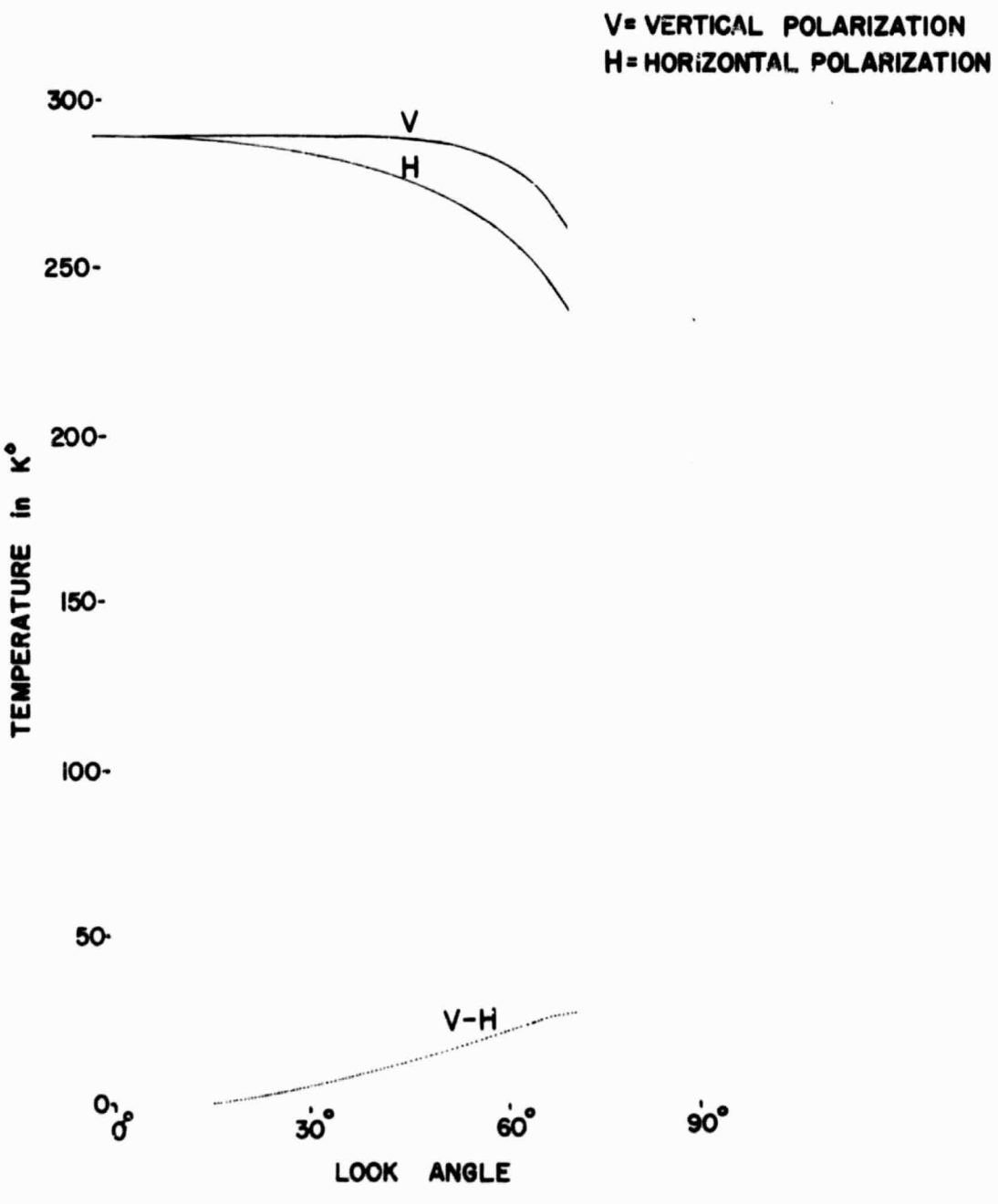
Table 7 (Cont'd.)

SITE	TIME	$T_3(R)$	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	13:03	7.41	317.00	92.48	.229	.051	140°H
	13:04	252.12	317.90	94.06	.228	.085	70°H
	13:05	267.68	317.90	92.77	.231	.116	60°H
	13:11	275.32	318.00	93.29	.236	.242	50°H Boom Raised
	13:12	278.87	318.00	93.35	.236	.065	45°H
	13:14	280.21	318.00	92.13	.240	.013	40°H Boom Raised
	13:16	285.13	318.00	91.75	.241	.018	30°H
	13:19	285.07	318.00	92.25	.240	.225	20°H
	13:20	286.13	318.00	91.92	.237	.009	10°H
	13:22	286.12	318.00	91.78	.233	.082	0°H
			Pea Gravel Site #2 July 12, 1968				
	13:50	39.80	314.90	92.86	.223	.060	20°V Plate
	13:54	155.27	315.80	92.89	.220	.023	1/2" Dry
	13:58	199.53	316.20	92.81	.214	.014	1"
	14:10	230.64	316.59	92.89	220	.023	2"
	14:15	277.28	316.63	92.71	.217	.199	4"
	14:23	292.30	316.80	93.35	.231	.074	6"
	14:30	295.41	316.80	92.96	.221	.241	8"
			Pea Gravel Site #2 July 12, 1968				
	14:37	33.32	316.90	92.82	.215	.157	20°V Plate
	14:41	272.41	317.00	93.29	.213	.046	1/2" Wet
	14:45	282.42	317.00	93.66	.216	.060	1"
	14:48	277.74	317.00	92.95	.213	.051	1-1/2"
	14:50	277.45	317.00	92.82	.213	.116	2"

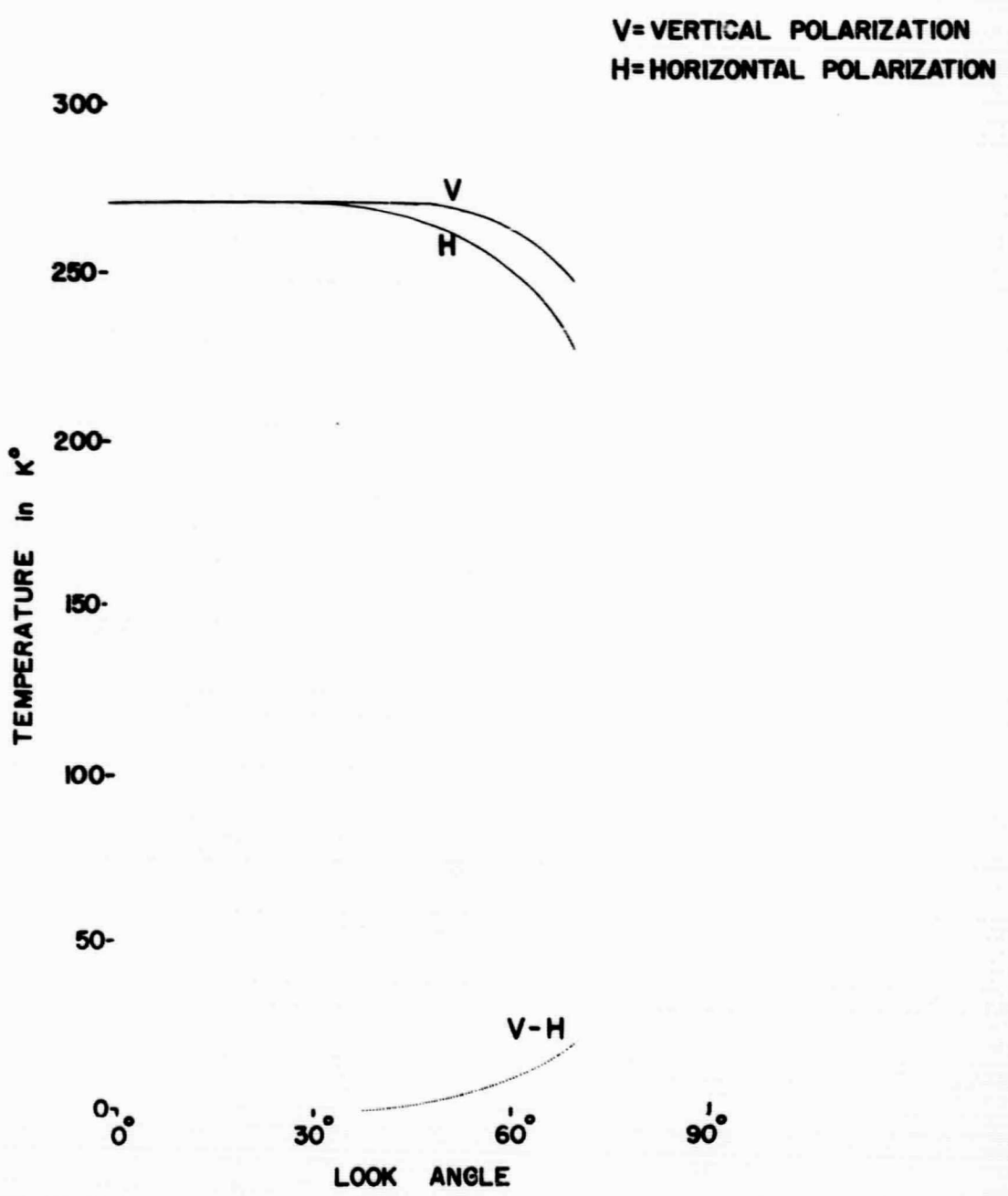
9.2 GHz MICROWAVE TEMPERATURES
1/4" AGGREGATE - RENO
1330 JULY 11, 1968
Figure 29



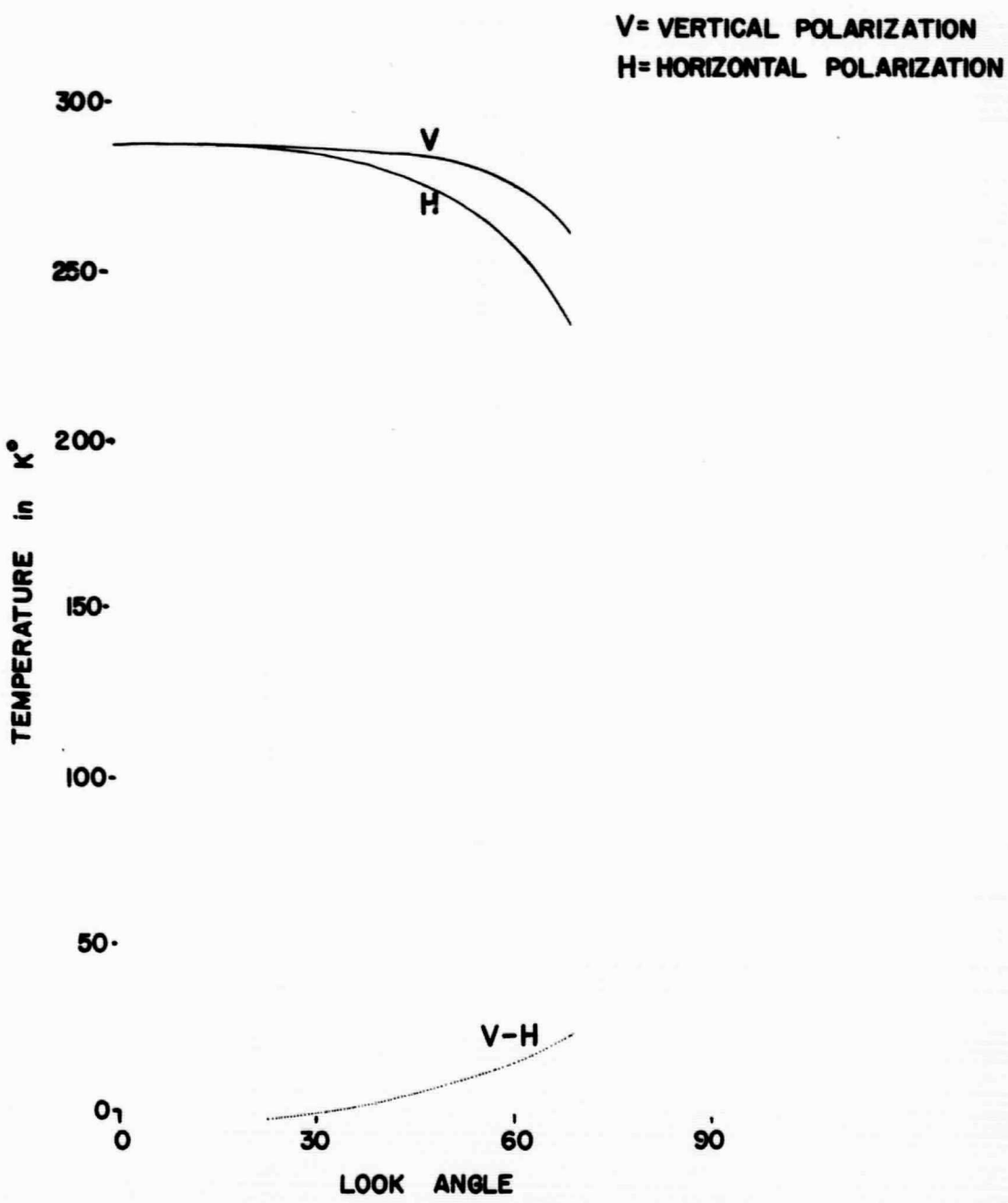
9.2 GHz MICROWAVE TEMPERATURES
1" AGGREGATE-RENO
1530 JULY 11, 1968
Figure 30



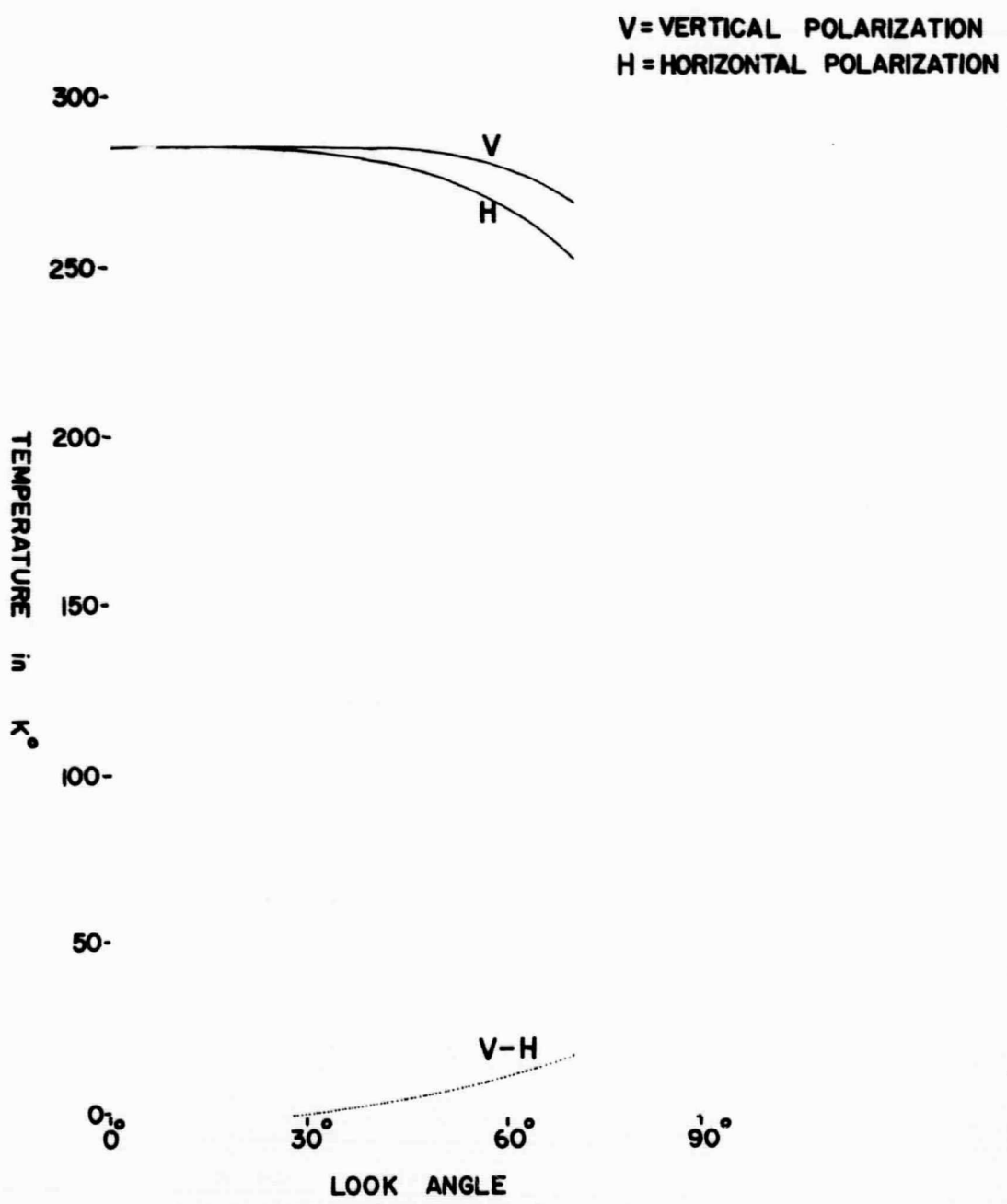
9.2 GHz MICROWAVE TEMPERATURES
1" AGGREGATE-RENO
1000 JULY 12, 1968
Figure 31



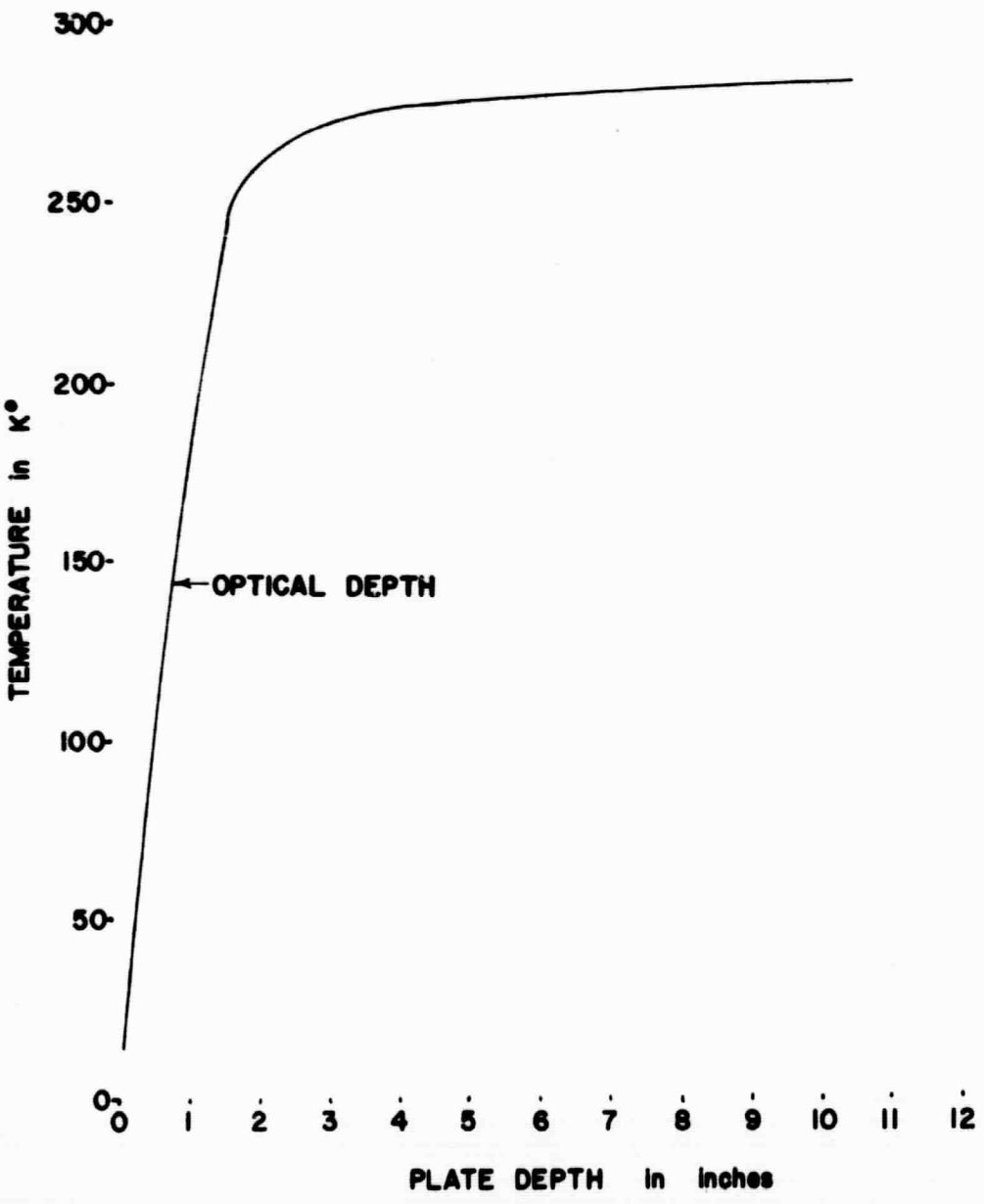
9.2 GHz MICROWAVE TEMPERATURES
1/4" GRANITE GRAVEL-RENO
1130 JULY 12, 1968
Figure 32



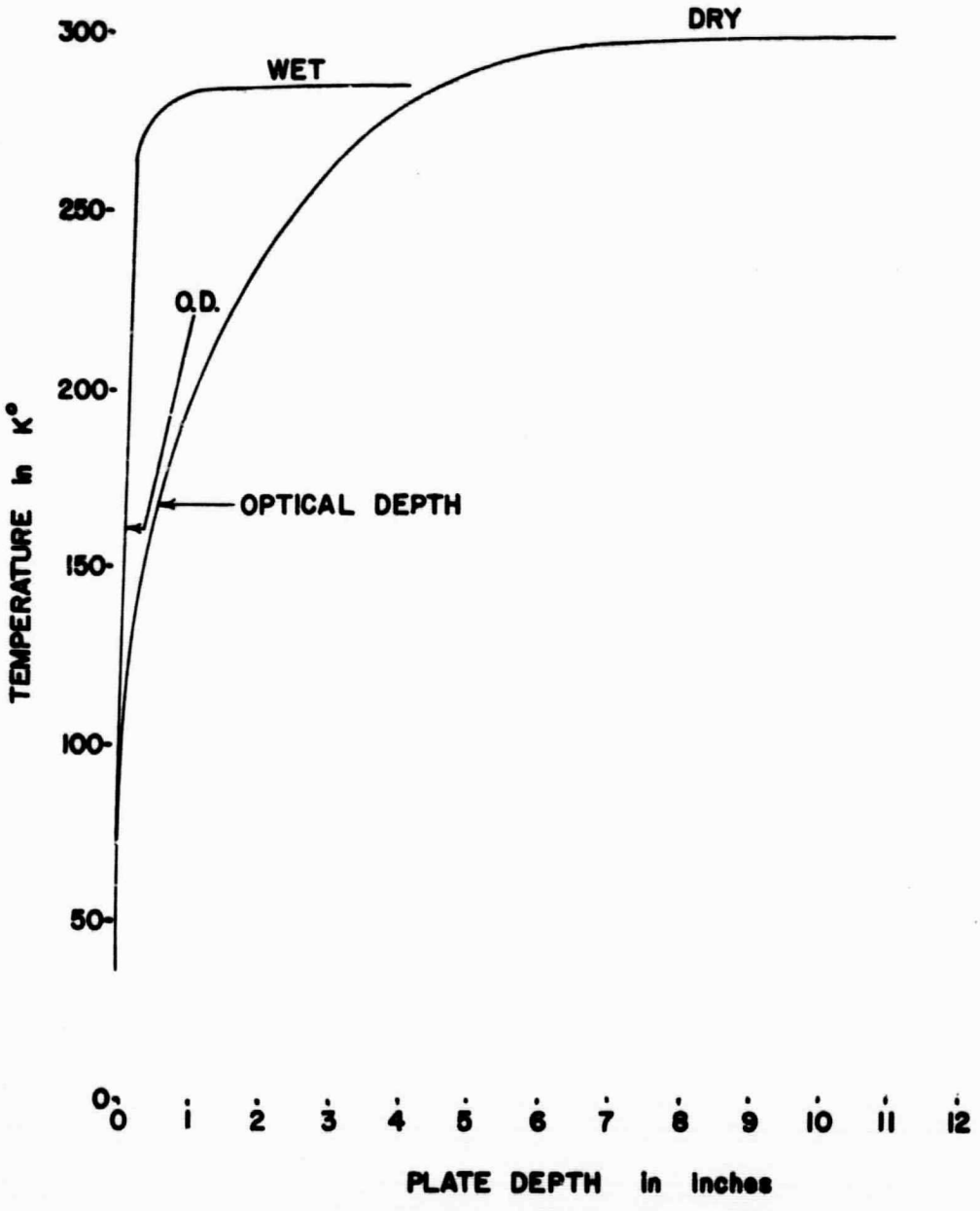
9.2 GHz MICROWAVE TEMPERATURES
LARGE BOULDERS-RENO
1230 JULY 12, 1968
Figure 33



9.2 GHz MICROWAVE TEMPERATURES
3/4" PUMICE - RENO
1130 JULY 11, 1968
Figure 34



9.2 GHz MICROWAVE TEMPERATURES
PEA GRAVEL - RENO
1430 JULY 12, 1968
Figure 35



MT. LASSEN CINDER PIT SITE

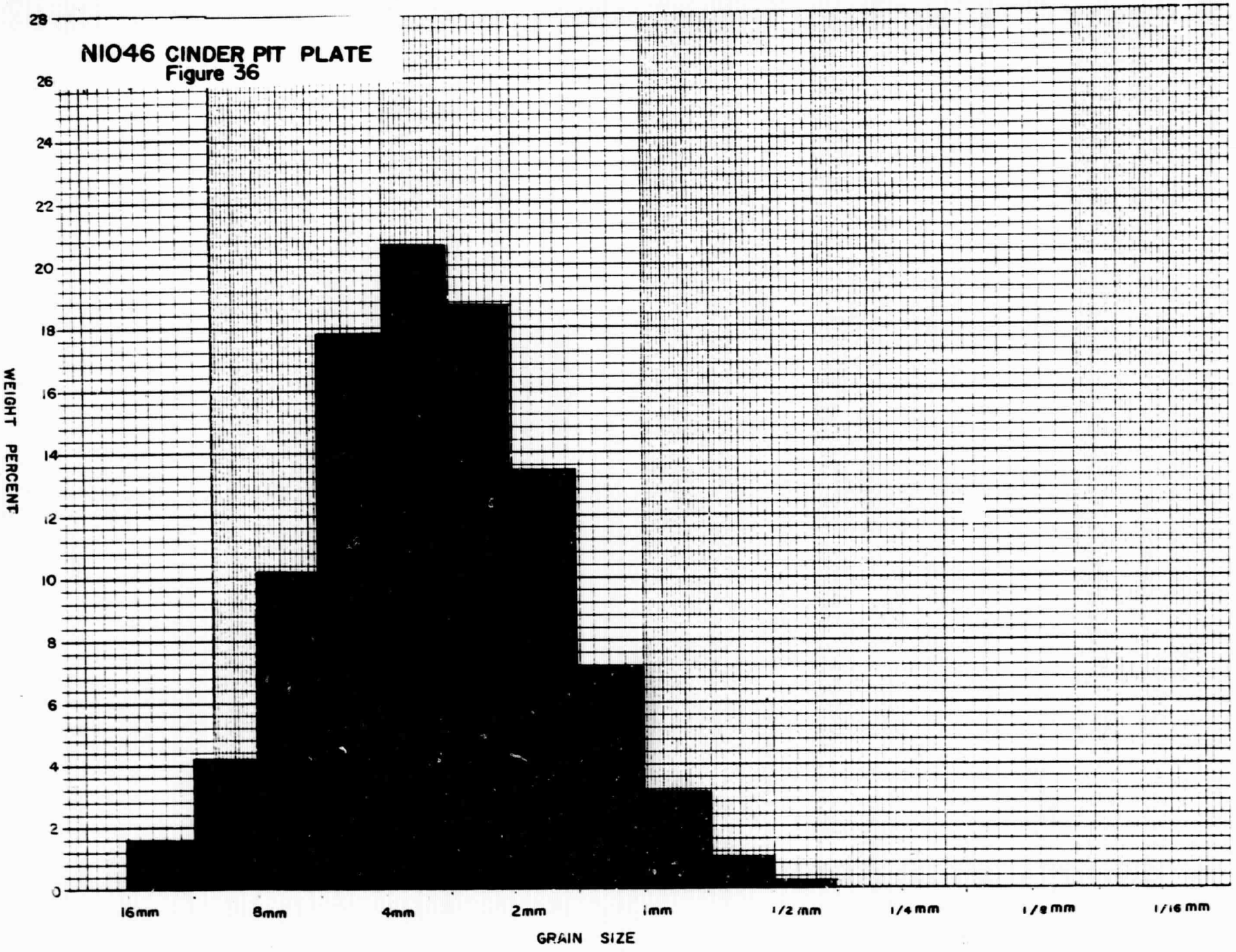
July 15 & 16, 1968

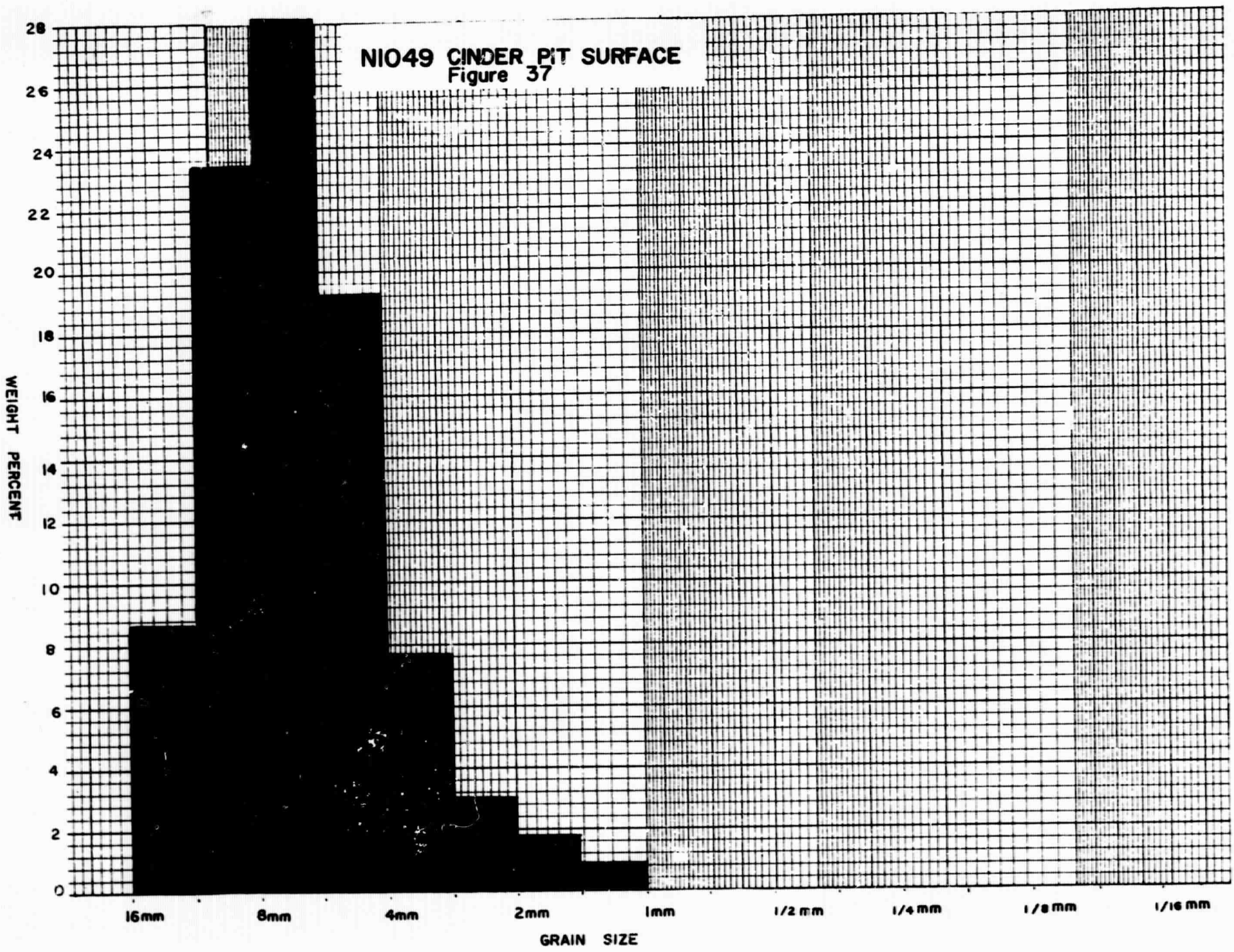
Table 8

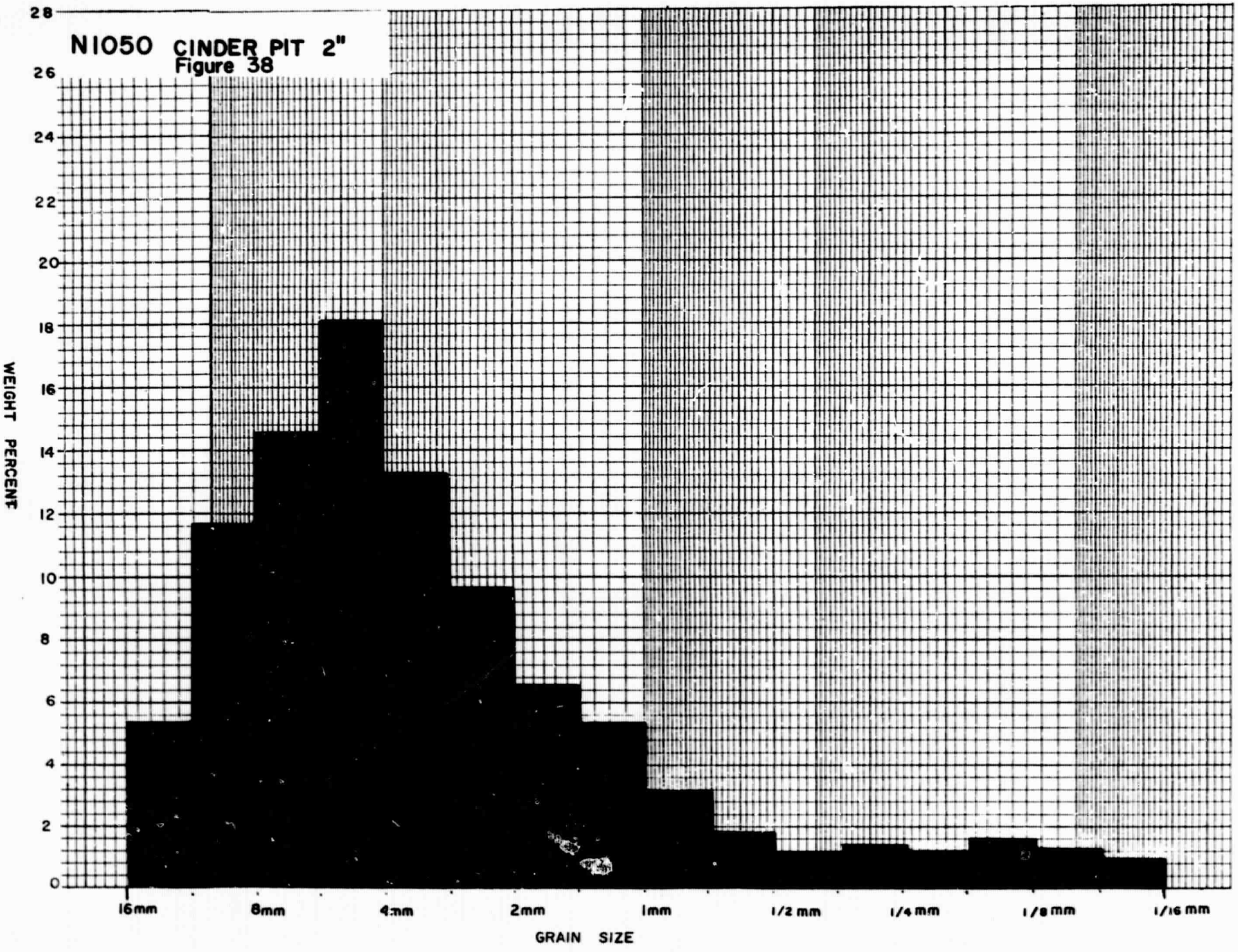
Poison Lake Cinder Pit

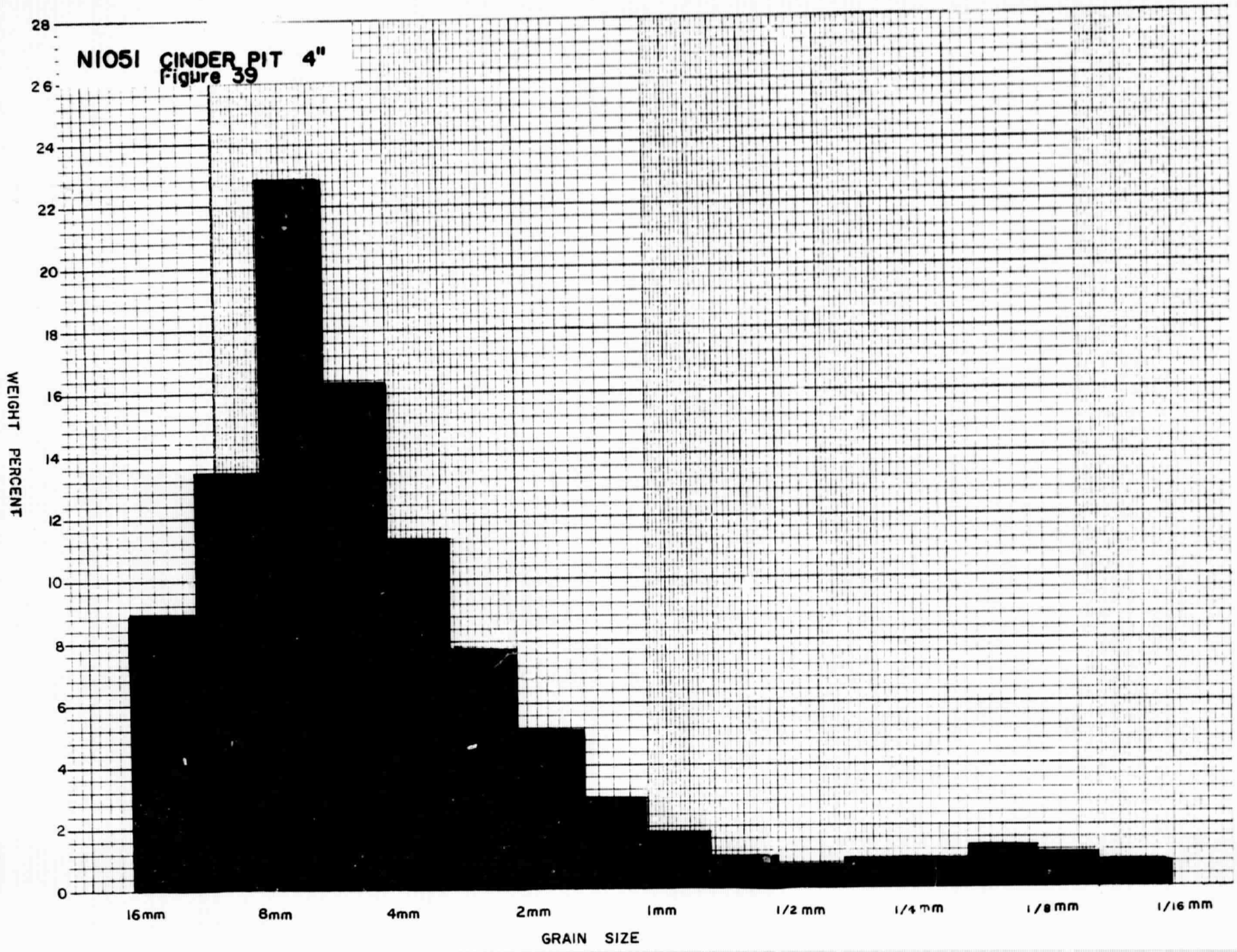
SOIL MOISTURE
July 15-16, 1968

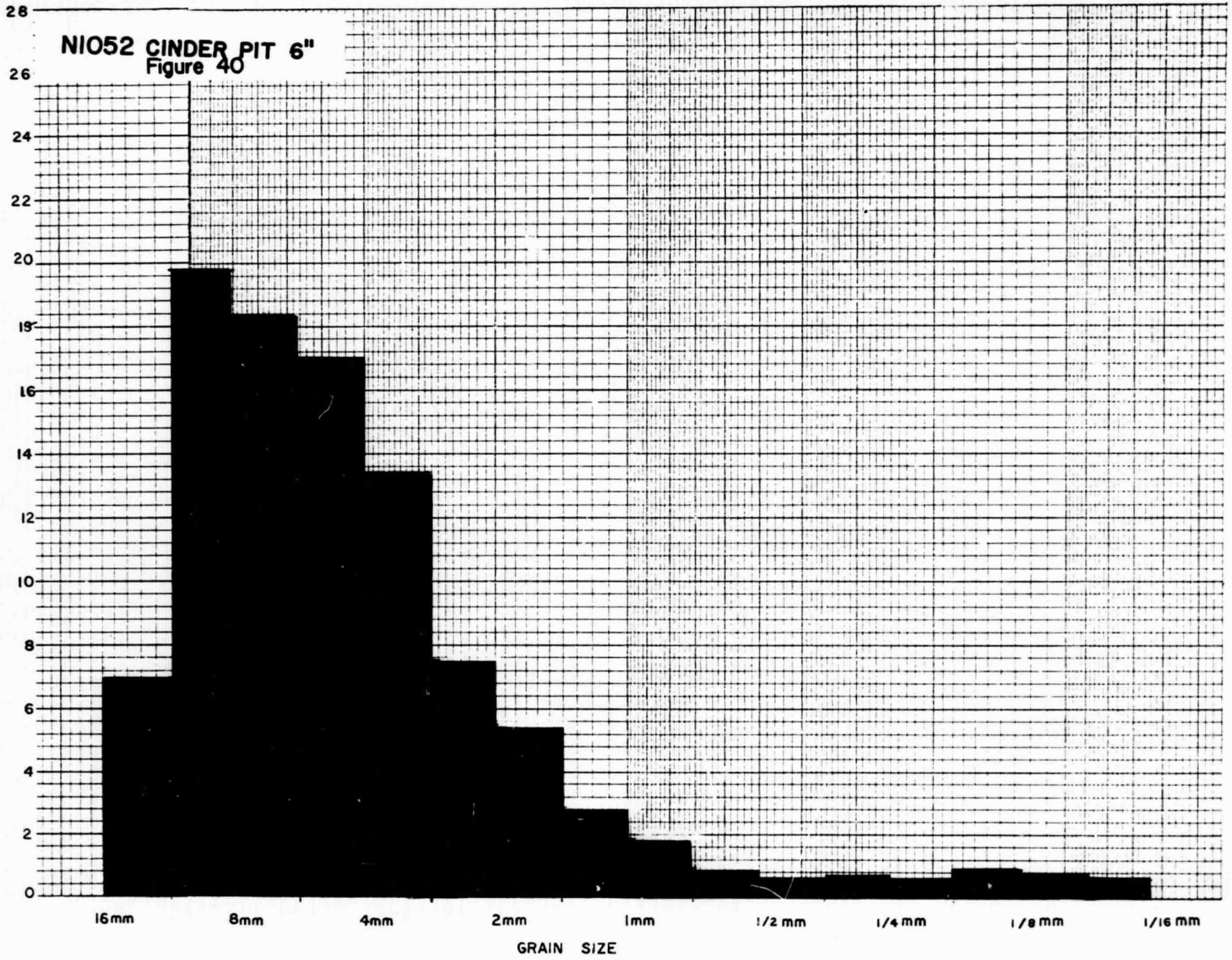
Sample No.		Wt. Percent Moisture	
N1043	(Cinder Pit 06:00 Surface)	0.40	
N1044	(Cinder Pit 06:00 Surface)	1.00	Average 0.87
N1045	(Cinder Pit 06:00 Surface)	1.22	
N1046	(Cinder Site Plate)	0.67	
N1047	(Cinder Site Plate)	1.02	Average 0.81
N1048	(Cinder Site Plate)	0.73	
N1049	(Cinder Pit Site #1 Surface)	0.37	
N1050	(Cinder Pit Site #1 2")	1.13	
N1051	(Cinder Pit Site #1 4")	3.48	
N1052	(Cinder Pit Site #1 6")	10.00	
N1053	(Cinder Pit Site #1 1')	14.69	
N1054	(Cinder Pit Site #1 2')	16.94	
N1055	(Cinder Pit Site #1 3')	15.63	

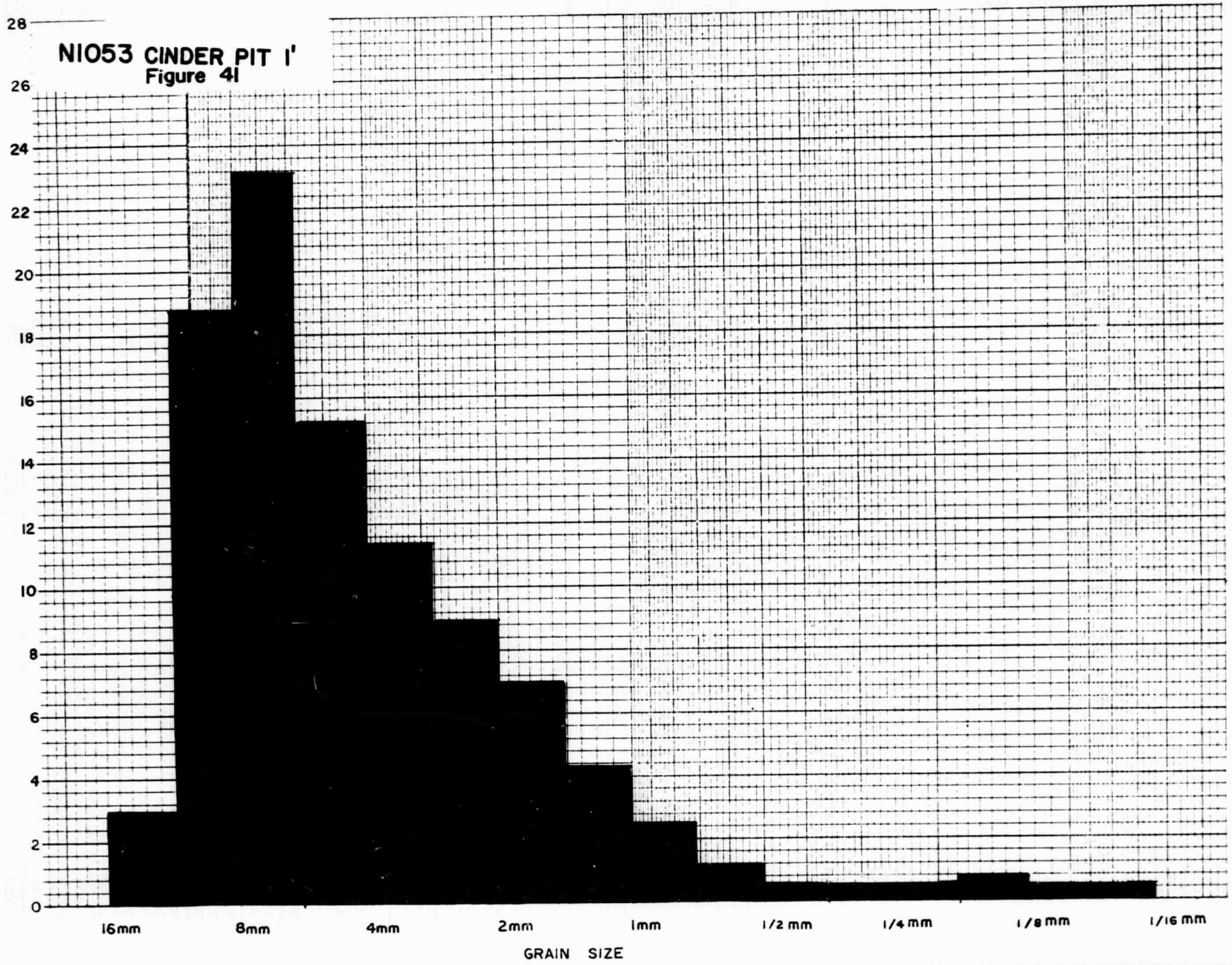

N1046 CINDER PIT PLATE
Figure 36
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

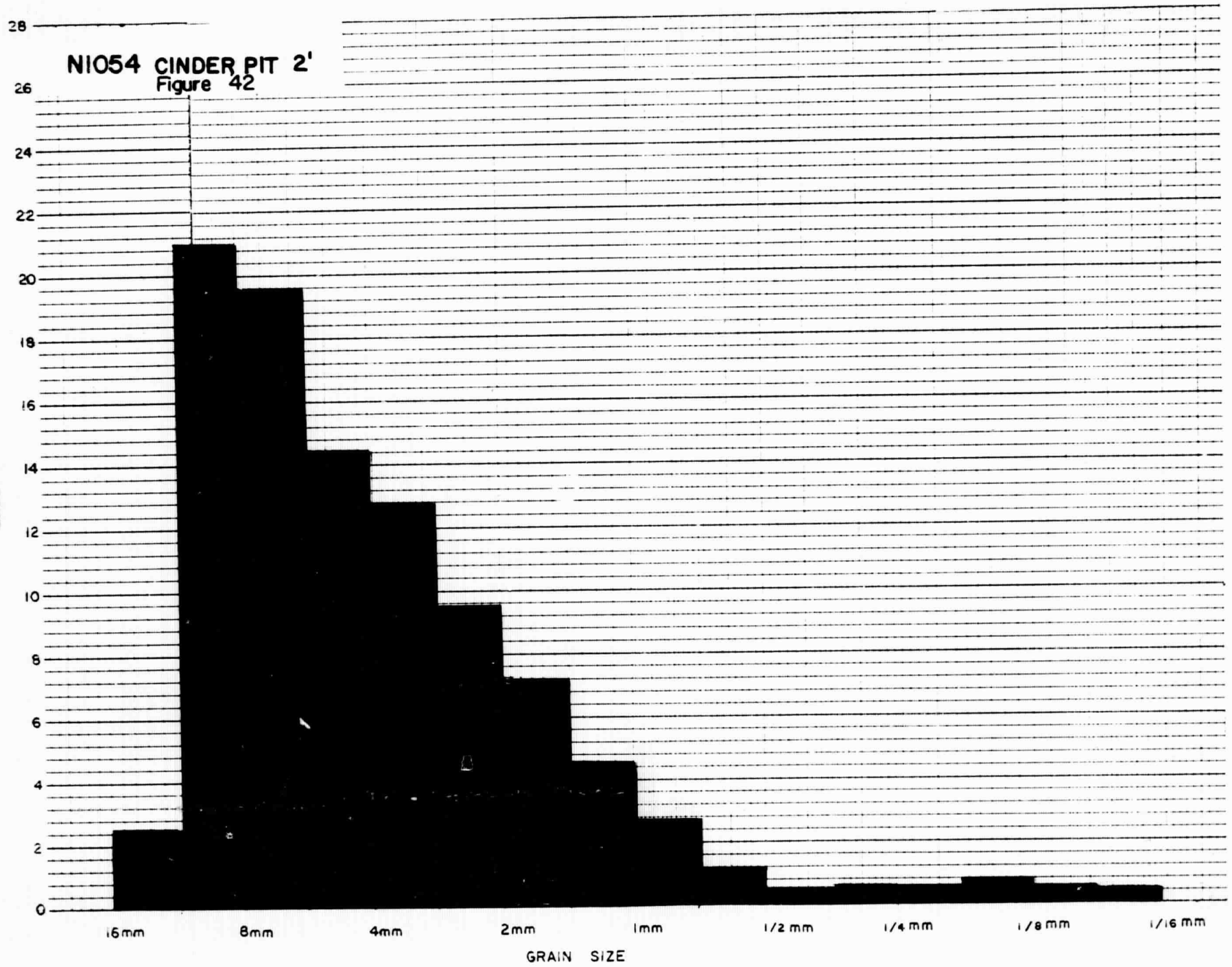

N1049 CINDER PIT SURFACE
Figure 37
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

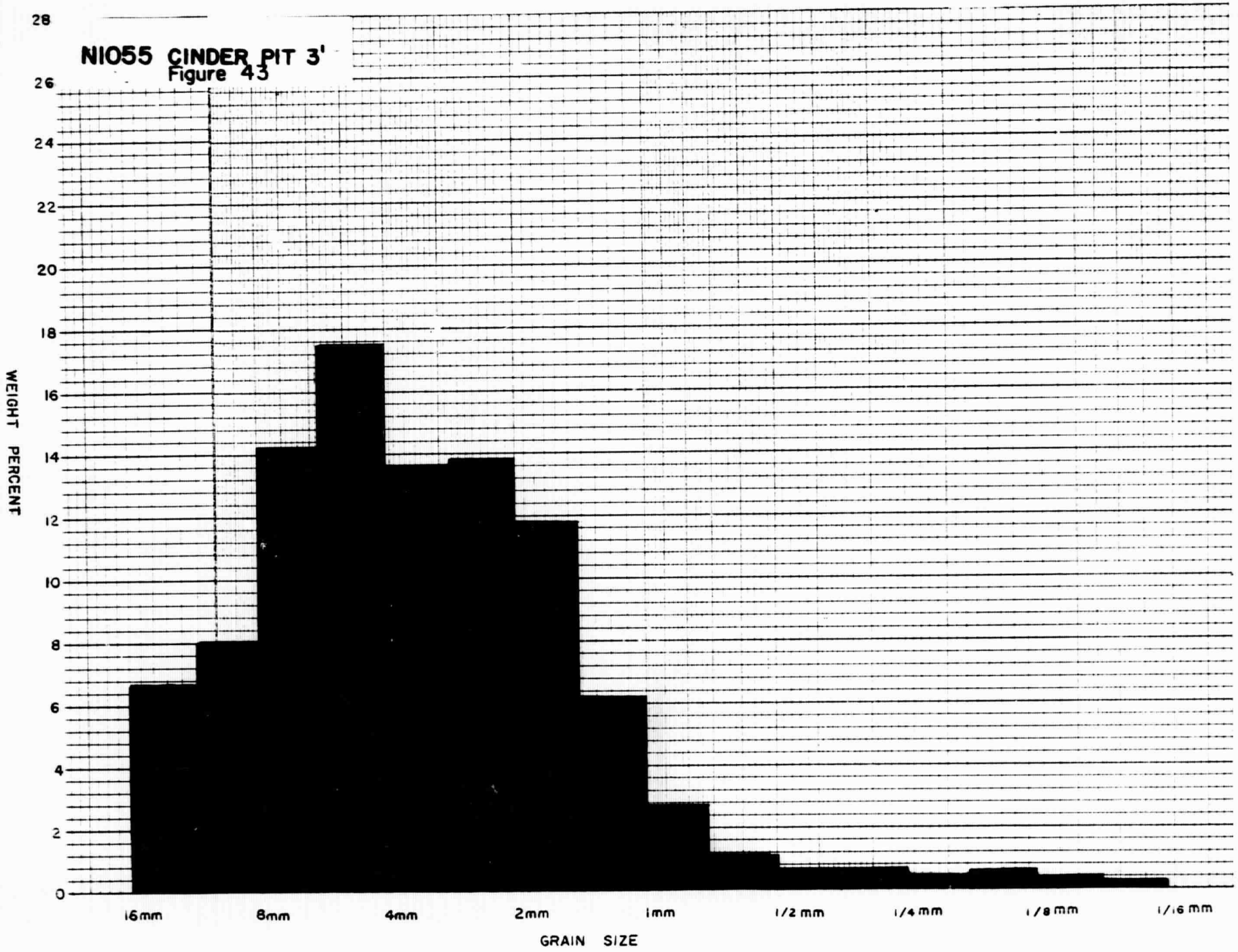

N1050 CINDER PIT 2"
Figure 38
WEIGHT PERCENT
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1051 CINDER PIT 4"
Figure 39
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1052 CINDER PIT 6"
Figure 40
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1053 CINDER PIT 1'
Figure 41
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1054 CINDER PIT 2'
Figure 42
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE


N1055 CINDER PIT 3'
Figure 43
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
WEIGHT PERCENT
16mm
8mm
4mm
2mm
1mm
1/2 mm
1/4 mm
1/8 mm
1/16 mm
GRAIN SIZE

RADIOMETER TEMPERATURE DATA

Mt. Lassen Cinder Pit

July 15, 1968

Radiometric temperatures during plate experiment, surface temperatures as material was being added to top of plate taken between 12:11 and 13:32.

1" cover	43.5°C
2" cover	48.2°C
4" cover	32.5°C
8" cover	41.0°C
12" cover	44.5°C

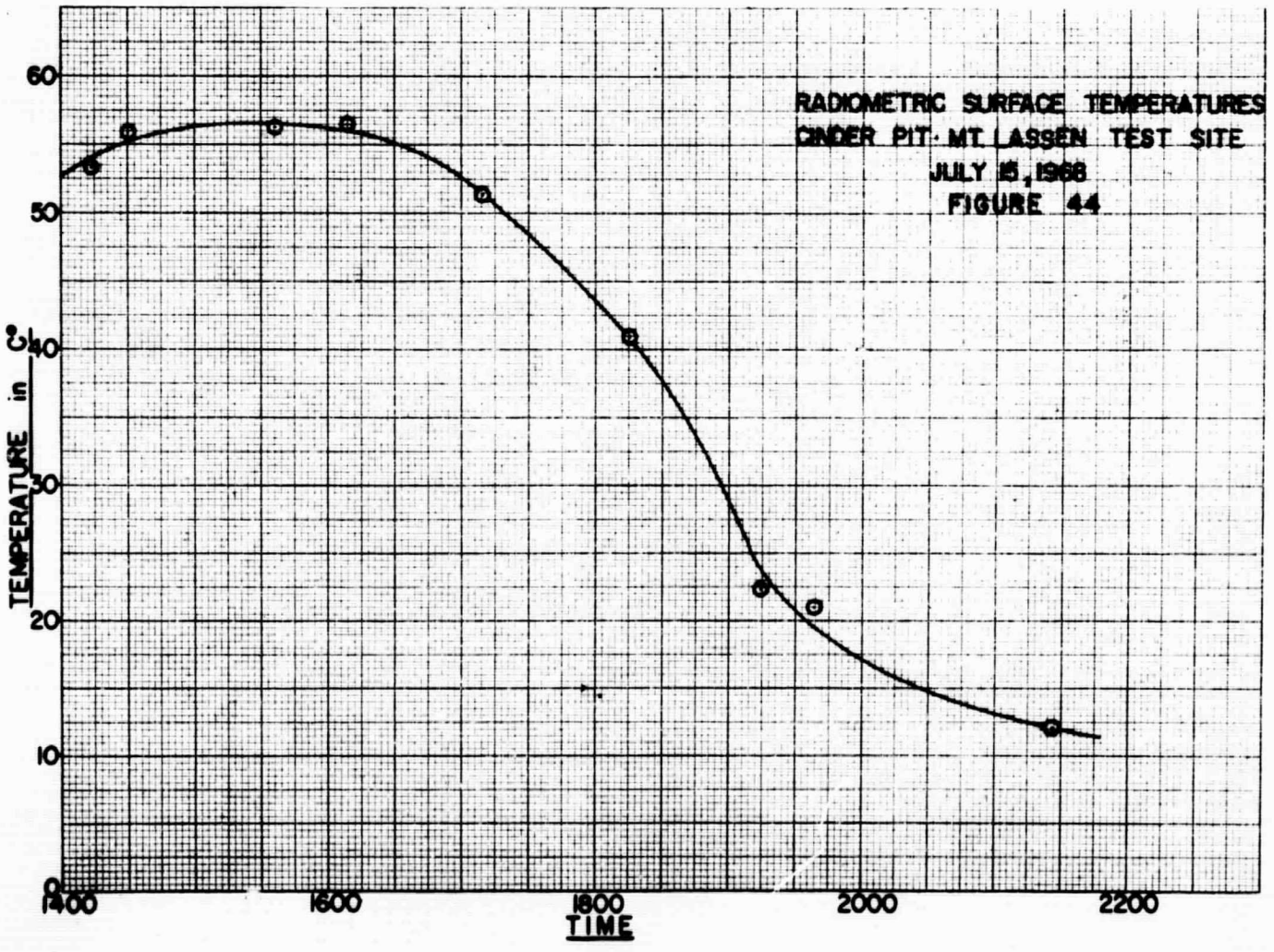


TABLE 9

Reduced Radiometer Data

Mt. Lassen
July 15, 1968

Horizontal: TB(COR)-1.42
T(CAL) 30.72
Vertical: TB(COR) -2.35
T(CAL) 30.37

Poison Lake Cinder Pit

SITE	TIME	X_3R	T_1	α	$\overline{X}$	ΔTB	COMMENTS	
	11:29	84.07	310.30	86.87	.260	.069	0" cinder	27°V
	11:31	85.72	310.80	86.24	.261	.039	0" cinder	27°V
	11:33	84.84	310.90	86.24	.259	.009	0" cinder	27°V
	11:40	82.01	311.50	88.57	.263	.159	0" cinder	27°V
	11:43	84.96	311.20	87.13	.261	.057	0" cinder	27°V
	11:56	161.24	314.70	87.10	.252	.074	1/2" cinder)	27°V
	11:59	157.72	315.20	87.22	.251	.035	1/2" cinder) RFI?	27°V
	12:10	214.66	316.30	87.14	.245	.027	1" cinder	27°V
	12:13	214.14	316.50	89.11	.244	.080	1" cinder	27°V
	12:26	238.27	317.10	89.99	.241	.036	2" cinder	27°V
	12:28	238.81	317.10	89.30	.242	.018	2" cinder	27°V
	12:50	274.78	316.90	90.29	.248	.104	4" cinder	27°V
	12:52	274.78	316.80	89.77	.246	.135	4" cinder	27°V
	12:54	274.33	316.80	89.89	.247	.103	4" cinder	27°V
	13:13	300.82	316.60	90.85	.245	.064	8" cinder	27°V
	13:15	300.11	316.30	90.91	.244	.095	8" cinder	27°V
	13:27	301.07	316.20	91.04	.246	.000	12" cinder	27°V
	13:29	301.17	316.20	90.64	.248	.168	12" cinder	27°V
	14:36	300.83	317.90	92.69	.249	.088		10°V
	14:45	302.19	317.90	90.79	.248	.041		10°V
	14:50	301.45	318.00	92.37	.248	.000		30°V
	14:55	301.65	318.10	92.75	.247	.227		30°V
	15:00	303.21	318.40	92.89	.247	.088		45°V
	15:01	303.13	318.60	93.53	.244	.037		45°V
	15:10	296.47	319.20	93.11	.238	.042		45°H
	15:12	295.02	319.20	93.82	.241	.052		45°H
	15:14	298.75	319.20	93.70	.240	.051		30°H
	15:18	298.74	319.30	93.97	.240	.132		30°H
	15:22	300.37	319.30	94.07	.244	.221		10°H
	15:24	300.58	319.30	93.62	.242	.421		10°H

TABLE 9 (Cont'd.)

SITE	TIME	X_3R	T_1	α	$\bar{X}$	ΔTB	COMMENTS	
	15:30	300.79	319.10	93.97	.243	.075		10°H
	15:33	300.09	319.00	94.80	.245	.081		10°H
	15:36	298.64	319.00	94.95	.245	.071		30°H
	15:39	299.02	319.00	93.93	.245	.042		30°H
	15:40	294.83	319.00	95.08	.243	.000		45°H
	15:44	295.27	319.10	94.35	.241	.094		45°H
	15:47	303.19	319.20	93.52	.244	.243		45°V
	15:50	303.45	319.30	93.33	.242	.028		45°V
	15:52	302.00	319.40	93.58	.243	.173		30°V
	15:55	302.42	319.50	93.47	.243	.093		30°V
	15:58	301.21	319.50	92.93	.242	.009		10°V
	16:01	300.52	319.40	94.43	.244	.038		10°V
	16:30	300.91	319.20	94.54	.241	.014		10°V
	16:32	300.60	319.20	95.11	.242	.038		10°V
	16:35	301.93	319.20	95.68	.243	.128		30°V
	16:37	301.87	319.30	94.51	.242	.128		30°V
	16:40	303.08	319.30	94.43	.245	.019		45°V
	16:42	302.88	319.30	95.05	.246	.095		45°V
	16:50	294.98	319.40	96.24	.246	.105		45°H
	16:52	295.19	319.40	95.15	.247	.204		45°H
	16:54	298.68	319.40	95.43	.248	.038		30°H
	16:55	298.40	319.30	95.74	.249	.024		30°H
	16:58	299.95	319.20	95.51	.248	.158		10°H
	17:00	299.96	319.20	96.41	.248	.034		10°H
	17:30	299.71	318.60	96.50	.245	.217		10°H
	17:31	299.84	318.50	95.69	.244	.081		10°H
	17:33	297.92	318.50	96.35	.246	.111		30°H
	17:36	298.00	318.50	95.93	.244	.119		30°H
	17:38	293.93	318.50	95.64	.244	.105		45°H
	17:40	293.66	318.50	96.47	.245	.120		45°H
	17:45	302.12	318.60	95.61	.244	.053		45°V
	17:47	301.90	318.60	94.97	.245	.152		45°V
	17:49	301.95	318.50	95.64	.247	.062	Repeat	45°V
	17:53	300.71	318.30	95.35	.248	.086		30°V
	17:54	301.04	318.30	95.07	.249	.157		30°V
	17:56	299.32	318.20	95.31	.248	.110		10°V
	17:59	299.62	318.20	95.13	.249	.043		10°V

TABLE 9 (Cont'd.)

SITE	TIME	X_3R	T_1	α	$\overline{X}$	ΔTB	COMMENTS	
	18:37	298.37	317.00	95.73	.252	.100		10°V
	18:41	298.28	316.80	95.82	.253	.091		10°V
	18:43	298.40	316.60	96.80	.258	.102		30°V
	18:45	298.43	316.40	95.35	.258	.048		30°V
	18:47	298.92	316.10	96.34	.258	.063		45°V
	18:50	298.61	315.80	97.18	.258	.010		45°V
	18:56	290.93	315.50	97.37	.257	.078		45°H
	18:58	290.91	315.60	97.85	.257	.044		45°H
	19:00	294.55	315.60	96.76	.259	.000		30°H
	19:03	294.50	315.60	96.53	.261	.092		30°H
	19:05	296.00	315.70	99.53	.263	.055		10°H
	19:06	296.90	315.70	96.56	.262	.053		10°H
	19:30	295.13	314.30	97.35	.266	.122		10°H
	19:32	295.25	314.20	96.77	.265	.092		10°H
	19:34	292.42	314.10	97.37	.266	.068		30°H
	19:35	292.52	314.10	97.20	.265	.073		30°H
	19:37	287.99	314.00	97.83	.267	.078		45°H
	19:38	287.56	314.00	98.67	.268	.015		45°H
	19:45	297.71	312.60	96.41	.267	.063	(	45°V
	19:46	297.96	313.90	95.83	.264	.067	(RFI	45°V
	19:48	295.46	313.90	96.23	.265	.048		30°V
	19:50	295.35	313.90	96.58	.266	.048		30°V
	19:52	295.50	313.90	94.71	.264	.024		10°V
	19:53	294.51	313.90	95.99	.266	.153		10°V
							CAL. #1	
	21:00	292.59	312.90	93.94	.269	.085		10°V
	21:04	291.95	312.90	95.55	.272	.014		30°V
	21:05	292.06	312.90	95.86	.269	.038		45°V
	21:07	291.76	312.80	96.38	.270	.010		45°V
	21:15	283.04	312.60	96.41	.267	.063		45°H
	21:16	287.41	312.50	96.85	.270	.068		30°H
	21:18	291.04	312.40	96.29	.268	.014		10°H

TABLE 9 (Cont'd.)

SITE	TIME	X_3R	T_1	α	$\bar{X}$	ΔTB	COMMENTS	
	22:00	289.03	311.10	97.59	.275	.068		10°H
	22:04	285.88	311.10	97.11	.277	.151		30°H
	22:08	281.10	311.00	96.92	.276	.053		45°H
	22:10	-7.01	310.90	99.74	.278	.014		180°H
	22:15	289.81	310.90	95.68	.280	.038		45°V
	22:16	289.94	310.80	96.54	.282	.039		30°V
	22:18	289.94	310.80	95.70	.282	.024		10°V
	23:07	287.84	310.60	95.35	.289	.143		10°V
	23:10	288.46	310.60	94.45	.287	.109		30°V
	23:12	288.33	310.70	94.13	.287	.024		45°V
	23:17	277.16	310.70	96.98	.287	.053		45°H
	23:18	283.31	310.70	96.92	.287	.102		30°H
	23:20	286.98	310.70	95.81	.287	.034		10°H
	23:23	-4.79	310.70	98.37	.286	.059		180°H
				Poison Lake Cinder Pit July 16, 1968				
	00:25	-11.11	310.70	100.33	.292	.271	[Note base &	180°H
	00:26	275.72	310.70	95.84	.296	.024	Cal Shift-	45°H
	00:27	275.79	310.70	95.85	.295	.105	switch iso-	45°H
	00:29	281.59	310.70	95.11	.294	.010	lation]	30°H
	00:31	284.39	310.70	95.61	.295	.076		10°H
	00:36	285.53	310.60	94.26	.293	.104		10°V
	00:38	285.51	310.60	94.92	.296	.052		30°V
	00:40	285.50	310.60	95.96	.296	.029		45°V
	00:42	-3.38	310.60	97.95	.287	.171		180°V
	01:57	-4.89	310.00	98.28	.291	.079		180°V
	01:59	283.83	310.00	94.88	.297	.057		45°V
	02:02	283.98	309.90	94.40	.295	.170		30°V
	02:04	283.27	309.80	94.70	.297	.047		10°V
	02:10	283.54	309.80	96.02	.295	.072		10°H
	02:12	278.87	309.80	96.50	.296	.014		30°H
	02:14	272.88	309.80	96.98	.296	.073		45°H
	02:16	-6.36	310.00	99.42	.287	.060		180°H

TABLE 9 (Cont'd.)

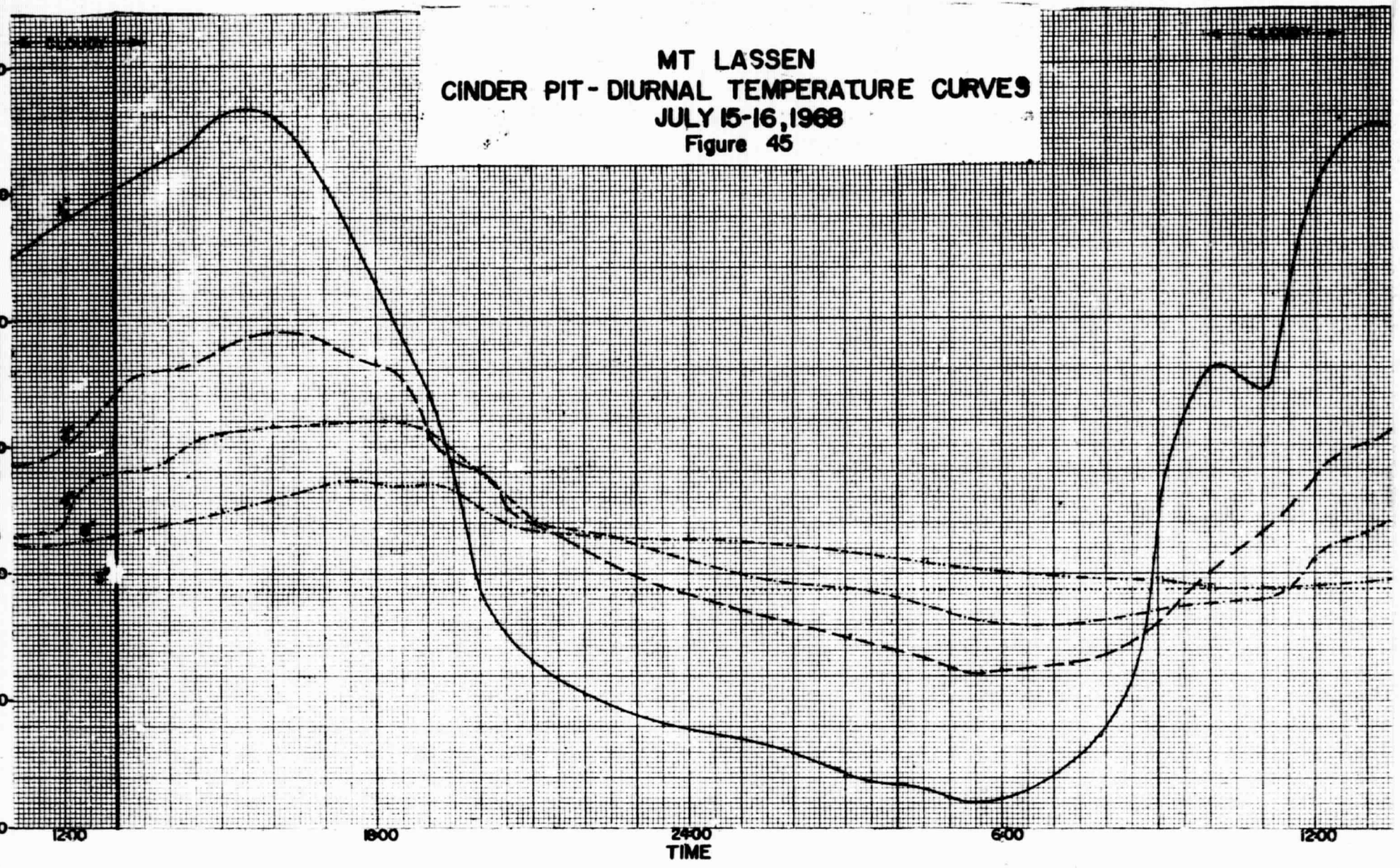
SITE	TIME	X_3R	T_1	α	$\bar{X}$	ΔTB	COMMENTS	
	03:28	281.53	309.90	96.27	.289	.087		10°H
	03:30	278.51	309.90	96.83	.289	.179		30°H
	03:32	272.39	309.90	97.23	.289	.005		45°H
	03:34	-5.70	309.90	99.72	.288	.055		180°H
	03:39	-2.67	309.80	98.30	.286	.211		180°V
	03:42	282.26	309.70	95.11	.291	.076		45°V
	03:43	282.40	309.70	95.55	.291	.119	80% R.H.	30°V
	03:45	281.70	309.60	96.14	.292	.115		10°V
	04:50	282.11	309.70	94.60	.291	.071		10°V
	04:55	281.23	308.80	95.19	.291	.148		30°V
	04:58	281.01	308.90	95.01	.292	.713		45°V
	05:02	-4.10	309.00	97.51	.291	.005		180°V
	05:08	-10.06	309.00	99.69	.292	.314		180°H
	05:10	271.87	309.00	95.39	.295	.014		45°H
	05:13	276.86	308.90	94.84	.296	.076		30°H
	05:17	279.98	308.80	95.75	.294	.043		10°H
	06:30	279.33	309.60	95.66	.296	.062	Sun on cinder	10°H
	06:33	276.15	309.60	96.11	.298	.043		30°H
	06:36	270.46	309.70	96.47	.299	.005		45°H
	06:38	-9.30	309.80	98.76	.297	.193		180°H
	06:45	-3.45	309.90	96.81	.295	.048		180°V
	06:48	280.30	309.90	94.10	.299	.165		45°V
	06:51	280.38	310.00	93.92	.297	.005		30°V
	06:53	279.96	310.00	94.05	.297	.056		10°V

TABLE 9 (Cont'd.)

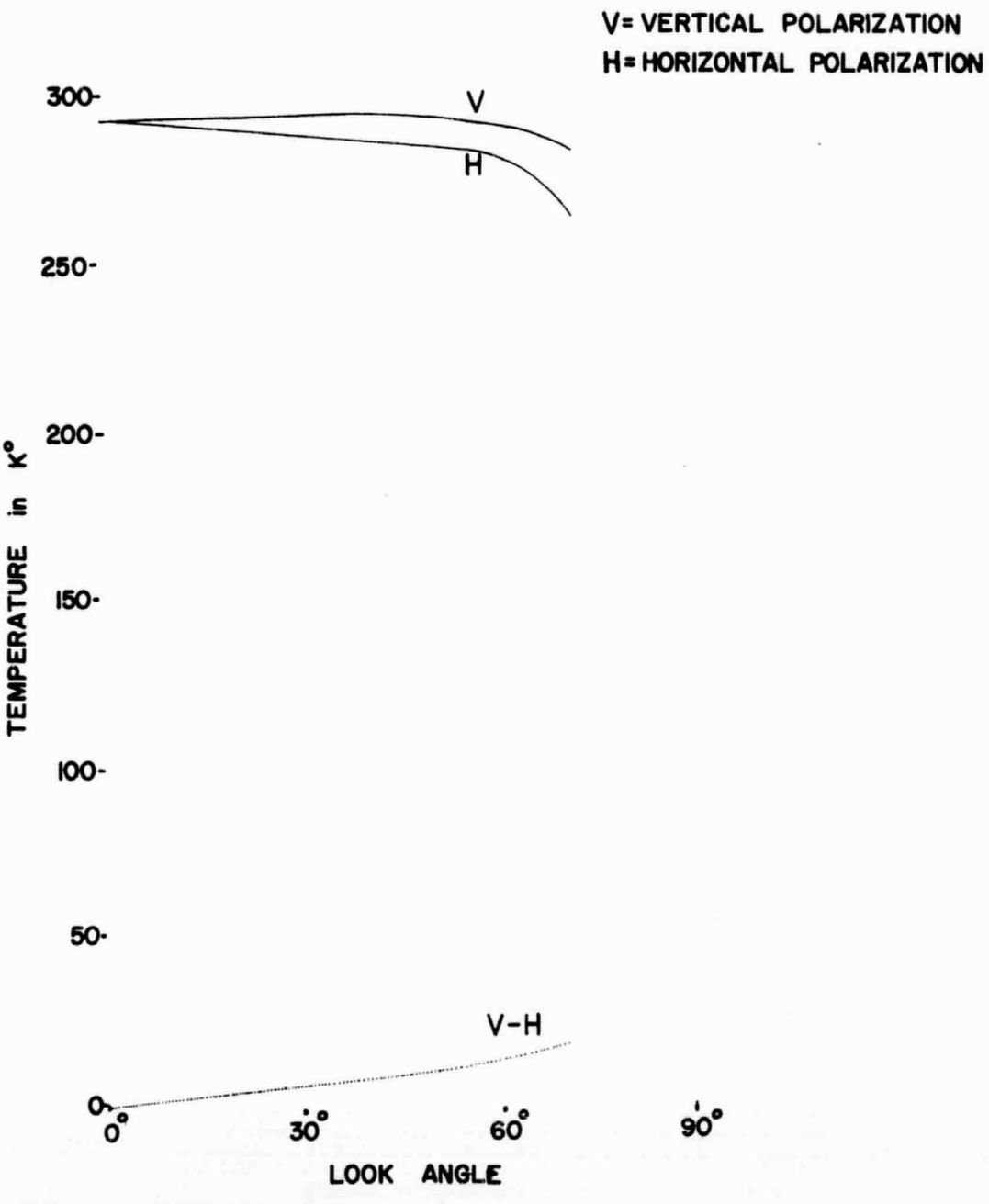
SITE	TIME	X_3R	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	07:30	280.28	310.30	94.80	.288	.185	10°V
	07:33	281.22	310.60	94.77	.286	.052	30°V
	07:35	281.30	310.80	95.25	.285	.148	45°V
	07:37	-5.04	311.30	96.52	.283	.179	180°V
	07:44	-8.54	312.00	97.74	.282	.078	180°H
	07:46	273.52	312.40	94.32	.283	.009	45°H
	07:48	278.74	312.70	93.03	.280	.074	30°H
	07:52	281.00	312.28	94.68	.278	.128	10°H
	08:32	282.86	314.50	95.87	.267	.024	10°H
	08:35	280.43	314.50	95.67	.267	.057	30°H
	08:37	276.35	314.70	95.39	.265	.005	45°H
	08:41	-9.38	314.80	98.29	.266	.084	180°H
	08:45	-9.71	314.80	97.84	.271	.010	180°V
	08:47	285.50	315.10	94.32	.269	.189	45°V
	08:51	285.45	315.10	94.83	.271	.052	30°V
	08:53	285.55	315.00	93.17	.268	.126	10°V
	09:28	287.03	315.60	94.89	.276	.043	10°V
	09:30	287.54	315.58	93.81	.274	.033	10°V
	09:32	289.12	315.90	93.86	.272	.136	30°V
	09:35	288.23	315.80	94.85	.272	.133	30°V
	09:37	289.53	316.10	94.57	.268	.222	45°V
	09:40	289.30	316.10	95.10	.266	.024	45°V
	09:49	235.85	316.60	98.70	.263	.064	180°H
	09:52	281.25	316.80	94.28	.265	.222	45°H
	09:54	281.23	316.90	95.12	.262	.071	45°H
	09:56	285.82	316.90	95.02	.261	.029	30°H
	09:58	286.06	316.80	95.49	.261	.029	30°H
	10:00	288.28	316.80	95.58	.260	.048	10°H
	10:02	288.44	316.80	95.63	.261	.100	10°H
	10:06	236.25	316.80	97.61	.262	.102	180°V
	10:30	291.26	318.70	92.24	.260	.189	10°V
	10:34	290.65	318.60	92.85	.261	.130	10°V
	10:35	292.90	318.50	92.90	.259	.177	30°V
	10:37	293.00	318.20	93.03	.236	.042	30°V
	10:40	293.48	318.10	95.01	.255	.062	45°V

TABLE ((Cont'd._

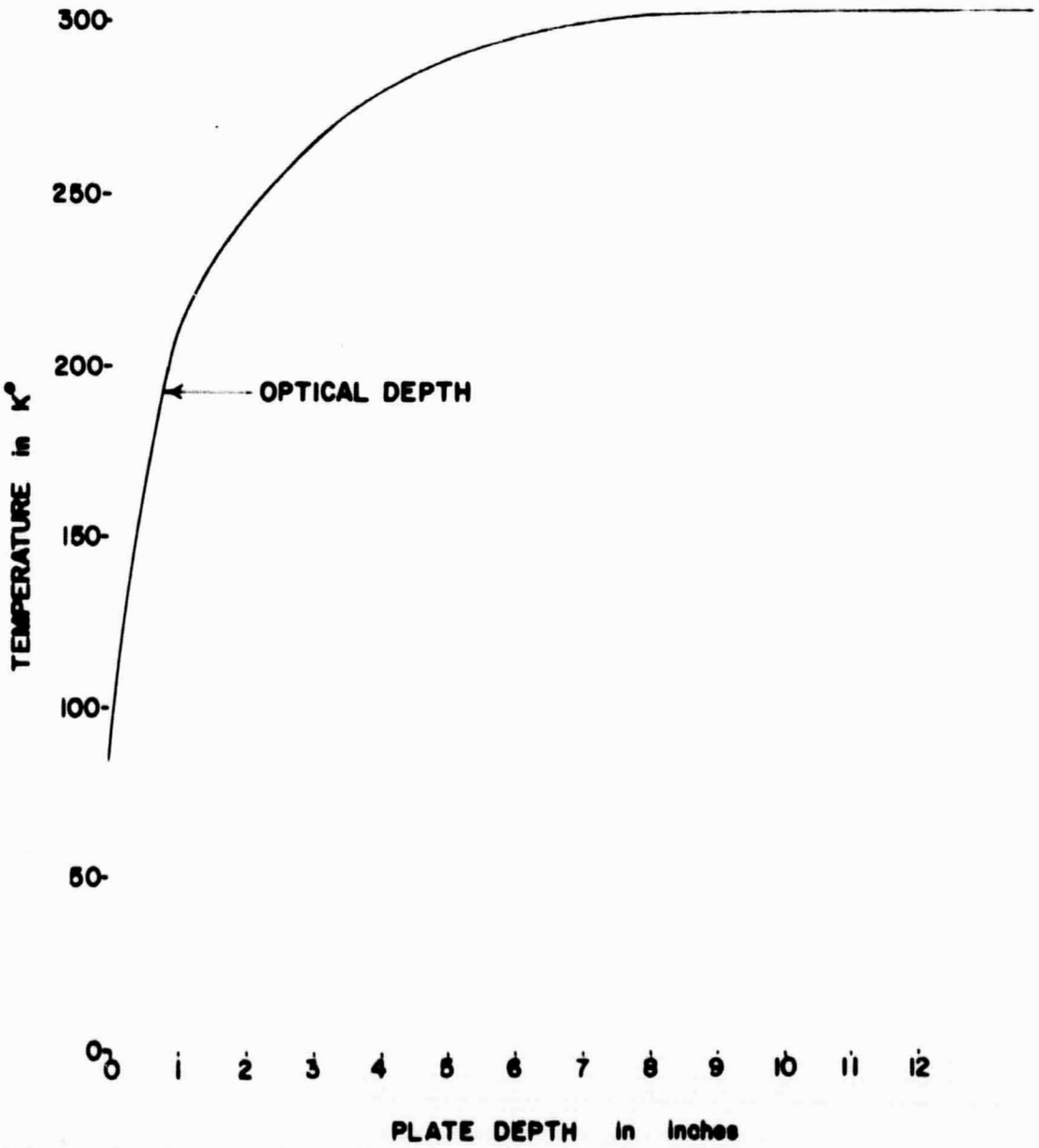
SITE	TIME	X_3R	T_1	α	$\bar{X}$	ΔTB	COMMENTS
	10:42	293.01	317.80	95.77	.252	.029	45°V
	10:44	236.38	317.50	97.39	.249	.073	180°V
	10:45	236.18	317.50	97.76	.249	.073	180°V
	10:53	236.74	317.30	99.00	.245	.129	180°H
	10:55	235.38	317.00	99.92	.246	.065	180°H
	10:59	285.84	316.90	96.44	.250	.169	45°H
	11:00	285.71	316.80	95.39	.247	.339	45°H
	11:02	287.38	316.70	97.02	.251	.073	30°H
	11:04	287.68	316.50	97.14	.252	.170	30°H
	11:07	290.39	316.40	95.55	.254	.124	10°H
	11:08	290.08	316.30	96.91	.252	.048	10°H
	11:52	-3.56	317.00	97.49	.246	.175	180°H
	11:55	286.68	316.90	96.21	.257	.192	45°H
	11:57	290.44	316.90	95.61	.259	.172	30°H
	12:00	292.09	316.80	95.06	.257	.090	10°H
	12:03	293.30	316.60	93.40	.255	.233	10°V
	12:05	295.32	316.50	94.98	.254	.090	30°V
	12:07	296.70	316.50	96.00	.254	.034	45°V
	12:09	-5.37	316.50	98.06	.252	.127	180°V
	12:53	-7.24	317.30	102.22	.257	.020	180°V
	12:57	300.18	317.50	99.33	.264	.025	45°V
	13:02	298.51	317.50	98.03	.264	.196	30°V
	13:05	292.62	317.70	98.17	.263	.103	10°V
	13:10	290.93	317.80	99.40	.262	.134	10°H
	13:12	292.07	317.80	98.71	.259	.168	30°H
	13:20	288.97	317.50	101.04	.254	.308	45°H
	13:25	-6.65	317.60	97.41	.251	.391	180°H
	13:50	-10.43	317.00	99.05	.251	.099	180°H
	13:51	291.29	316.70	95.29	.256	.019	45°H
	13:54	295.68	316.70	94.88	.257	.062	30°H
	13:57	297.30	316.80	94.19	.257	.099	10°H
	14:02	297.78	316.80	93.10	.260	.140	10°V
	14:05	299.92	316.70	94.05	.262	.085	30°V
	14:07	301.68	316.70	95.13	.258	.033	45°V
	14:10	-7.76	316.70	97.03	.253	.039	180°V


MT LASSEN
CINDER PIT - DIURNAL TEMPERATURE CURVES
JULY 15-16, 1968
Figure 45
TEMPERATURE in C°
80
60
40
20
0
1200
1800
2400
6:00
1200
TIME

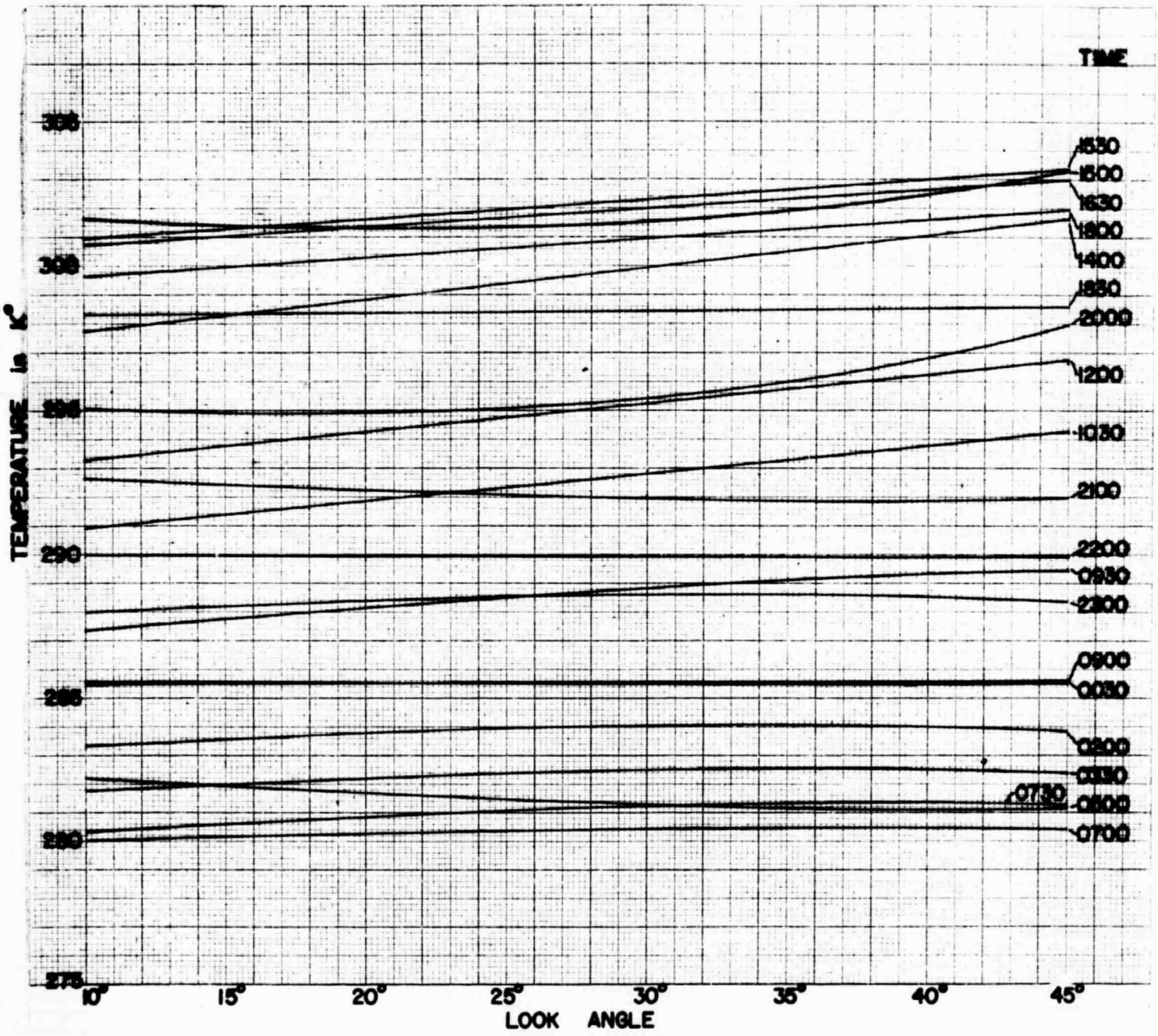
9.2 GHz MICROWAVE TEMPERATURES –
AVERAGE OF DIURNAL CINDER PIT RUNS
JULY 15-16,1968
Figure 46



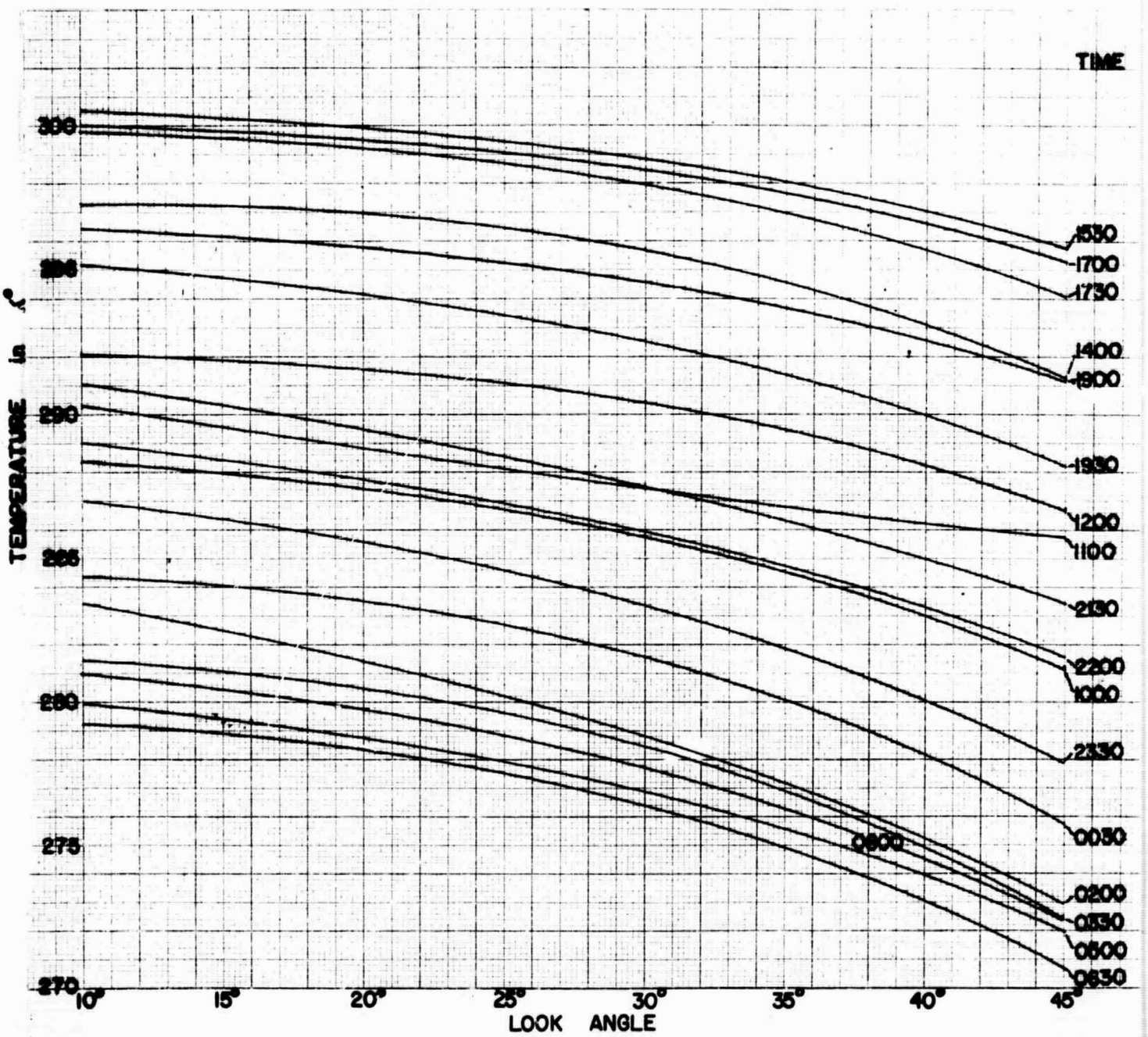
9.2 GHz MICROWAVE TEMPERATURES
CINDER PIT - MT. LASSEN
1200 JULY 15, 1968
Figure 47



DIURNAL VARIATIONS IN VERTICAL POLARIZED SIGNAL
9.2 GHz RADIOMETER TEMPERATURES
CINDER PIT - MT. LASSEN
JULY 15-16,1968
Figure 48



DIURNAL VARIATIONS IN HORIZONTAL POLARIZED SIGNAL
9.2 GHz RADIOMETER TEMPERATURES
CINDER PIT - MT. LASSEN
JULY 15-16, 1968
Figure 49



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