

A00041

TEC-21

BEULAH Thermal Data
Field Sheets.
Holes B1-B14
BEULAH, OREGON

HOLE DEPTHS FOR BUELLAH.

Hole No	Depth in metres.
B-1	49.
B-2	51
B-3	46
B-4	50 metres.
B-5	49
B-6	50.
B-7	50.
B-8	37.
B-9	50.
B-10	48.
B-11	34.
B-12	13.
B-13	50.
B-14	49.
8	

TEMPERATURE - DEPTH LOG

Location Beulah, Oregon Date June 11, 1975

Map Beulah Quadrangle

Property T 20 S R 38 E sec NW 1/4 17

Drill Hole B-1 Date Drilled May 28, 1975 Elevation 4240 ft.

Instrument _____ Operator D Pilkington

Comments logged at 0900 hrs. Filled with H₂O date drilled

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
0	3.890	23.025			
1	5.190	15.615	-7.410		
2	6.449	10.190	-5.425		
3	6.830	8.885	-1.305		
4	6.829	8.890	0.005		
5	6.656	9.505	0.615		
6	6.415	10.395	0.890		
7	6.254	11.010	0.615		
8	6.191	11.255	0.245		
9	6.167	11.350	0.095		
10	6.162	11.370	0.020		
11	6.159	11.385	0.015		Probably cold H ₂ O aquifer
12	6.155	11.400	0.015		" " " "
13	6.147	11.430	0.030		
14	6.138	11.465	0.035		
15	6.127	11.510	0.055		
16	6.113	11.565	0.055		
17	6.100	11.610	0.045		
18	6.087	11.670	0.060		
19	6.075	11.720	0.050		
20	6.061	11.775	0.055		

TEMPERATURE - DEPTH LOG

Location _____ Date _____

Map _____

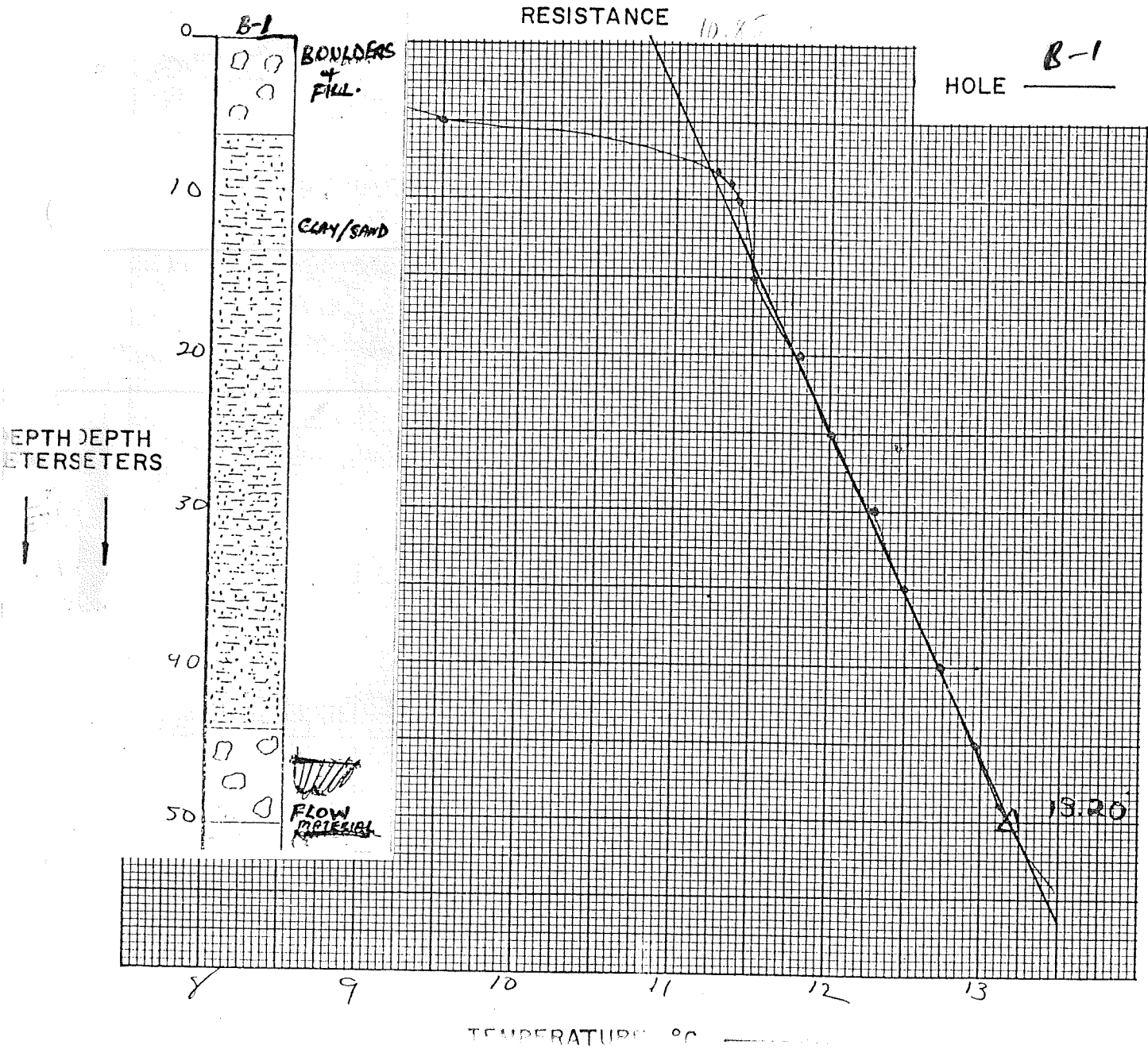
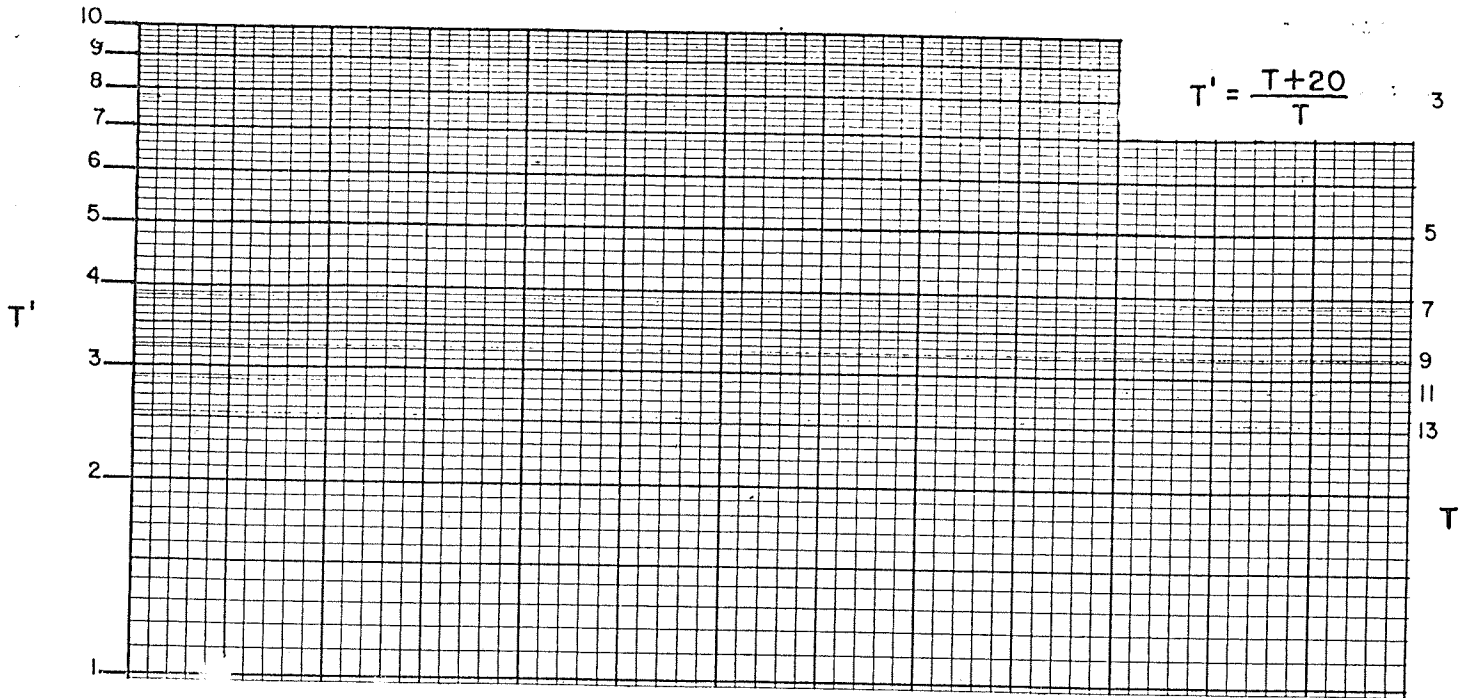
Property _____ T _____ R _____ sec _____

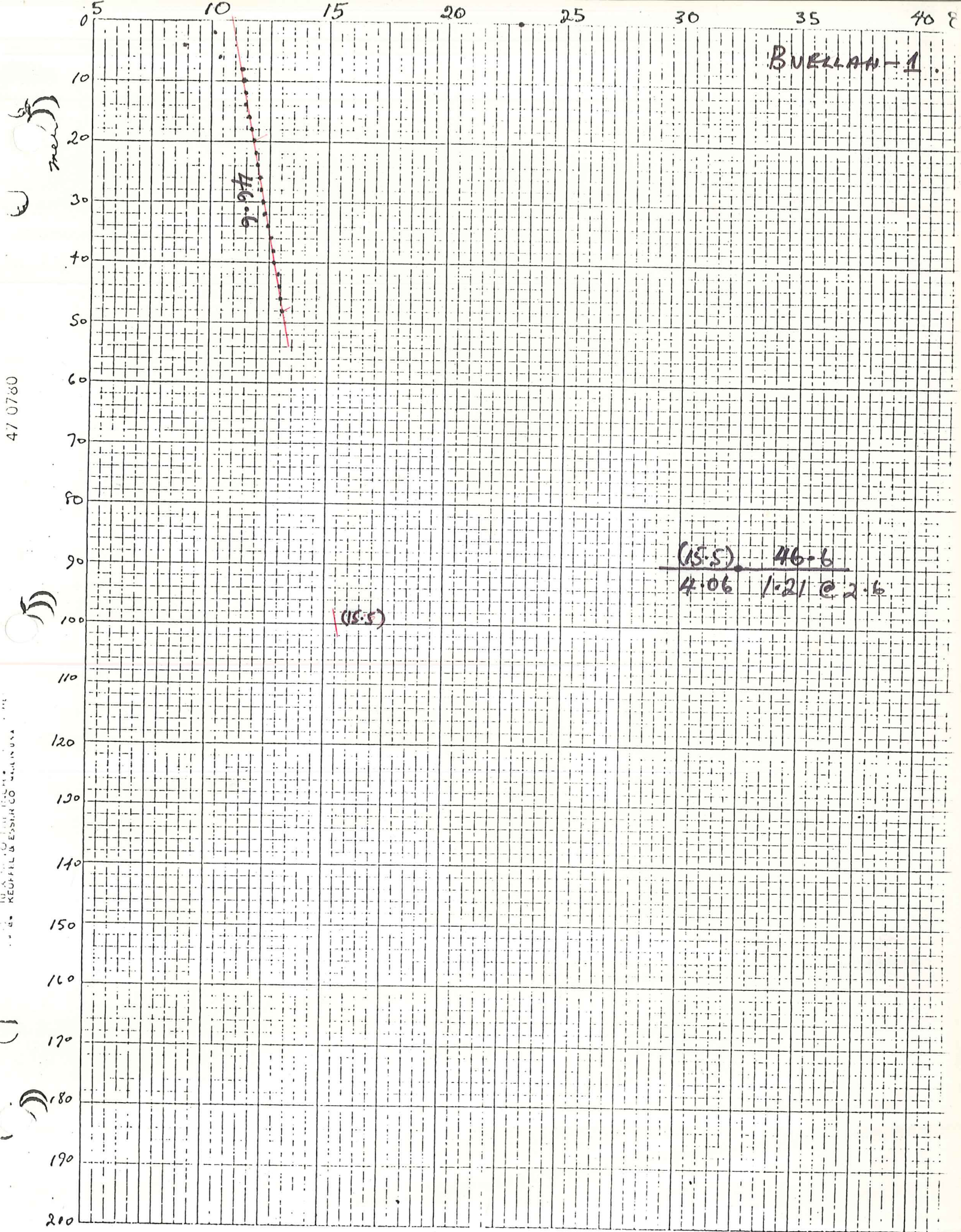
Drill Hole B-1 Date Drilled _____ Elevation _____ ft.

Instrument _____ Operator _____

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
21	6.050	11.820	0.045			
22	6.038	11.865	0.055			
23	6.025	11.920	0.045			
24	6.014	11.965	0.055			
25	6.000	12.020	0.045			
26	5.989	12.065	0.045			
27	5.978	12.110	0.055			
28	5.965	12.165	0.055			
29	5.952	12.220	0.045			
30	5.941	12.265	0.045			
31	5.930	12.310	0.055			
32	5.917	12.365	0.045			
33	5.906	12.410	0.040			
34	5.896	12.450	0.050			
35	5.884	12.500	0.050			
36	5.872	12.550	0.050			
37	5.860	12.600	0.045			
38	5.849	12.645	0.050			
39	5.838	12.695	0.040			
40	5.828	12.735	0.045			
41	5.817	12.780	0.055			





BUELLAN-1.

46.6

(15.5)

(15.5) 46.6
4.06 1.21 @ 2.6

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100% KEUFFEL & ESSER CO. MADE IN U.S.A.

TEMPERATURE - DEPTH LOG

Location Beulah, Oregon Date June 11, 1975

Map Beulah Quadrangle

Property _____ T 20S R 37E sec sw 1/4 10

Drill Hole B-2 Date Drilled May 28, 1975 Elevation 3360 ft.

Instrument _____ Operator D Pilkington

Comments log at 1100 hrs. Filled with H₂O at 11:00.

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
0	4.082	21.670			
1	4.570	18.840	-2.830		
2	5.920	12.350	-6.390		
3	6.442	10.290	-2.060		
4	6.316	10.770	0.480		
5	6.145	11.440	0.670		
6	6.073	11.725	0.285		
7	5.946	12.245	0.520		
8	5.893	12.465	0.220		
9	5.821	12.555	0.090		
10	5.858	12.610	0.055		
11	5.847	12.655	0.045		
12	5.806	12.830	0.175		
13	5.797	12.865	0.035		
14	5.794	12.880	0.015		
15	5.793	12.885	0.005		
16	5.791	12.890	0.005		
17	5.788	12.905	0.015		
18	5.781	12.935	0.030		
19	5.776	12.955	0.020		
20	5.766	13.000	0.045		
			0.035		

TEMPERATURE - DEPTH LOG

Location _____ Date _____

Map _____

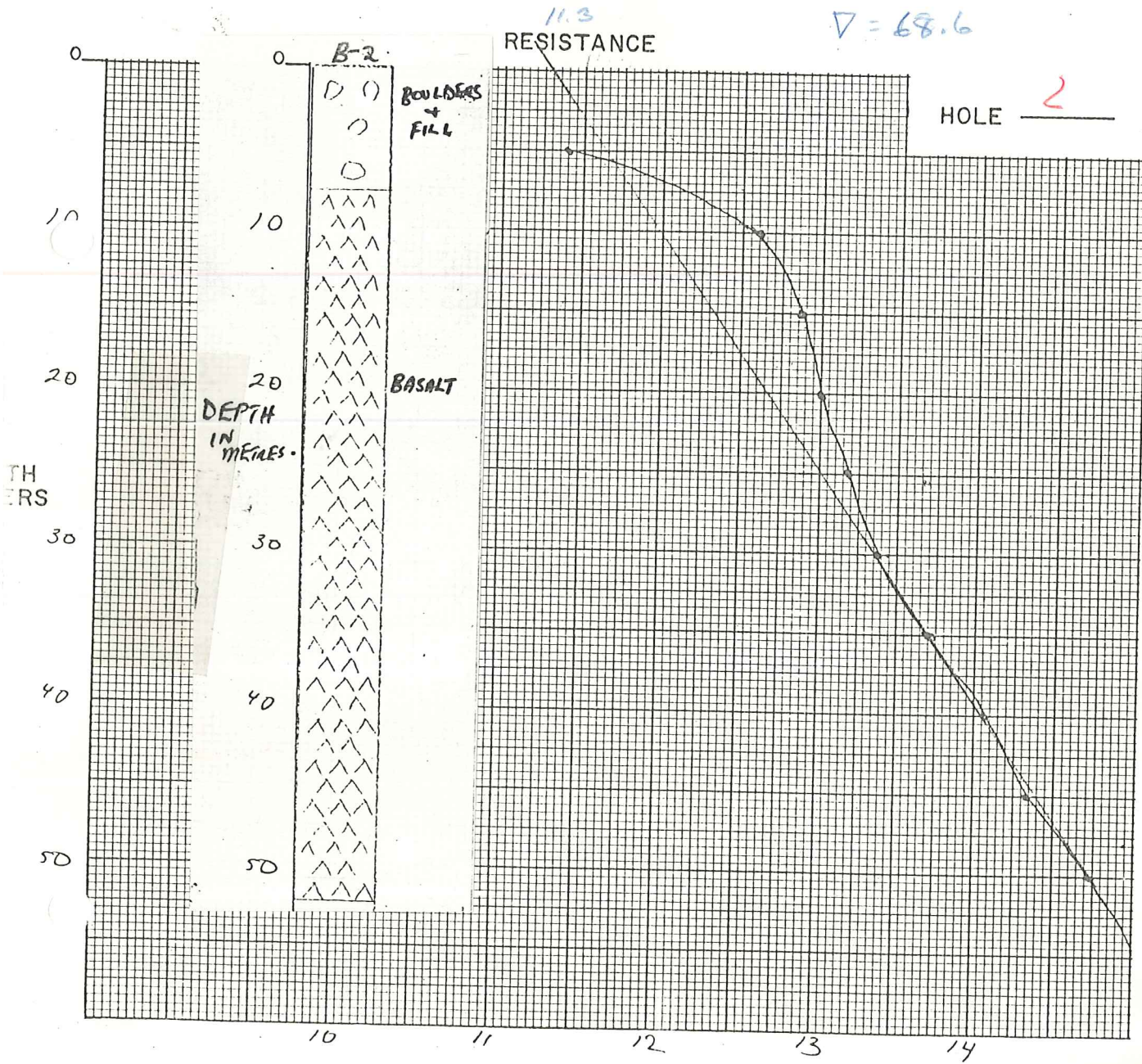
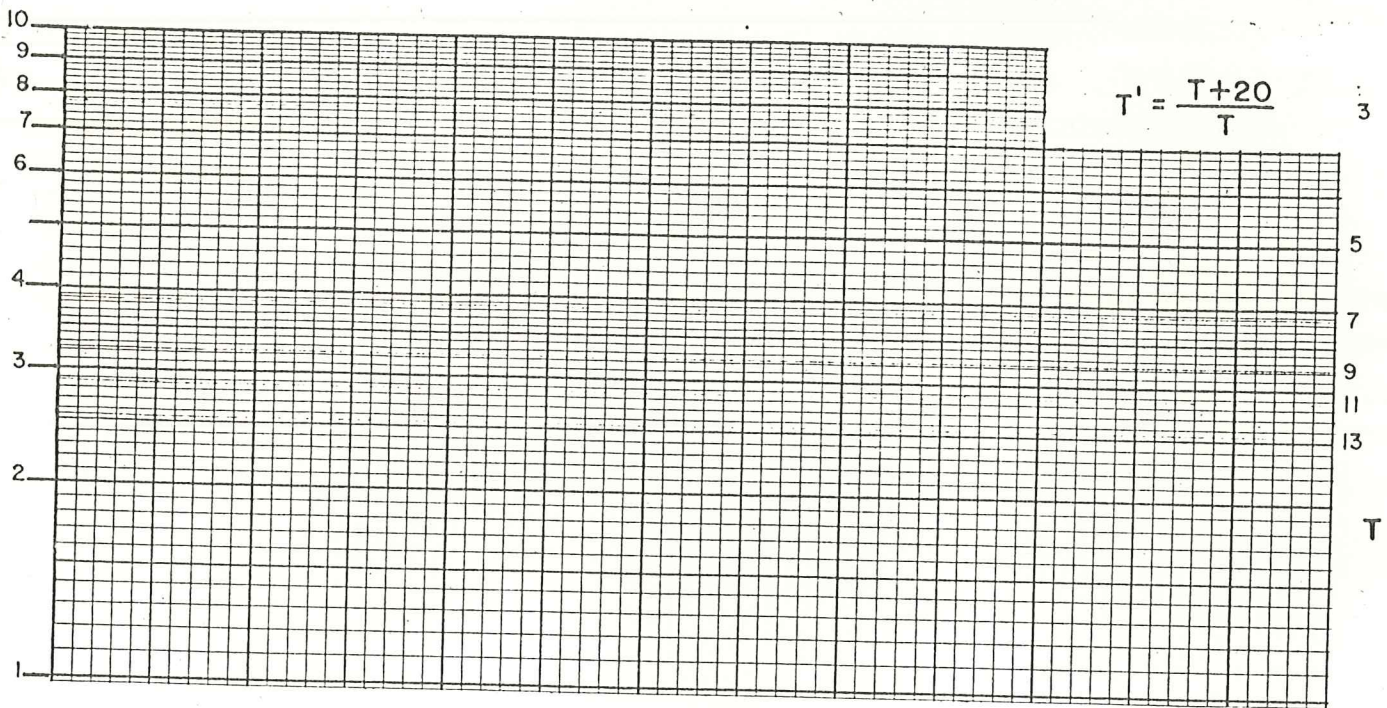
Property _____ T _____ R _____ sec _____

Drill Hole B-7 Date Drilled _____ Elevation _____ ft.

Instrument _____ Operator _____

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
21	5.757	13.035	0.050		
22	5.746	13.085	0.040		
23	5.737	13.125	0.030		
24	5.729	13.155	0.035		
25	5.721	13.190	0.040		
26	5.712	13.230	0.045		
27	5.702	13.275	0.040		
28	5.693	13.315	0.050		
29	5.681	13.365	0.025		
30	5.675	13.390	0.025		
31	5.669	13.415	0.015		
32	5.666	13.430	0.010		Probable cold H ₂ O aquifer
33	5.664	13.440	0.150		" " " "
34	5.630	13.590	0.110		Probable Hot H ₂ O aquifer
35	5.605	13.700	0.125		" " " "
36	5.576	13.825	0.060		" " " "
37	5.563	13.885	0.055		
38	5.550	13.940	0.060		
39	5.537	14.000	0.065		
40	5.523	14.065	0.055		
41	5.510	14.120	0.050		



TEMPERATURE

BUELLAN-2

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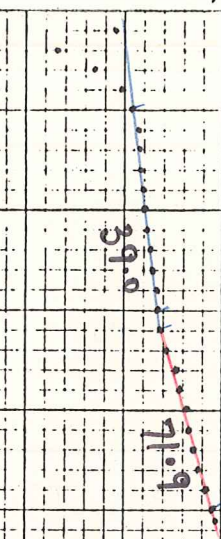
U

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KEUFFEL & ESSER CO. MADE IN USA

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(18.4) 39.0-71.9
2.63 3.60 @ 5.0

(18.4)

TEMPERATURE - DEPTH LOG

Location Beulah, Oregon Date June 11, 1975

Map Beulah Quadrangle

Property T 19 S R 38 E sec SW 1/4 18

Drill Hole B-3 Date Drilled May 29, 1975 Elevation 4280 ft.

Instrument _____ Operator D Pilkington

Comments logged at 1230 hrs Filled with H₂O after drilled.

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
0	3.720	24.205			
1	4.150	21.330	-2.875		
2	6.710	9.310	12.020		
3	7.020	8.235	-1.075		
4	7.365	7.085	-1.150		
5	7.488	6.695	0.370		
6	7.195	7.640	0.945		
7	6.825	8.900	1.260		
8	6.657	9.500	0.600		
9	6.608	9.680	0.180		
10	6.599	9.710	0.030		
11	6.601	9.705	-0.005		Probable cold H ₂ O zone
12	6.605	9.690	-0.015		" " " "
13	6.605	9.690	0.000		" " " "
14	6.603	9.695	0.005		
15	6.602	9.700	0.005		
16	6.601	9.705	0.005		
17	6.595	9.725	0.020		
18	6.586	9.760	0.035		
19	6.574	9.800	0.040		
20	6.567	9.830	0.030		
			0.035		

TEMPERATURE - DEPTH LOG

Location _____ Date _____

Map _____

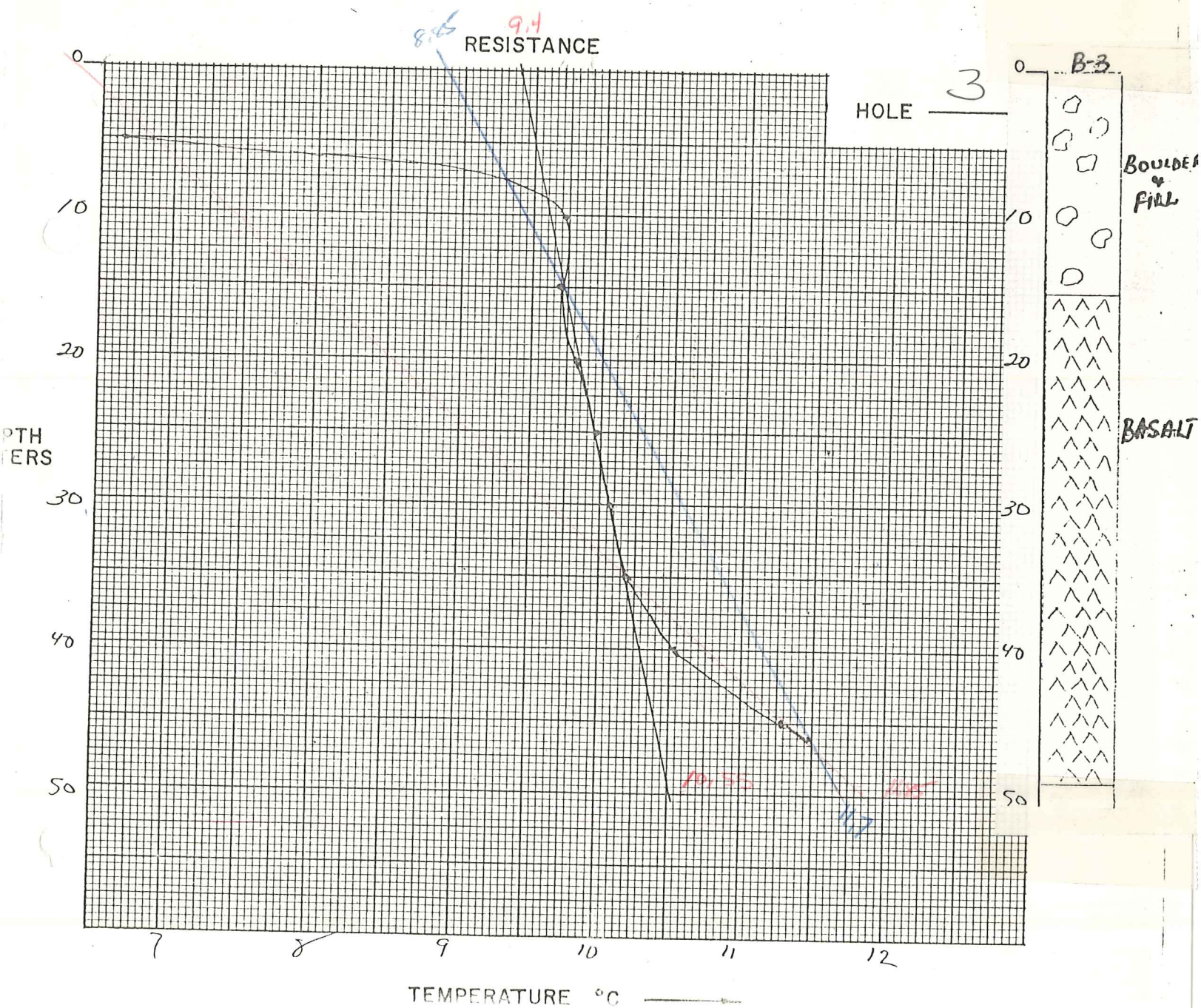
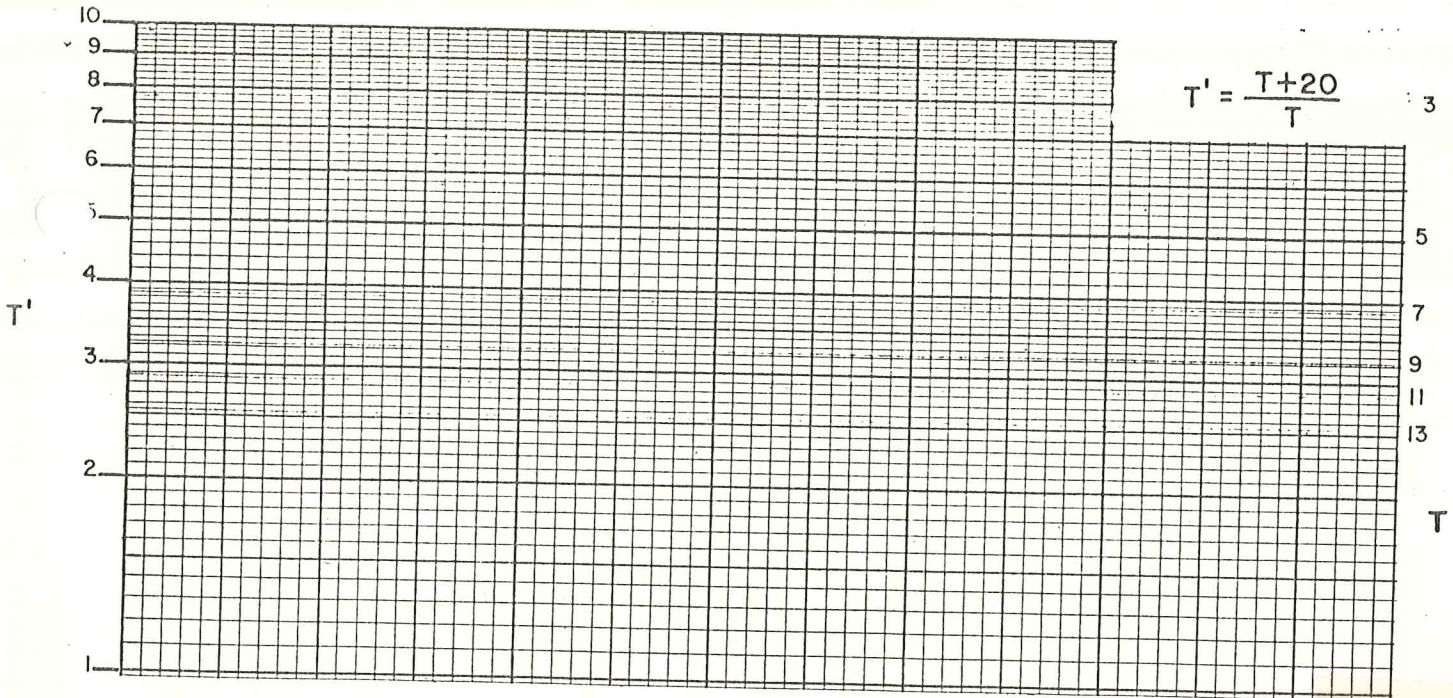
Property _____ T _____ R _____ sec _____

Drill Hole B-3 Date Drilled _____ Elevation _____ ft.

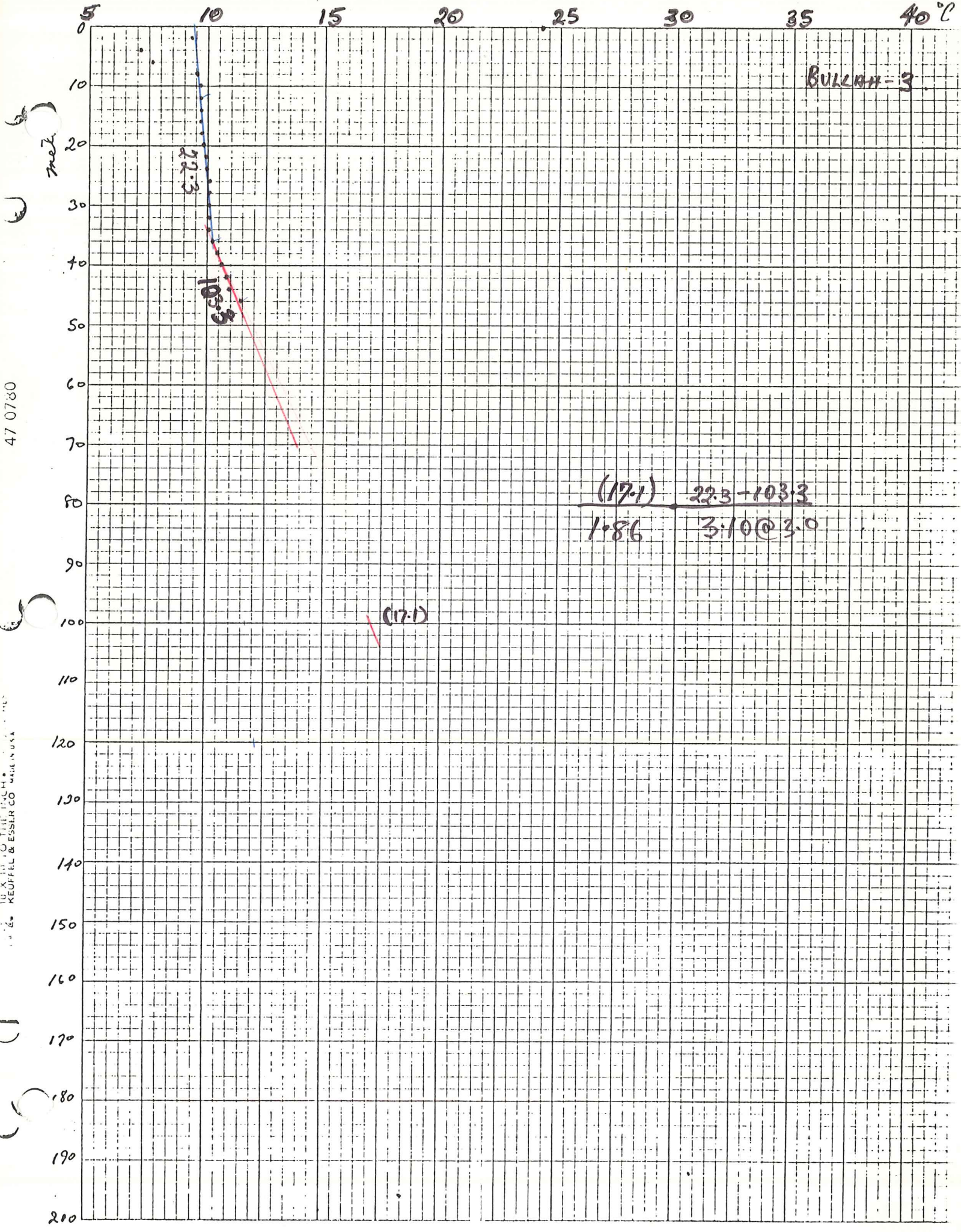
Instrument _____ Operator _____

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
21	6557	9.865			
22	6544	9.915	0.050		
23	6540	9.925	0.010		
24	6539	9.930	0.005		
25	6530	9.965	0.035		
26	6517	10.015	0.050		
27	6511	10.030	0.015		
28	6508	10.045	0.015		Chilled zone
29	6503	10.060	0.015		chilled zone
30	6502	10.070	0.010		chilled zone
31	6508	10.045	-0.025		Probable Cold H ₂ O Aquifer
32	6505	10.055	0.010		Probable Cold H ₂ O Aquifer
33	6503	10.060	0.005		chilled zone
34	6496	10.090	0.030		chilled zone
35	6476	10.165	0.075		
36	6460	10.225	0.060		
37	6437	10.310	0.085		
38	6413	10.400	0.090		
39	6385	10.505	0.105		
40	6364	10.585	0.080		Probable Hot H ₂ O Aquifer
41	6324	10.740	0.155		
			0.105		Probable Hot H ₂ O Flow zone



BULK-H-3



47 0780

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TEMPERATURE - DEPTH LOG

Location Beulah Oregon Date October 16, 1975

Map Beulah Quadrangle

Property _____ T _____ R _____ sec _____

Drill Hole B-4 Date Drilled _____ Elevation _____ ft.

Instrument _____ Operator DP

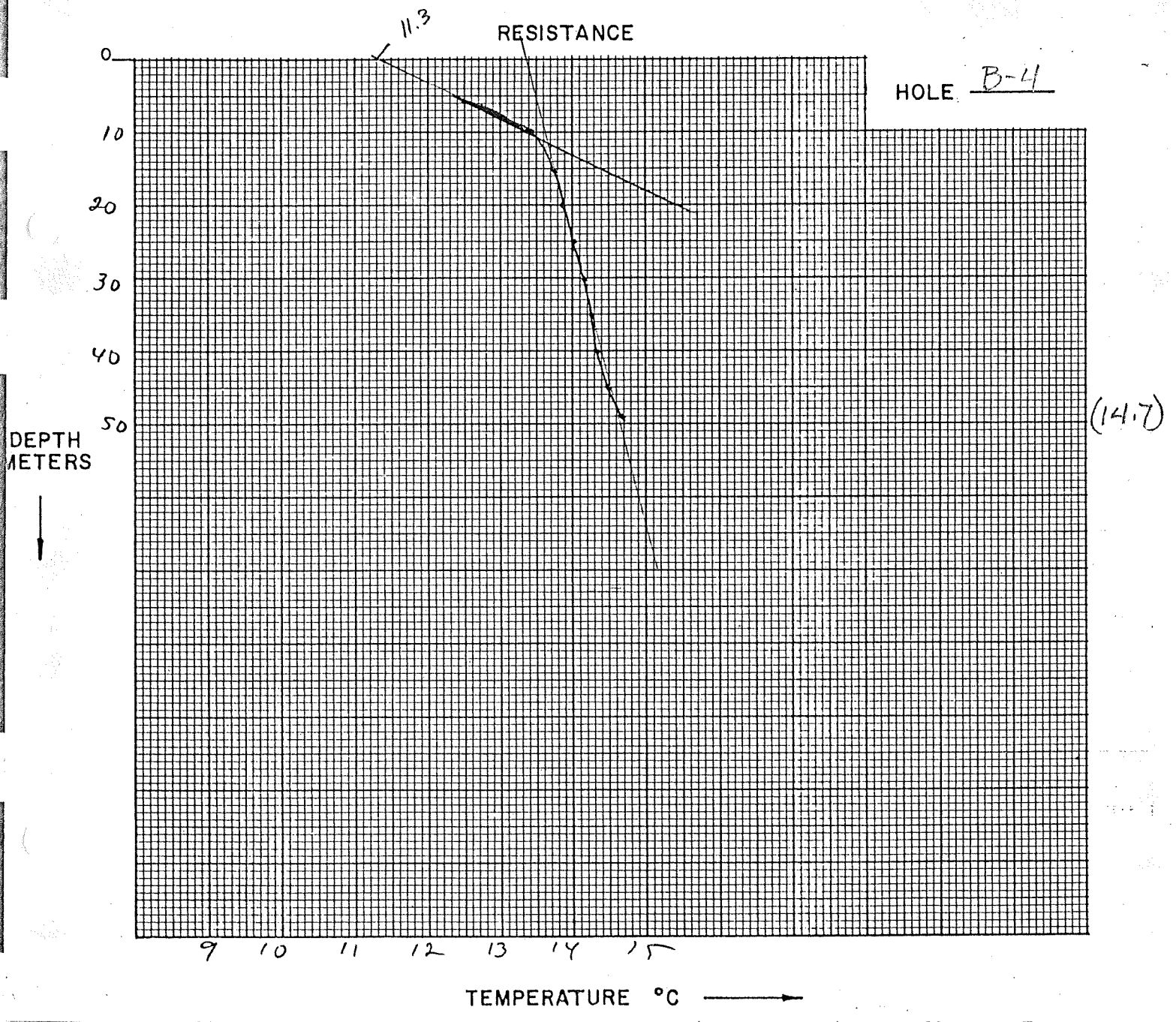
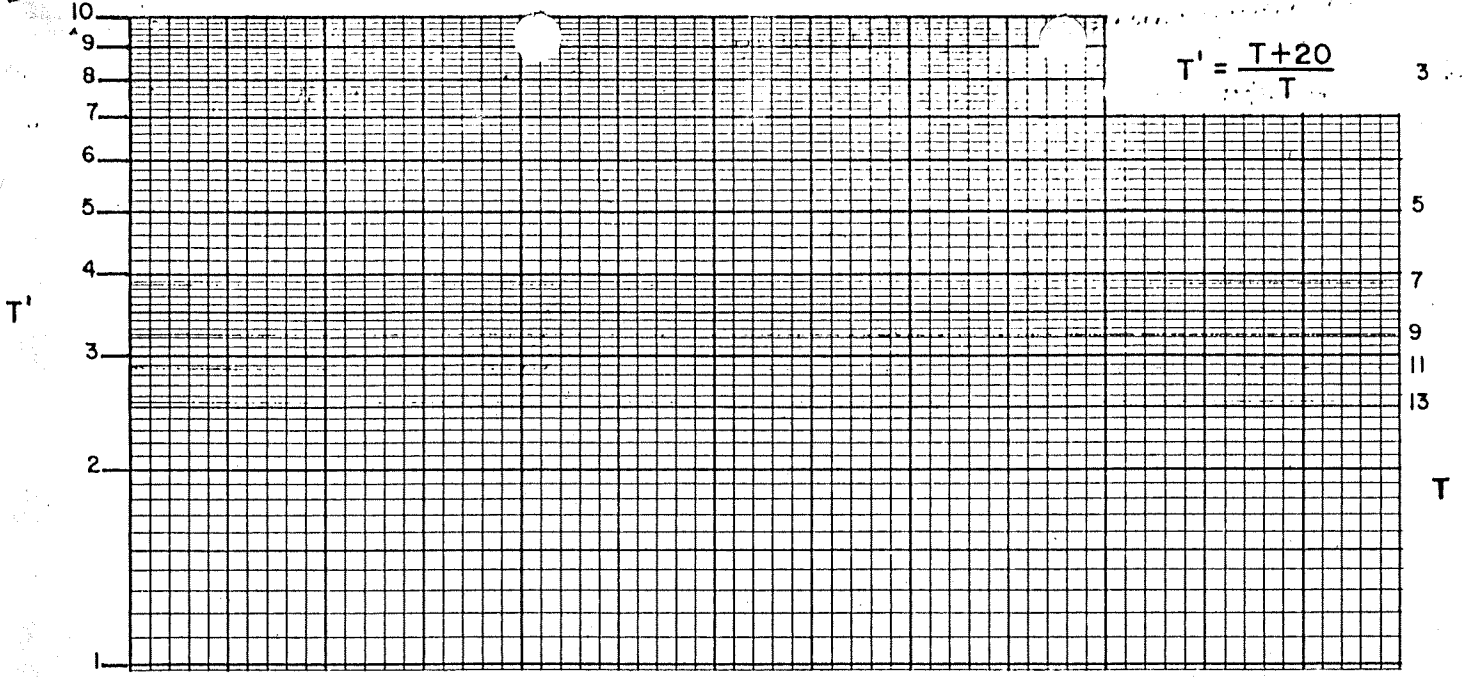
Comments 2ND TRIAL

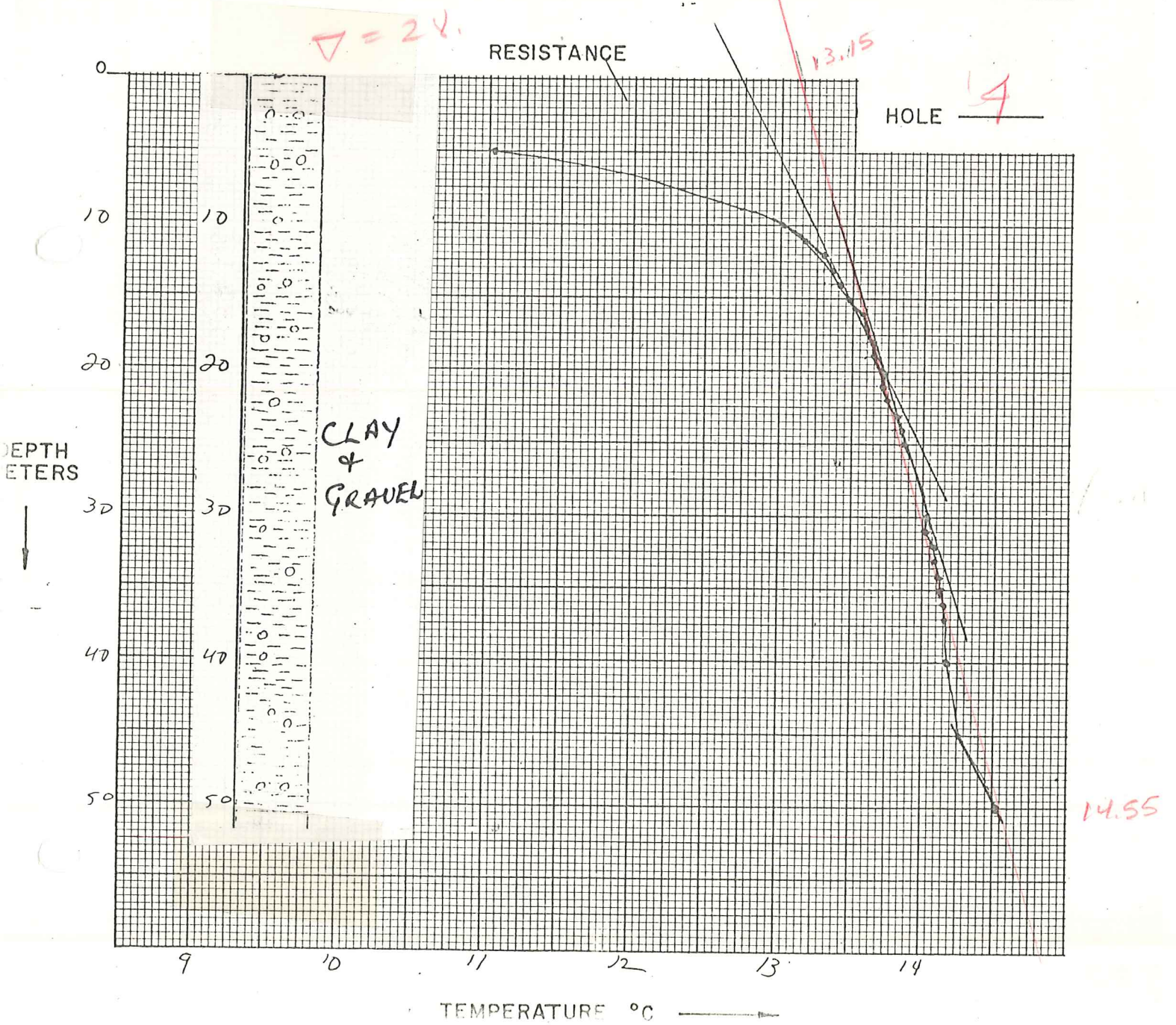
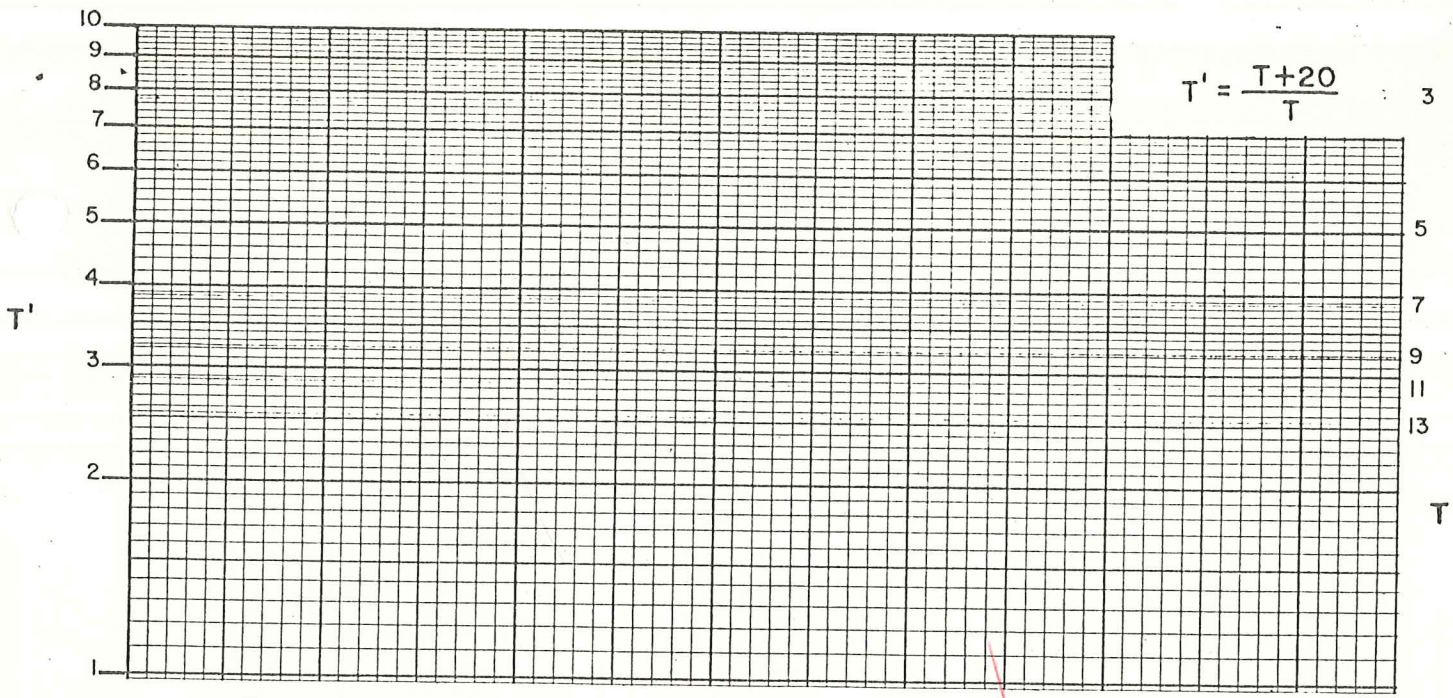
Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
1	5.343	14.890			
2	5.316	15.010	0.020		
3	5.675	13.960	-1.110		
4	5.925	12.330	-1.570		
5	6.020	11.940	-0.390		
6	5.885	12.495	0.555		
7	5.755	12.960	0.465		
8	5.745	13.090	0.130		
9	5.719	13.200	0.110		
10	5.680	13.370	0.170		AVE
11	5.650	13.500	0.130		10-119 M
12	5.633	13.575	0.075		34.0 °C/Km
13	5.620	13.670	0.055		
14	5.613	13.665	0.035		
15	5.596	13.740	0.075		
16	5.595	13.745	0.005		
17	5.585	13.785	0.040		
18	5.582	13.800	0.015		
19	5.576	13.825	0.025		
20	5.570	13.855	0.030		
21	5.568	13.860	0.005		
			0.020		

TEMPERATURE - DEPTH LOG

Location _____ Date _____
 Map _____
 Property _____ T _____ R _____ sec _____
 Drill Hole 4 Date Drilled _____ Elevation _____ ft.
 Instrument _____ Operator _____
 Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
22	5.564	13.880				
23	5.552	13.935	0.055			
24	5.545	13.965	0.030			
25	5.535	14.010	0.045			
26	5.529	14.035	0.025			
27	5.524	14.060	0.025			
28	5.517	14.090	0.030			
29	5.508	14.130	0.040			
30	5.504	14.150	0.020			
31	5.496	14.185	0.035			
32	5.489	14.215	0.030			
33	5.484	14.240	0.025			
34	5.481	14.255	0.015			
35	5.475	14.280	0.025			
36	5.473	14.290	0.010			
37	5.468	14.310	0.020			
38	5.466	14.320	0.010			
39	5.463	14.335	0.015			
40	5.461	14.345	0.010			
41	5.460	14.350	0.005			
42	5.456	14.365	0.015			
			0.020			

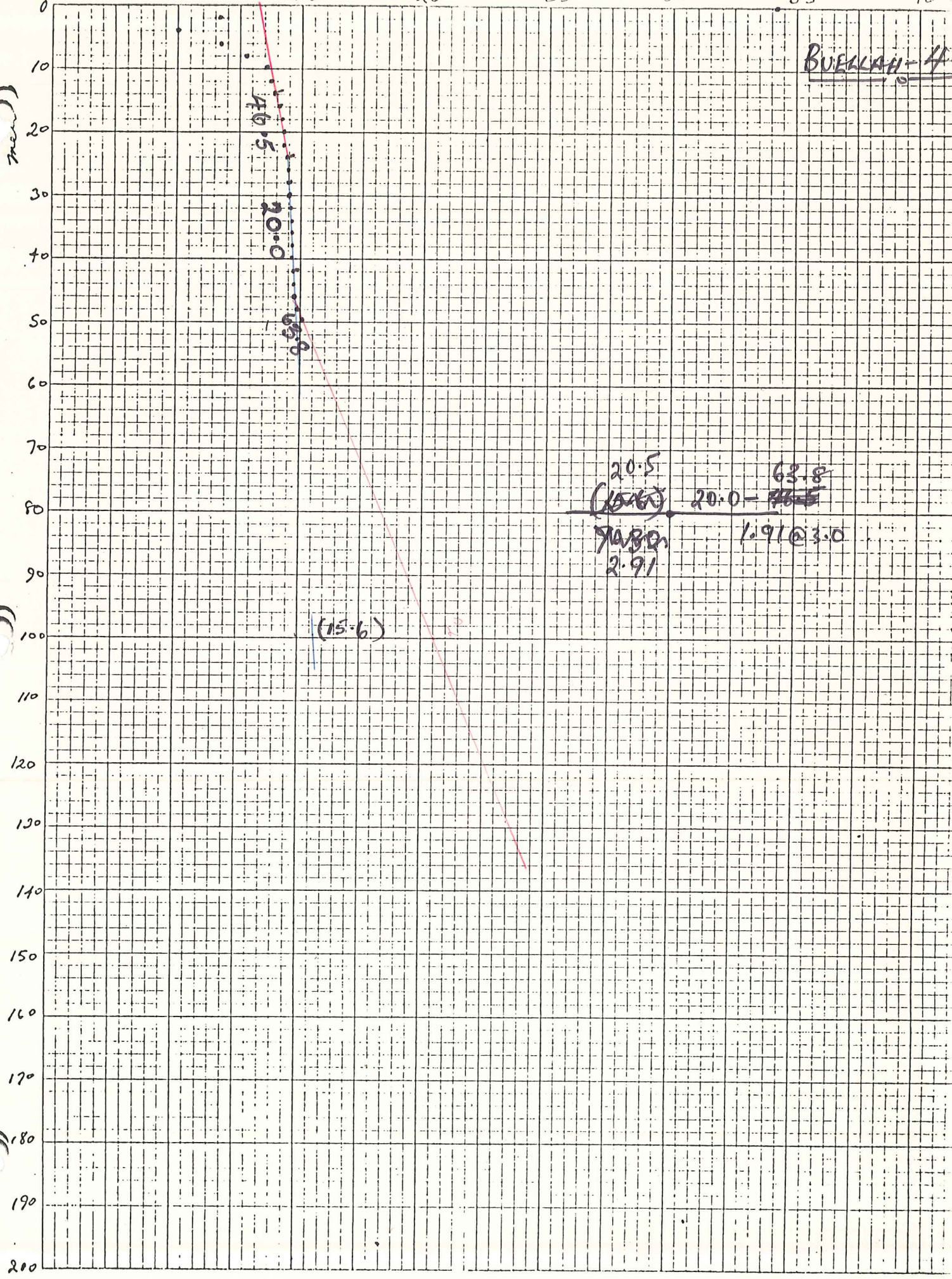




BUELLAH-4

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U.S. GEOLOGICAL SURVEY
KEUFFEL & ESSLER CO. WASHINGTON, D.C.



TEMPERATURE - DEPTH LOG

Location Bentah Oregon Date June 11, 1975

Map Bentah

Property T 18S R 37E sec 5 sub 4 18 15

Drill Hole B-5 Date Drilled May 31, 1975 Elevation 4970 ft.

Instrument _____ Operator D Pilkington

Comments logged @ 1515 hrs. Filled with H₂O with 1/6!

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
0	2.589	34.180				
1	5.150	15.810	-18.370			
2	6.434	10.320	-5.490			
3	6.885	8.690	-1.630			
4	6.815	8.935	0.245			
5	6.650	9.525	0.590			
6	6.450	10.260	0.735			
7	6.315	10.775	0.515			
8	6.239	11.070	0.295			
9	6.207	11.195	0.125			
10	6.200	11.220	0.025			
11	6.197	11.235	0.015			
12	6.198	11.230	-0.005			
13	6.197	11.235	0.005			
14	6.195	11.240	0.005			
15	6.192	11.255	0.015			
16	6.186	11.270	0.015			
17	6.177	11.310	0.040			
18	6.163	11.365	0.055			
19	6.151	11.415	0.050			
20	6.143	11.445	0.030			
			0.030			

TEMPERATURE - DEPTH LOG

Location _____ Date _____

Map _____

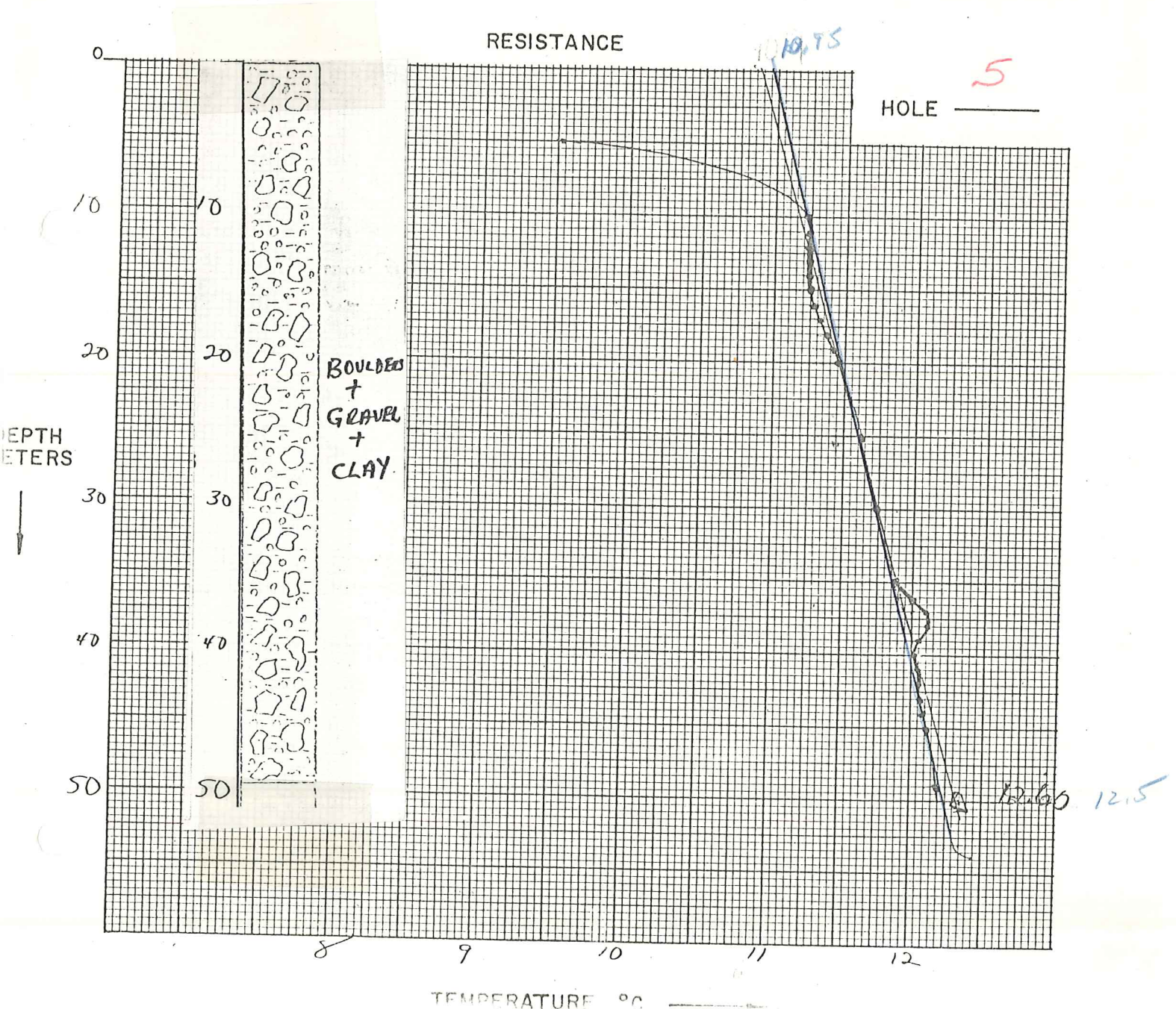
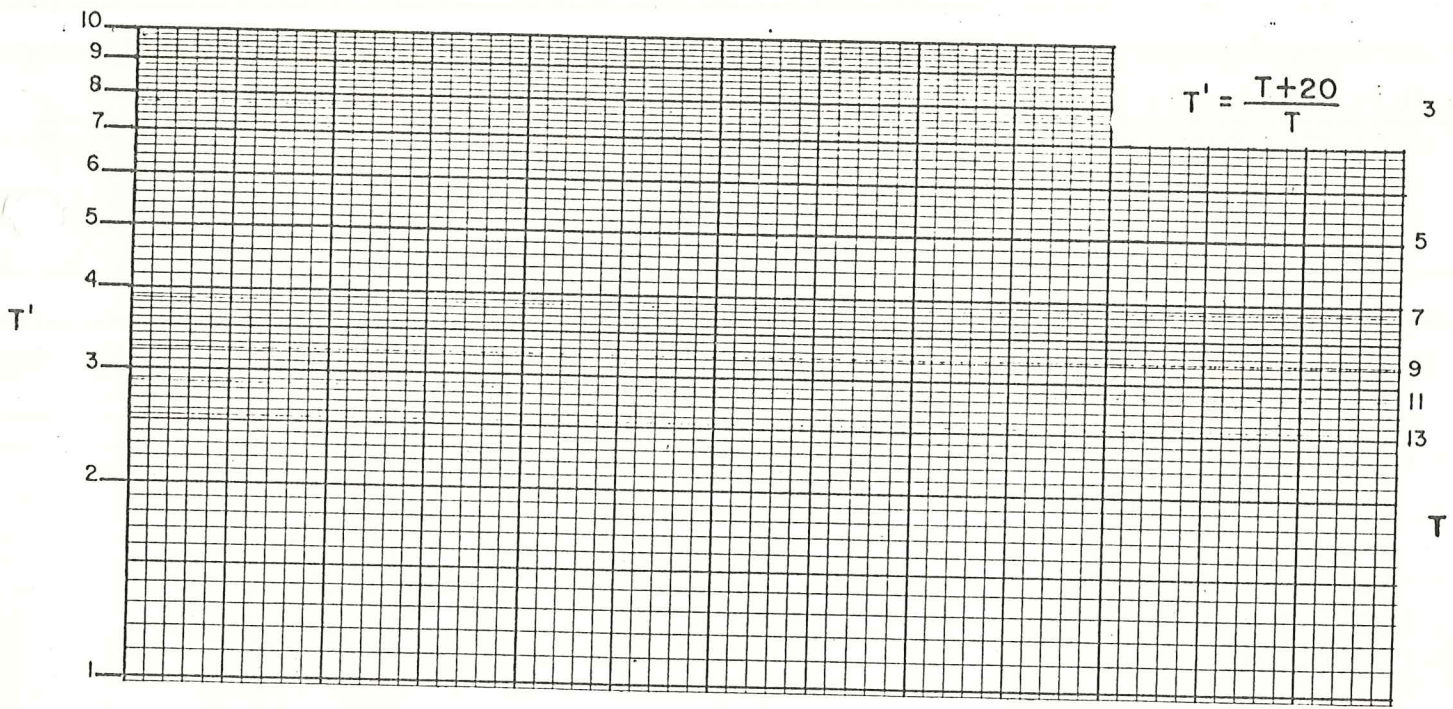
Property _____ T _____ R _____ sec _____

Drill Hole _____ Date Drilled _____ Elevation _____ ft.

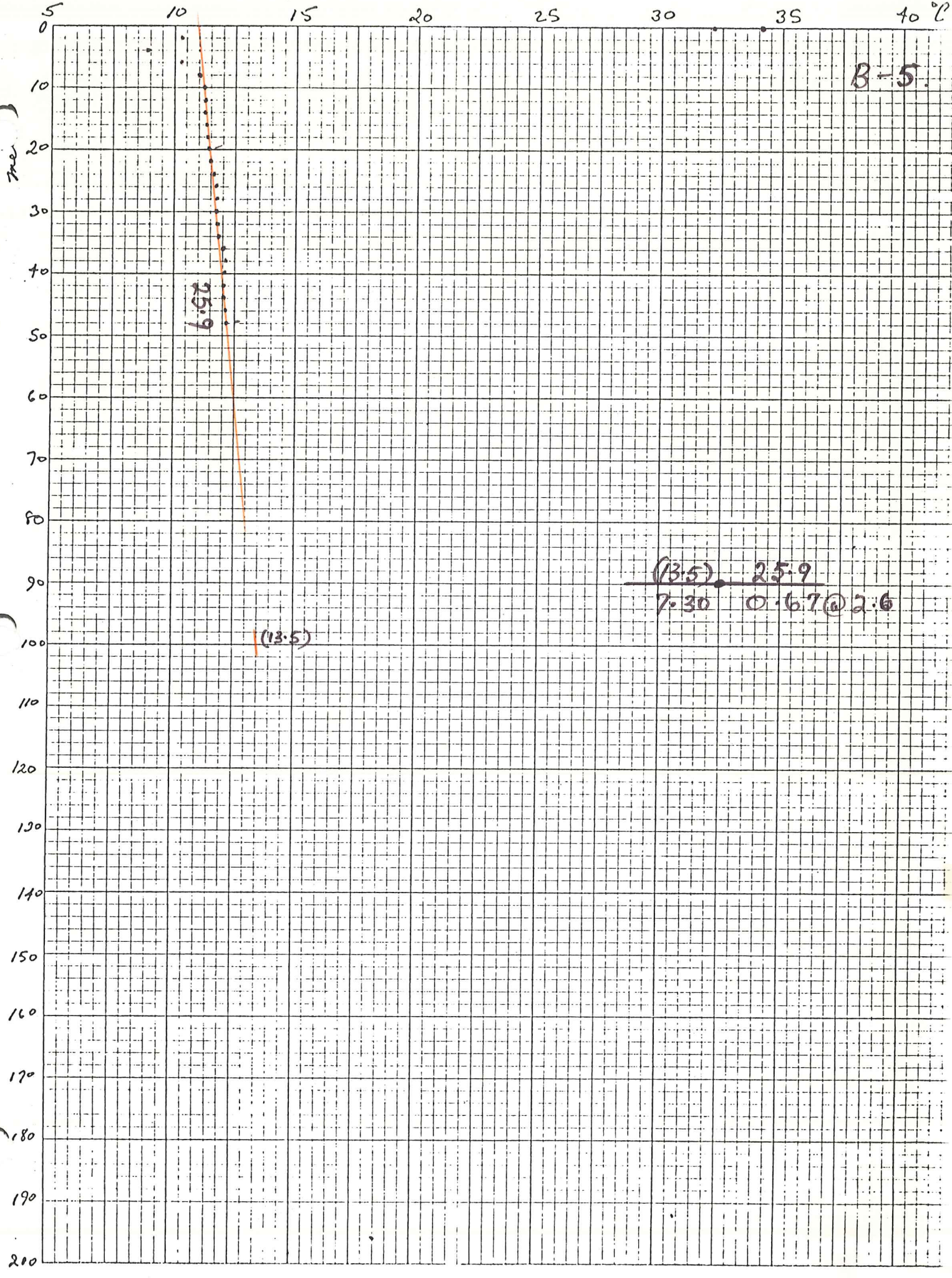
Instrument _____ Operator _____

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
21	6.136	11.475			
22	6.129	11.500	0.025		
23	6.120	11.540	0.040		
24	6.113	11.565	0.025		
25	6.100	11.620	0.055		
26	6.089	11.660	0.040		
27	6.084	11.680	0.020		
28	6.084	11.680	0.000		
29	6.080	11.700	0.020		
30	6.074	11.725	0.025		
31	6.068	11.745	0.020		
32	6.063	11.765	0.020		
33	6.057	11.790	0.025		
34	6.050	11.820	0.030		
35	6.038	11.865	0.045		
36	6.005	12.000	0.135		Hot water zone
37	5.978	12.110	0.110		Hot water zone
38	5.980	12.105	-0.005		Cold water layer
			-0.050		
39	5.992	12.055			" " "
			-0.020		
40	5.997	12.035			" " "
			0.010		
41	5.995	12.045			
			0.000		



B-5



47 0780

MAXIMUM THERMISTOR KEUFFEL & ESSLER CO. MADE IN USA

TEMPERATURE DEPTH LOG

ΔT Well No. 6

Property-Project BEULAH Depth Logged _____

Map _____ Scale _____ Date: Drilled _____ Logged _____

State _____ County _____ Section _____ T _____ R _____

Instrument _____ Operator _____ Elevation _____ ft.

Comments _____

COMPUTER PROCESSING

RT JUSTIFY: Card A

Proj No		Well No		Date Logged			*												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
6	6	2							6	12	JE	75	CM						

* 19- Write F if Fahrenheit, 20- Write F if Feet

Site Description																				Operator		Editor																		
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
3	.	5	KM	WEST	OF	HORSE	FLAT	RES																																

Card B

Scale Unit		Map Size		Map Location ^Δ				N Lat		W Long		^Δ Measure from SW corner of map; except AMS sheets measure from bottom center degree mark (W,-) (E,+) Use decimals																										
in	cm	(7,5,15,60)		Degree	Min	Degree	Min	Degree	Min																													
21	22	23	24	25	26	27	28	29	30	31	32		33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50								
CM					15	.		44	.	00					118	.					15	.																

Northing					Easting					Elev					Write M if meters Use decimals																								
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65		66	67	68	69	70	71	72	73	74	75	76	77	78	79	80									
									2	.	1									1	.	9																	

	SEGMENT DEPTH		K	ΔK																																			
	Start	End																																					
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50										
C	10	.	0		50	.	0																																
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G																																							

Continue each card below.

	SEGMENT DEPTH		K	ΔK																																			
	Start	End																																					
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80										
C	.	9	9	9																																			
D																																							
E																																							
F																																							
G																																							

Final Segment: Start = .999

TEMPERATURE - DEPTH LOG

Location Bearah Date June 12, 1975

Map _____

Property T 18 S R 36 E sec NE 1/4 13

Drill Hole B-6 Date Drilled June 5, 1975 Elevation 4080 ft.

Instrument _____ Operator D. Pilkington

Comments logged at 1030 hrs. Filled w/ H₂O

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
0	3330	27.180				
1	5085	16.130	-11.050			
2	6065	11.760	-4.370			
3	6532	9.955	-1.805			
4	6.415	10.395	0.440			
5	6.201	11.220	0.825			
6	6.025	11.920	0.700			
7	5.880	12.515	0.595			
8	5.810	12.810	0.305			
9	5.771	12.975	0.165			
10	5.752	13.060	0.085			
11	5.736	13.125	0.065			
12	5.719	13.200	0.075			
13	5.696	13.300	0.100			
14	5.677	13.385	0.085			
15	5.654	13.485	0.100			
16	5.640	13.545	0.060			
17	5.625	13.610	0.065			
18	5.600	13.720	0.110			
19	5.574	13.835	0.115			
20	5.552	13.935	0.100			
			0.090			

TEMPERATURE - DEPTH LOG

Location _____ Date _____

Map _____

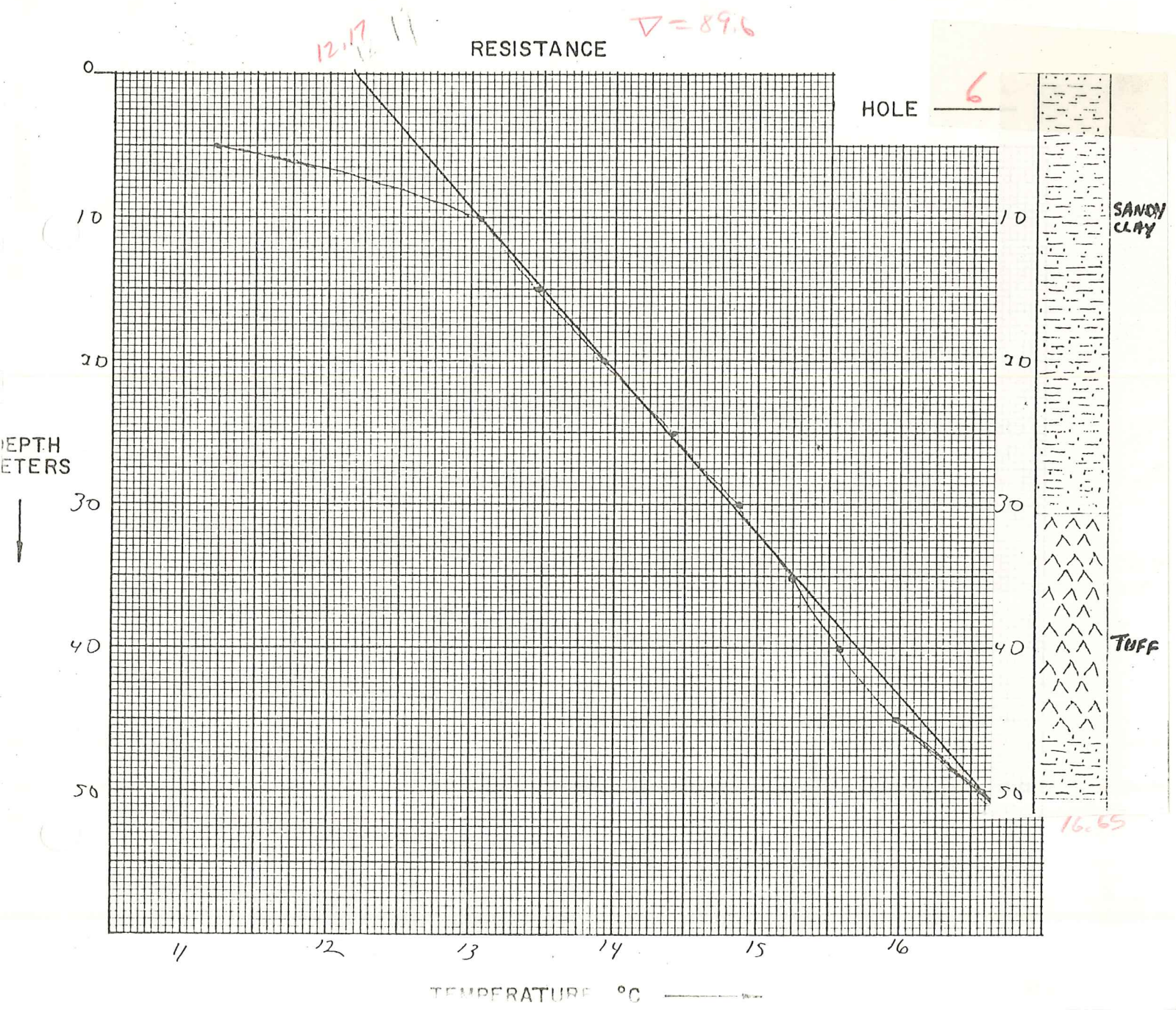
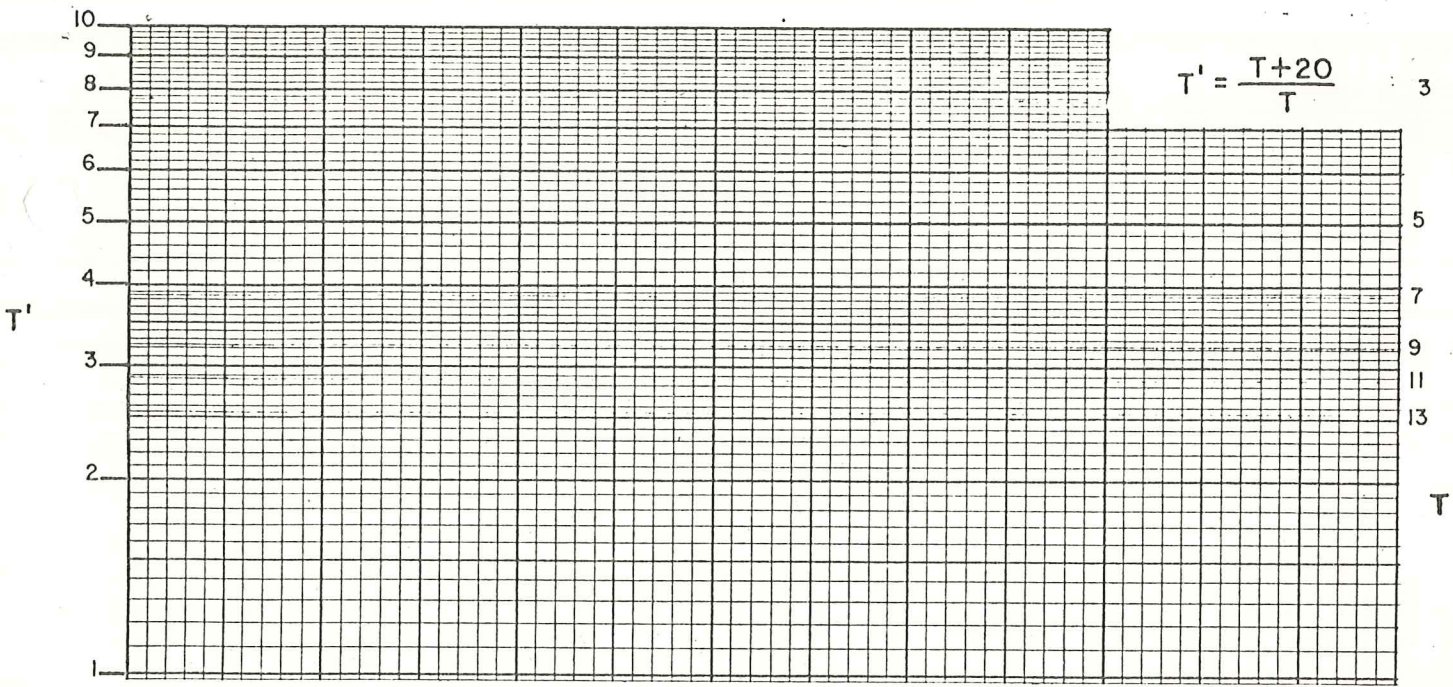
Property _____ T _____ R _____ sec _____

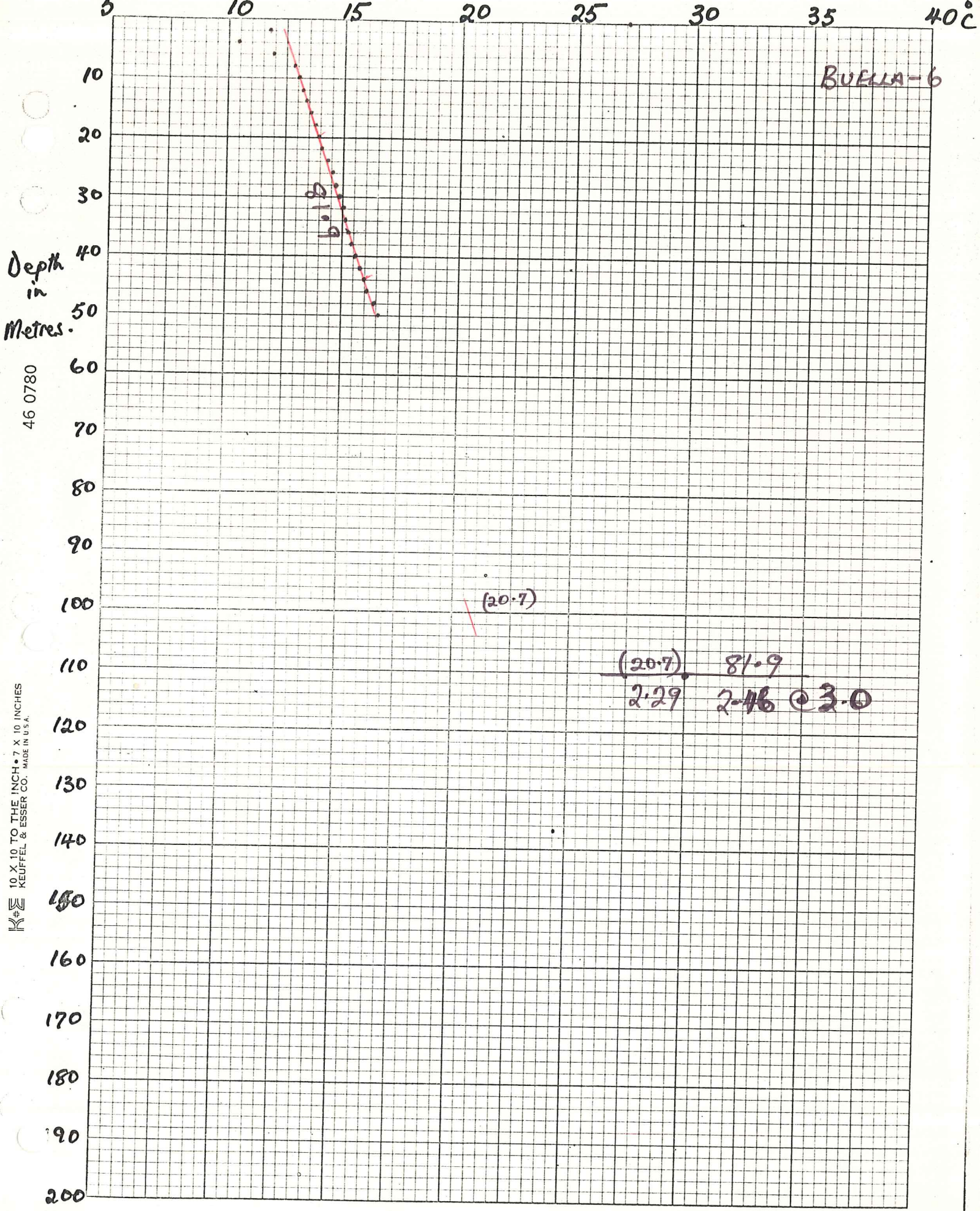
Drill Hole 6 Date Drilled _____ Elevation _____ ft.

Instrument _____ Operator _____

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
21	5.531	14.025				
22	5.510	14.120	0.095			
23	5.485	14.235	0.115			
24	5.464	14.330	0.095			
25	5.442	14.430	0.100			
26	5.422	14.520	0.090			
27	5.401	14.620	0.100			
28	5.383	14.700	0.080			
29	5.364	14.790	0.090			
30	5.346	14.875	0.085			
31	5.330	14.950	0.075			
32	5.311	15.040	0.090			
33	5.295	15.115	0.075			
34	5.278	15.195	0.080			
35	5.266	15.250	0.055			
36	5.254	15.310	0.060			
37	5.242	15.365	0.055			
38	5.230	15.420	0.055			
39	5.215	15.495	0.075			
40	5.199	15.570	0.075			
41	5.182	15.655	0.085			
			0.075			





TEMPERATURE - DEPTH LOG

Location Beulah Oregon Date June 12, 1975

Map Beulah Quadrangle

Property T 19 S R 37 E sec SE 1/4 29

Drill Hole B-7 Date Drilled June 6, 1975 Elevation 3850 ft.

Instrument _____ Operator D. Pilkington

Comments logged at 1215 hours. Filled with H₂O date drilled

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
0	4.950	16.805				
1	5.273	15.215	-1.590			
2	6.190	11.260	-3.955			
3	6.532	9.955	-1.305			
4	6.389	10.490	0.535			
5	6.170	11.340	0.850			
6	6.038	11.865	0.525			
7	5.989	12.065	0.200			
8	5.969	12.150	0.085			
9	5.933	12.295	0.145			
10	5.930	12.310	0.015			
11	5.927	12.320	0.010			
12	5.921	12.345	0.025			
13	5.912	12.385	0.040			
14	5.904	12.420	0.035			
15	5.895	12.455	0.035			
16	5.885	12.495	0.040			
17	5.870	12.560	0.065			
18	5.857	12.615	0.055			
19	5.847	12.655	0.040			
20	5.838	12.695	0.040			
			0.035			

TEMPERATURE - DEPTH LOG

Location _____ Date _____

Map _____

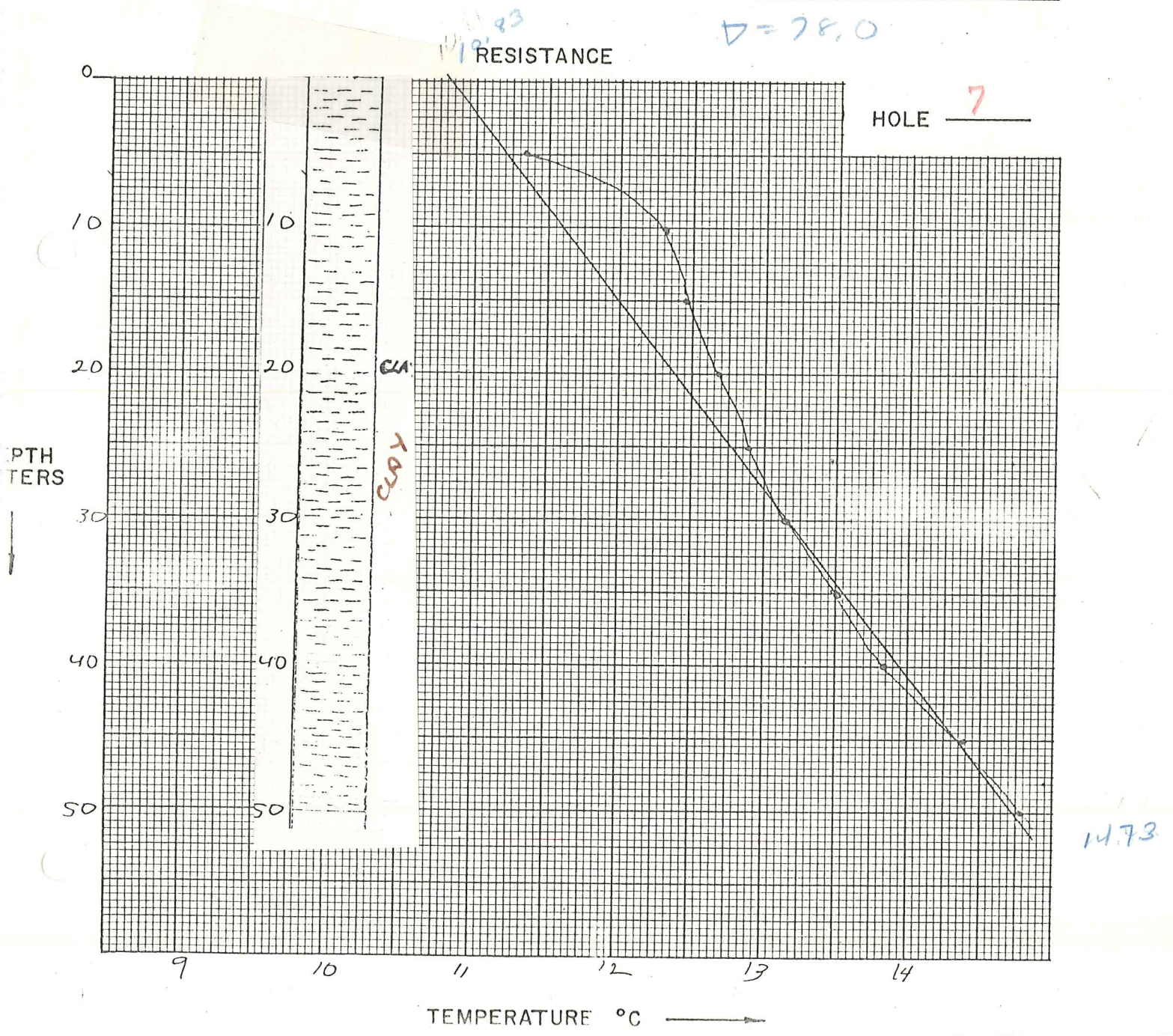
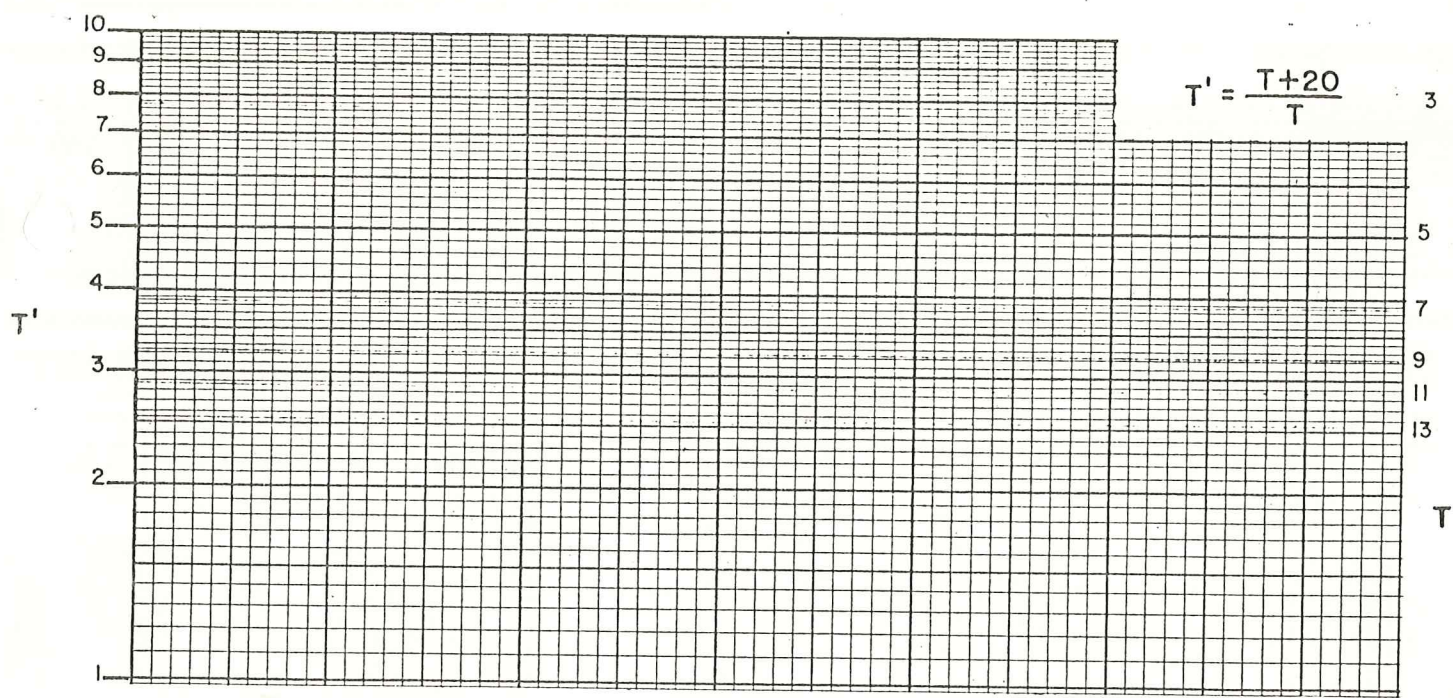
Property _____ T _____ R _____ sec _____

Drill Hole 7 Date Drilled _____ Elevation _____ ft.

Instrument _____ Operator _____

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient		Comments
				°C/Km	Avg.	
21	5.829	12.730				
			0.045			
22	5.819	12.725				
			0.045			
23	5.808	12.820				
			0.035			
24	5.800	12.855				
			0.045			
25	5.789	12.900				
			0.040			
26	5.780	12.940				
			0.035			
27	5.772	12.975				
			0.055			
28	5.759	13.030				
			0.060			
29	5.745	13.090				
			0.065			
30	5.730	13.155				
			0.060			
31	5.710	13.215				
			0.045			
32	5.705	13.260				
			0.050			
33	5.687	13.340				
			0.095			
34	5.665	13.435				
			0.070			
35	5.649	13.505				
			0.055			
36	5.637	13.560				
			0.070			
37	5.621	13.630				
			0.075			
38	5.603	13.705				
			0.145			
39	5.593	13.750				
			0.080			
40	5.575	13.830				
			0.050			
41	5.564	13.880				
			0.065			



5 10 15 20 25 30 35 40°C

BOELLAH-7

Depth
in
Metres.

46 0780

10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

8.57

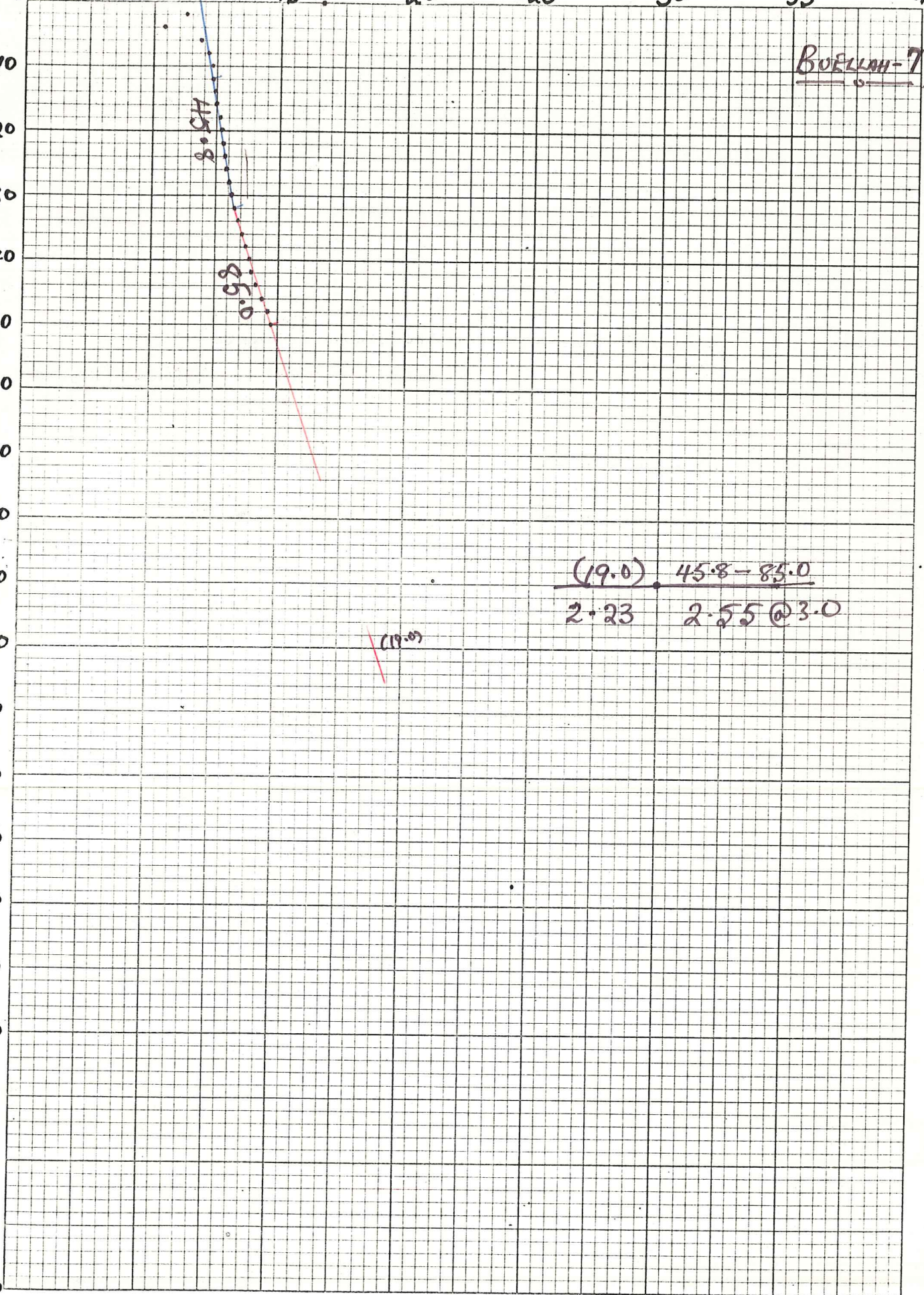
0.92

(19.0) 45.8 - 85.0

2.23 2.55 @ 3.0

(19.0)

10
20
30
40
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70
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100
110
120
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140
150
160
170
180
190
200



TEMPERATURE - DEPTH LOG

Location Beulah Oregon Date June 12, 1975

Map Beulah Quadrangle

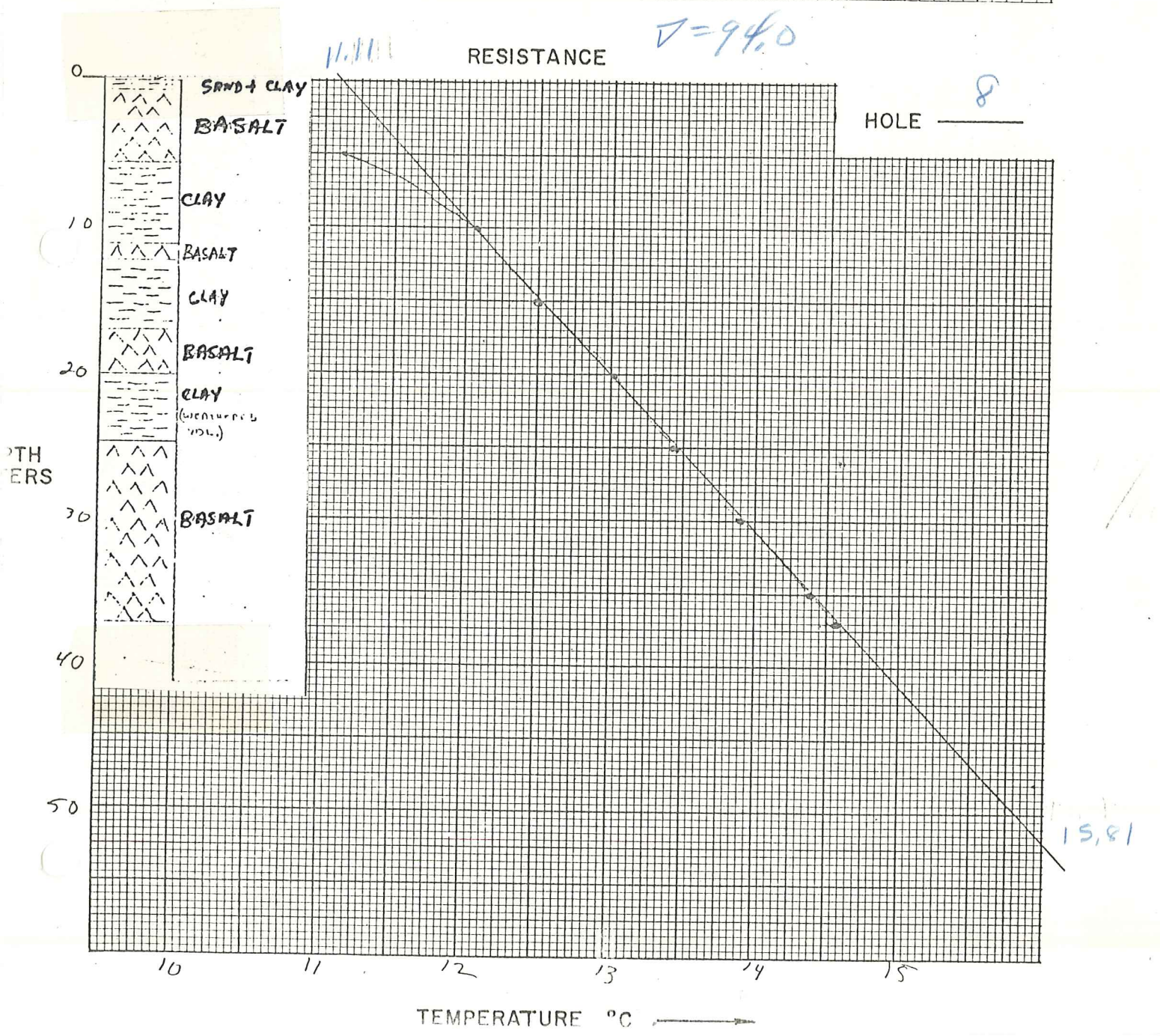
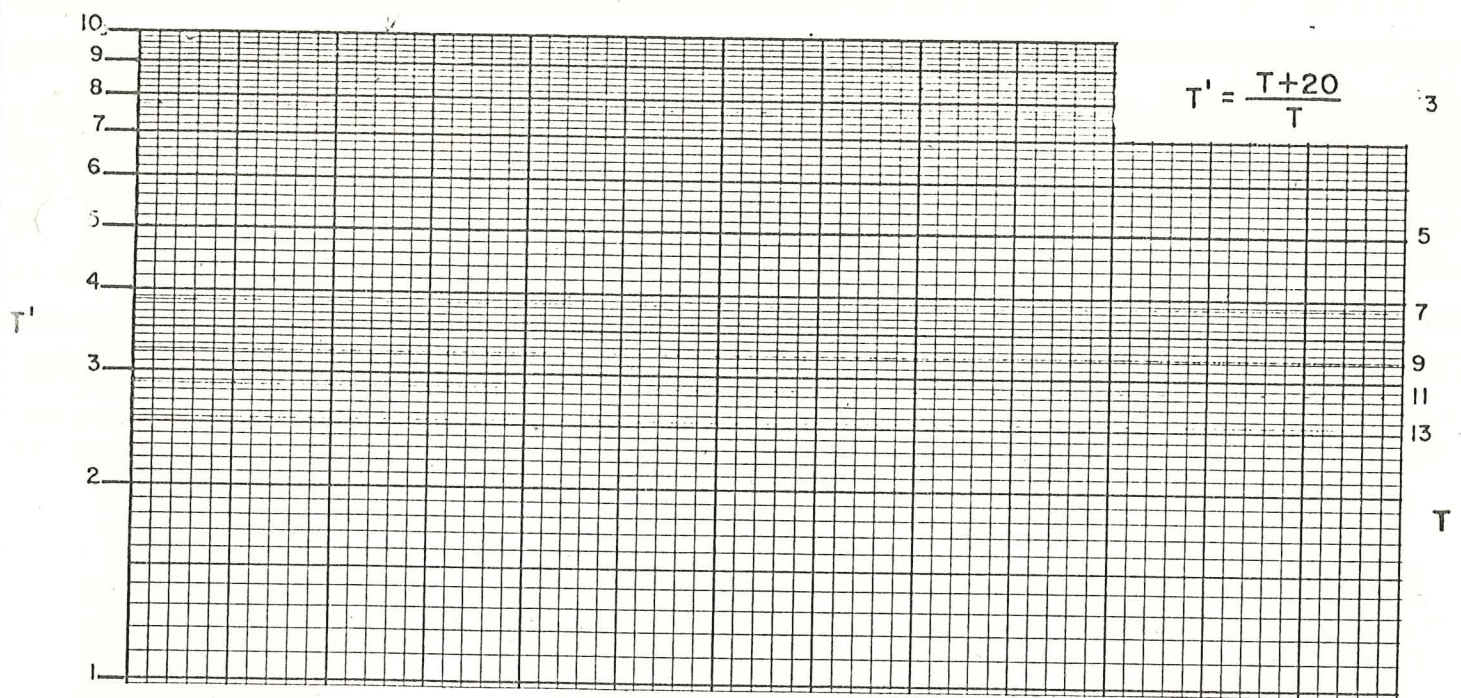
Property T 19S R R37E sec SW1/4 4

Drill Hole B-8 Date Drilled June 7, 1975 Elevation 3600 ft.

Instrument _____ Operator D Pilkington

Comments logged at 1330 hours Filled with H2O Feb 1975

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
0	4.340	20.170	-2.845		
1	4.850	17.325	-3.625		
2	5.835	12.700	-2.040		
3	6.345	10.660	0.445		
4	6.230	11.105	0.040		
5	6.219	11.145	0.175		
6	6.175	11.320	0.150		
7	6.137	11.470	0.265		
8	6.071	11.735	0.170		
9	6.029	11.905	0.160		
10	5.990	12.065	0.080		
11	5.970	12.145	0.090		
12	5.948	12.235	0.070		
13	5.931	12.305	0.105		
14	5.906	12.410	0.090		
15	5.884	12.500	0.040		
16	5.875	12.540	0.040		
17	5.865	12.580	0.055		
18	5.852	12.635	0.025		
19	5.846	12.660	0.350		
20	5.763	13.010	0.080		



5 10 15 20 25 30 35 40°C

BUELLAH-8

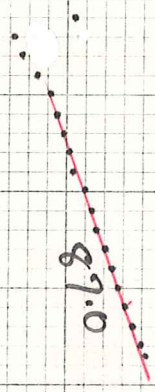
Depth
in
Metres.

46 0780

10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.



10
20
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120
130
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150
160
170
180
190
200



(20.2) 87.0
2.17 4.35 @ 5.0

(20.2)

TEMPERATURE DEPTH LOG

ΔT Well No. 9

Property-Project BEULAH Depth Logged _____
 Map _____ Scale _____ Date: Drilled _____ Logged _____
 State _____ County _____ Section _____ T _____ R _____
 Instrument _____ Operator _____ Elevation _____ ft.
 Comments _____

COMPUTER PROCESSING

RT JUSTIFY: **Card A**

Proj No		Well No		Date Logged			*												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
662				913			11/17/75	CM											

* 19- Write F if Fahrenheit, 20- Write F if Feet

Site Description																																																Operator				Editor			
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60																
11 KM SW OF BEULAH OREGON																																																DP				NLH			

Card B

Scale Unit		Map Size		Map Location ^Δ																									
in	cm	(7.5, 15., 60)		N Lat		W Long																							
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
CM		15.		43.		45.		118.				15.																	

Use decimals

^Δ Measure from SW corner of map; except AMS sheets measure from bottom center degree mark (W,-) (E,+)

Northing						Easting						Elev																	
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
15.5						0.3						384.0																	

Use decimals

Write M if meters

	SEGMENT DEPTH		K	ΔK
	Start	End		
C	13.0	29.0		
D	33.0	45.0	-3.0	.5
E	.999			
F				
G				

Continue each card below.

	SEGMENT DEPTH		K	ΔK
	Start	End		
C	29.0	33.0		
D	45.0	50.0		
E				
F				
G				

Final Segment: Start = .999

TEMPERATURE - DEPTH LOG

Location Bewlah, Oregon Date Nov 13, 1975

Map Bewlah Quadrangle

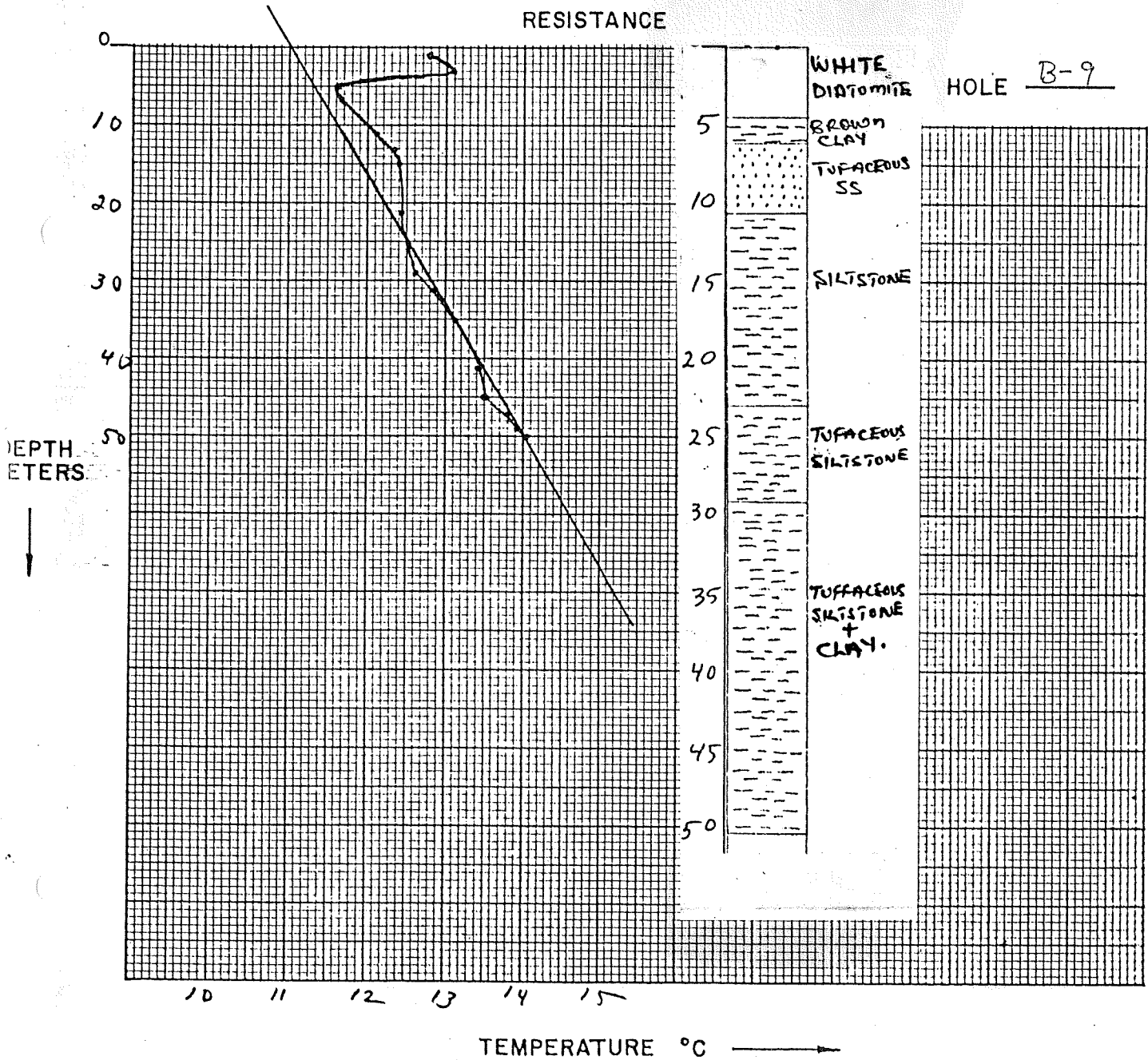
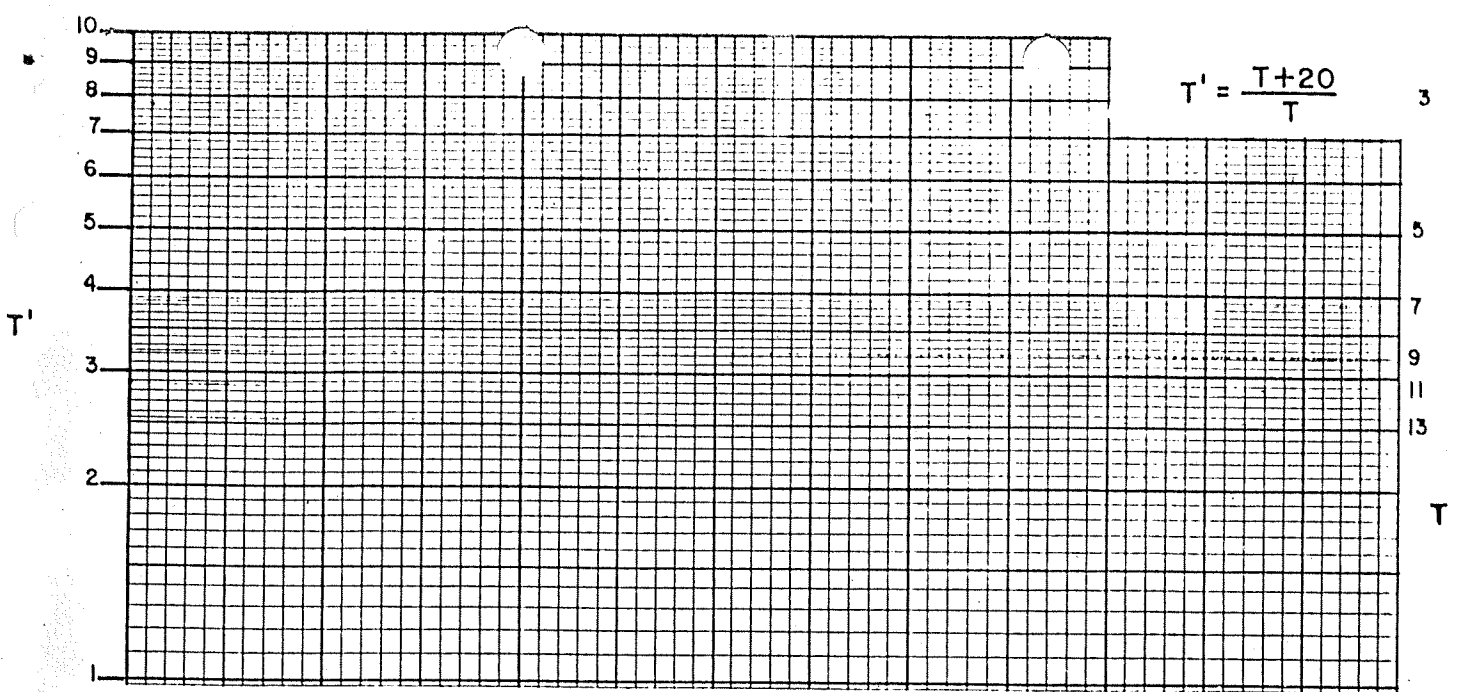
Property _____ T 20S R 30E sec SE $\frac{1}{4}$ SE $\frac{1}{4}$ 11

Drill Hole B-9 Date Drilled July 30, 1975 Elevation 3820 ft.

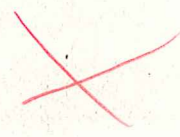
Instrument _____ Operator AD

Comments _____

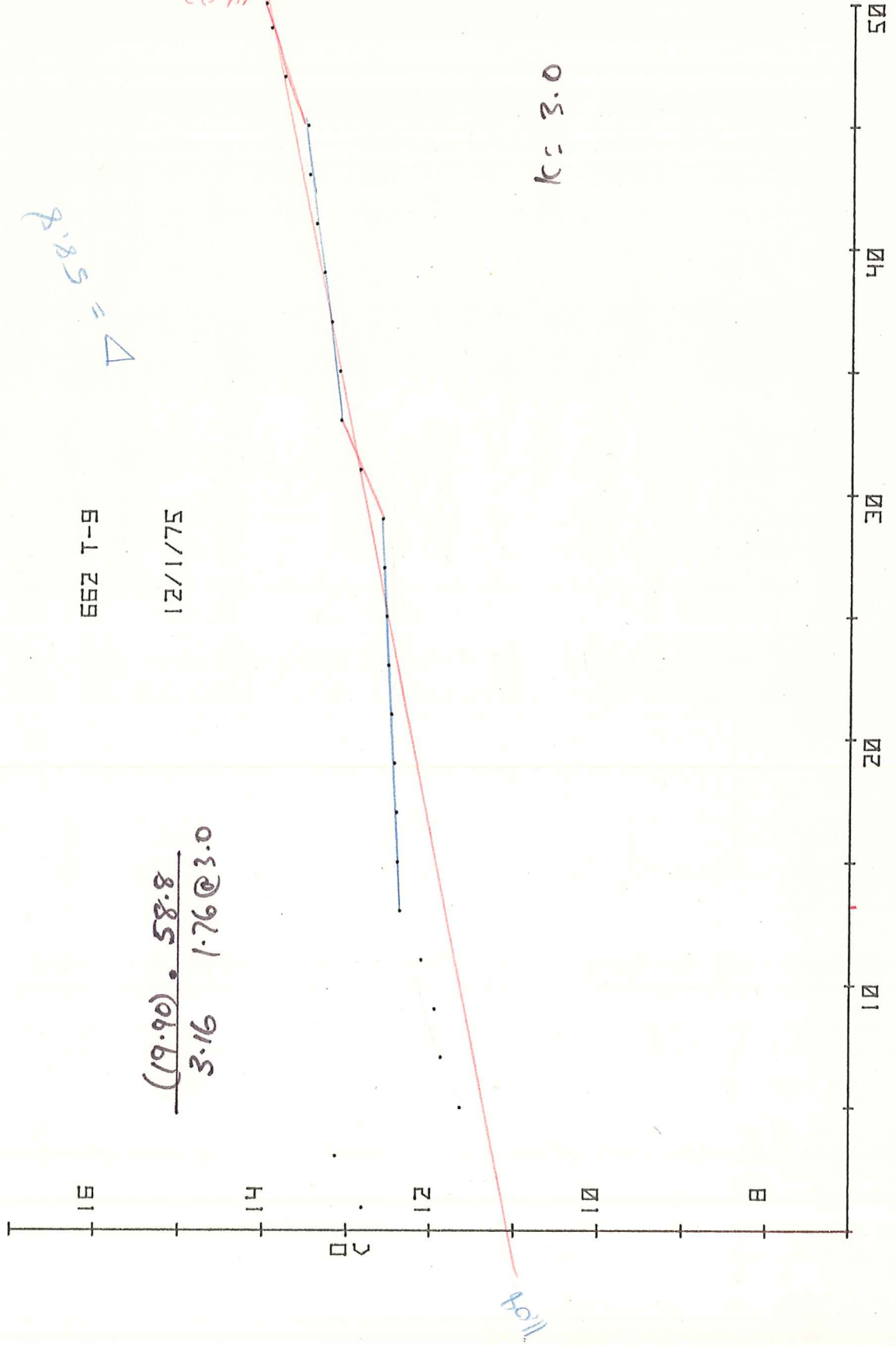
Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
1	5.809	12.815			
3	5.735	13.130	0.315	157.5	
5	6.092	11.650	-1.480	-74.0	
7	6.036	11.875	0.225	112.5	
9	6.016	11.955	0.080	40.0	
11	5.977	12.115	0.160	80.0	
13	5.916	12.365	0.250	125.0	
15	5.908	12.400	0.035	17.5	
17	5.904	12.415	0.015	7.5	
19	5.898	12.445	0.030	15.0	
21	5.888	12.485	0.040	20.0	Cold water flow (?)
23	5.880	12.520	0.035	17.5	
25	5.875	12.540	0.020	10.0	
27	5.866	12.575	0.035	17.5	
29	5.860	12.600	0.025	12.5	
31	5.798	12.860	0.260	130.0	
33	5.744	13.095	0.275	137.5	
35	5.737	13.125	0.030	15.0	
37	5.715	13.220	0.095	47.5	
39	5.692	13.315	0.095	47.5	
41	5.671	13.410	0.095	47.5	
			0.075	37.5	



TEMPERATURE VS DEPTH LOG FOR WELL-662 T-9
12/1/75



DEPTH METERS	TEMPERATURE DEGREES C	GRADIENT C/KM
1	12.815	157.5
3	13.13	-740
5	11.65	112.5
7	11.875	40
9	11.955	80
11	12.115	125
13	12.365	17.5
15	12.4	7.5
17	12.415	15
19	12.445	20
21	12.485	17.5
23	12.52	10
25	12.54	17.5
27	12.575	12.5
29	12.6	130
31	12.86	117.5
33	13.095	15
35	13.125	47.5
37	13.22	47.5
39	13.315	47.5
41	13.41	37.5
43	13.485	15
45	13.515	135
47	13.785	82.5
49	13.95	65
50	14.015	280.3



METERS

TEMPERATURE DEPTH LOG

ΔT Well No. 10

Property-Project BEULAH Depth Logged _____

Map _____ Scale _____ Date: Drilled _____ Logged _____

State _____ County _____ Section _____ T _____ R _____

Instrument _____ Operator _____ Elevation _____ ft.

Comments _____

COMPUTER PROCESSING

RT JUSTIFY: **Card A**

Proj No				Well No						Date Logged			*							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	*
6	6	2							10	09	SP			75	CM					

* 19- Write F if Fahrenheit, 20- Write F if Feet

Site Description																																																Operator						Editor					
2	KM	SOUTH	OF	COTTONWOOD	RES							JED																																															

Card B

Scale Unit		Map Size		Map Location ^Δ				N Lat				W Long			
in	cm	(7.5, 15., 60)	cm	Degree	Min	Degree	Min	Degree	Min	Degree	Min	Degree	Min	Degree	Min
0	M	15.		43.	45.	118.	30.								

Use decimals

Δ Measure from SW corner of map; except AMS sheets measure from bottom center degree mark (W,-) (E,+)

Northing						Easting						Elev						
																		F

Use decimals

Write M if meters

	SEGMENT DEPTH															
	Start				End				K				ΔK			
C	10.0				48.0				-3.0				-1.5			
D																
E																
F																
G																

Continue each card below.

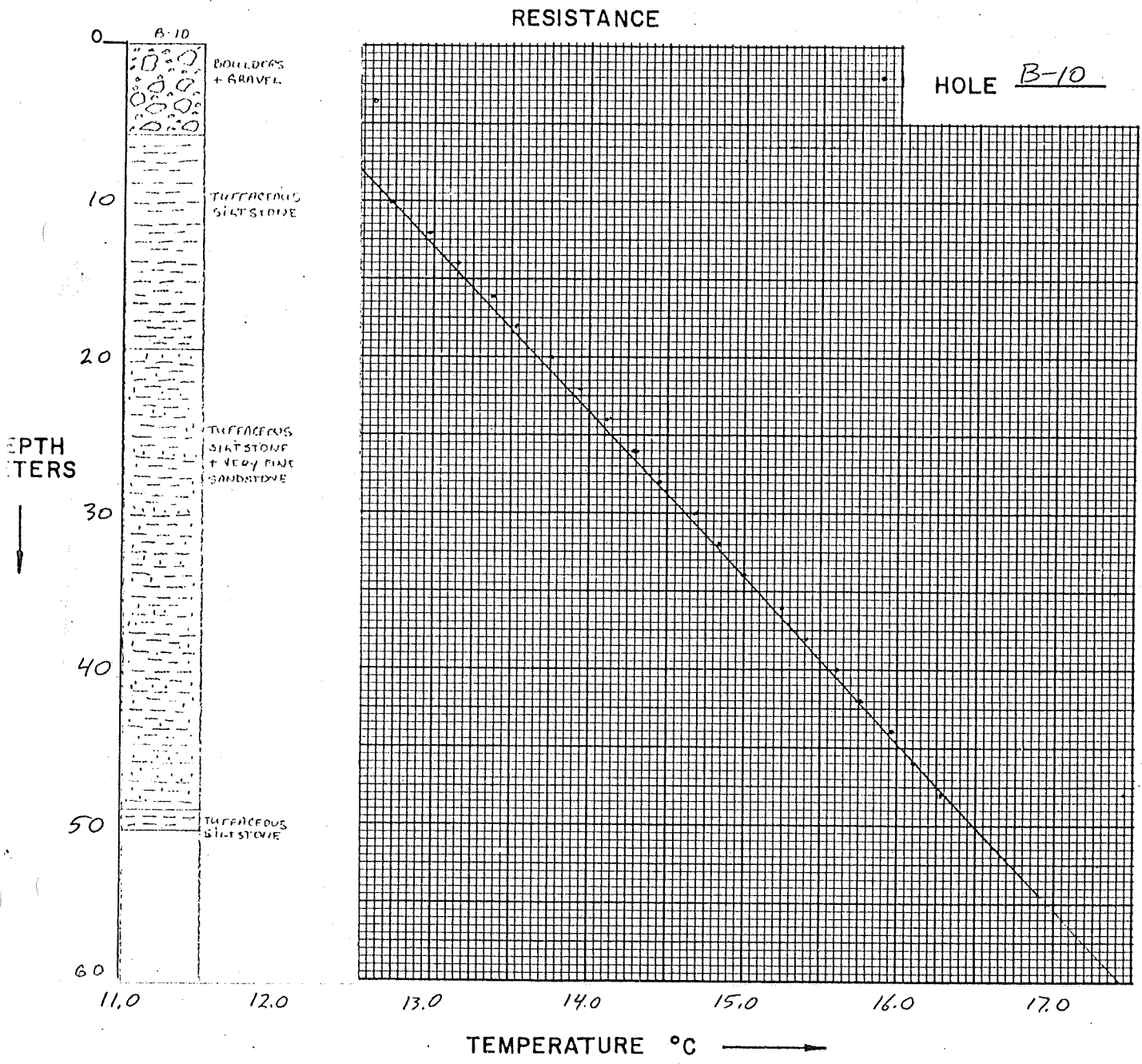
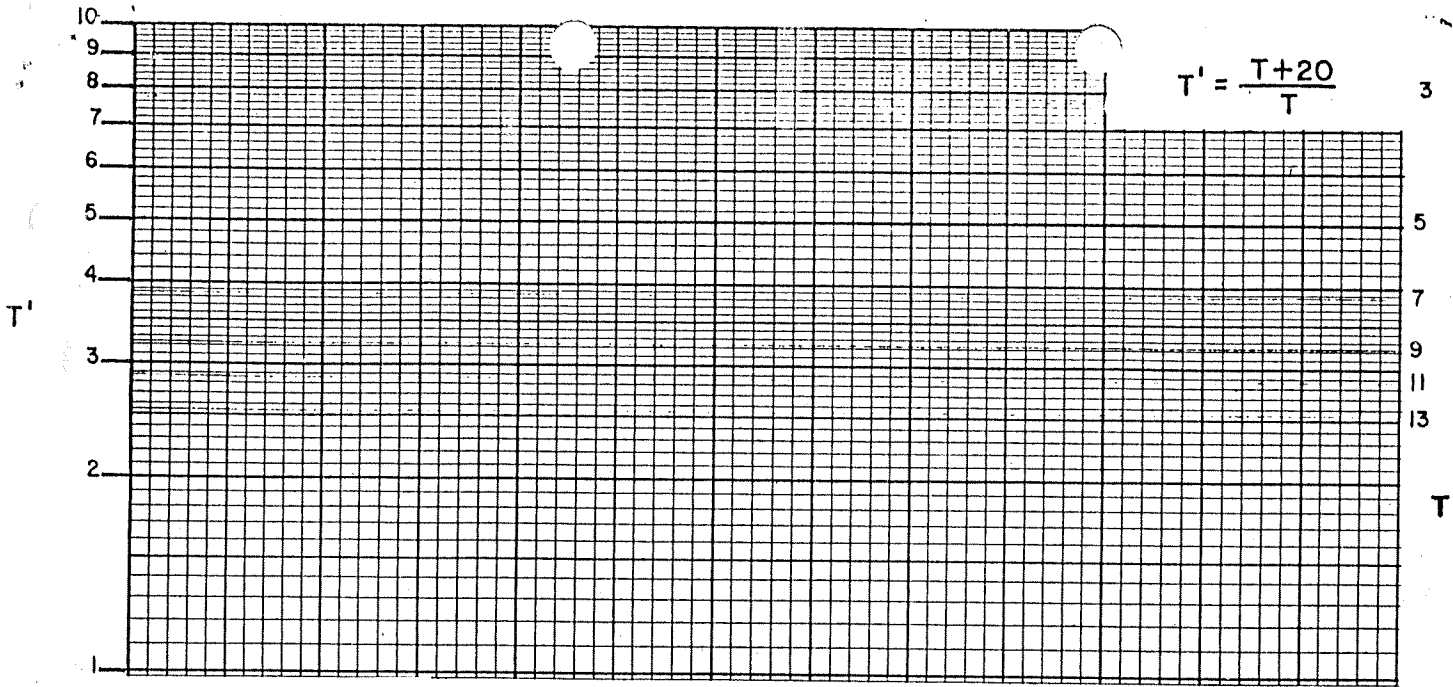
	SEGMENT DEPTH															
	Start				End				K				ΔK			
C	.999															
D																
E																
F																
G																

Final Segment: Start = .999

TEMPERATURE - DEPTH LOG

Location Beulah Date 9/10/75
 Map Drewsey Ore 15" Quad
 Property BLM T 195 R 36E sec 21
 Drill Hole B-10 Date Drilled _____ Elevation 3920 ft.
 Instrument _____ Operator JED
 Comments 3/4" PVC pipe 21 cm above ground

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
2	5136	15.875			
4	5857	12.615	-3.26	-1630.0	
6	6033	11.890	-0.725	-362.5	
8	5895	12.455	0.565	282.5	
10	5829	12.730	0.275	137.5 ←	
12	5773	12.970	0.240	120.0	AVE 10-48m
14	5733	13.140	0.170	85.0	93.3°C/Km
16	5680	13.370	0.230	115.0	
18	5646	13.520	0.150	75.0	
20	5591	13.760	0.240	120.0	
22	5553	13.930	0.170	85.0	
24	5513	14.110	0.180	90.0	
26	5473	14.290	0.180	90.0	
28	5436	14.460	0.170	85.0	
30	5386	14.690	0.230	115.0	
32	5354	14.835	0.145	72.5	
34	5316	15.015	0.180	90.0	
36	5268	15.240	0.225	112.5	
38	5231	15.415	0.175	87.5	
40	5189	15.620	0.205	102.5	
42	5160	15.760	0.140	70.0	



T'

$$T' = \frac{T+20}{T}$$

3

5

7

9

11

13

T

PROJECTED T TO 100M
RESISTANCE

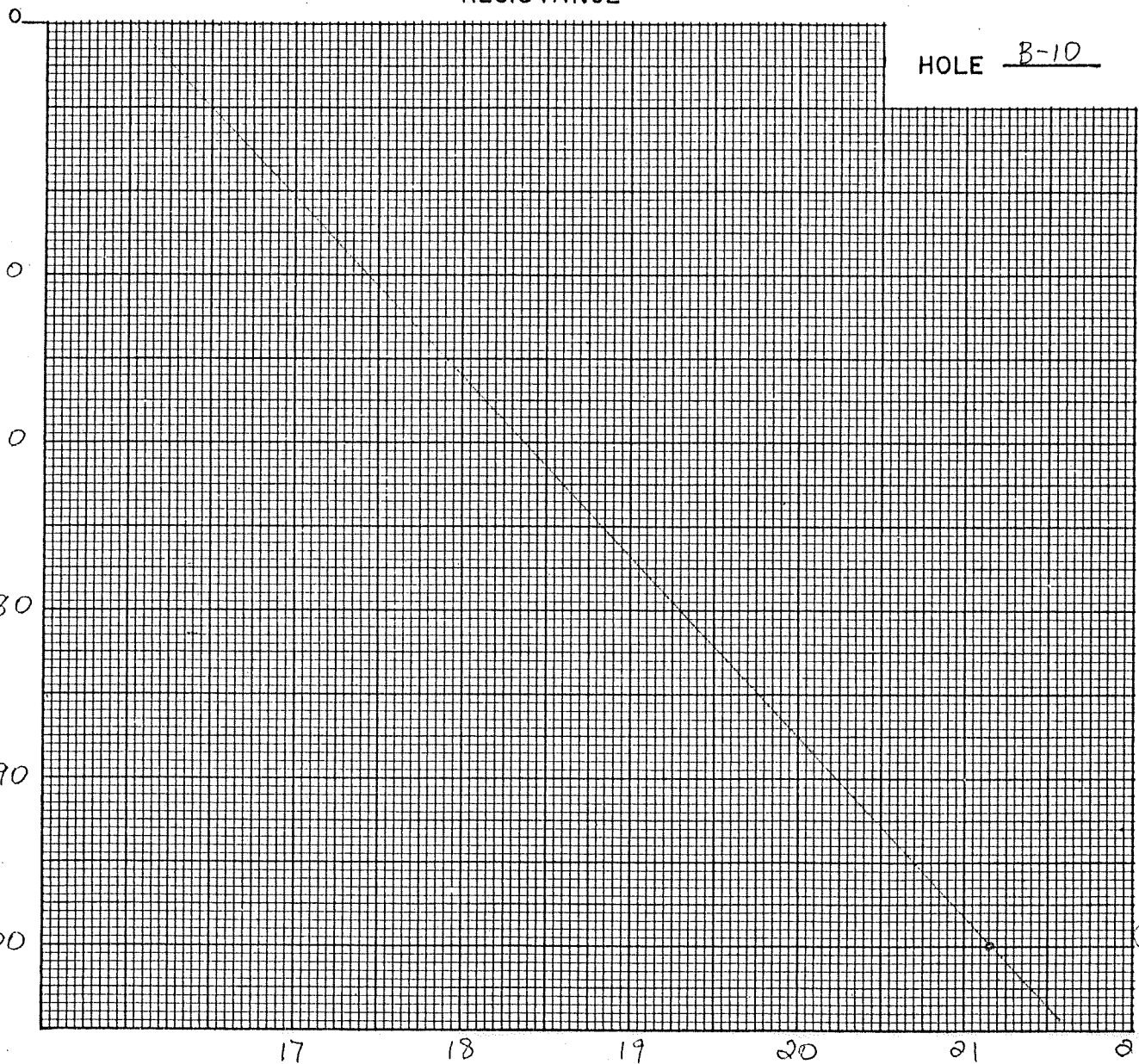
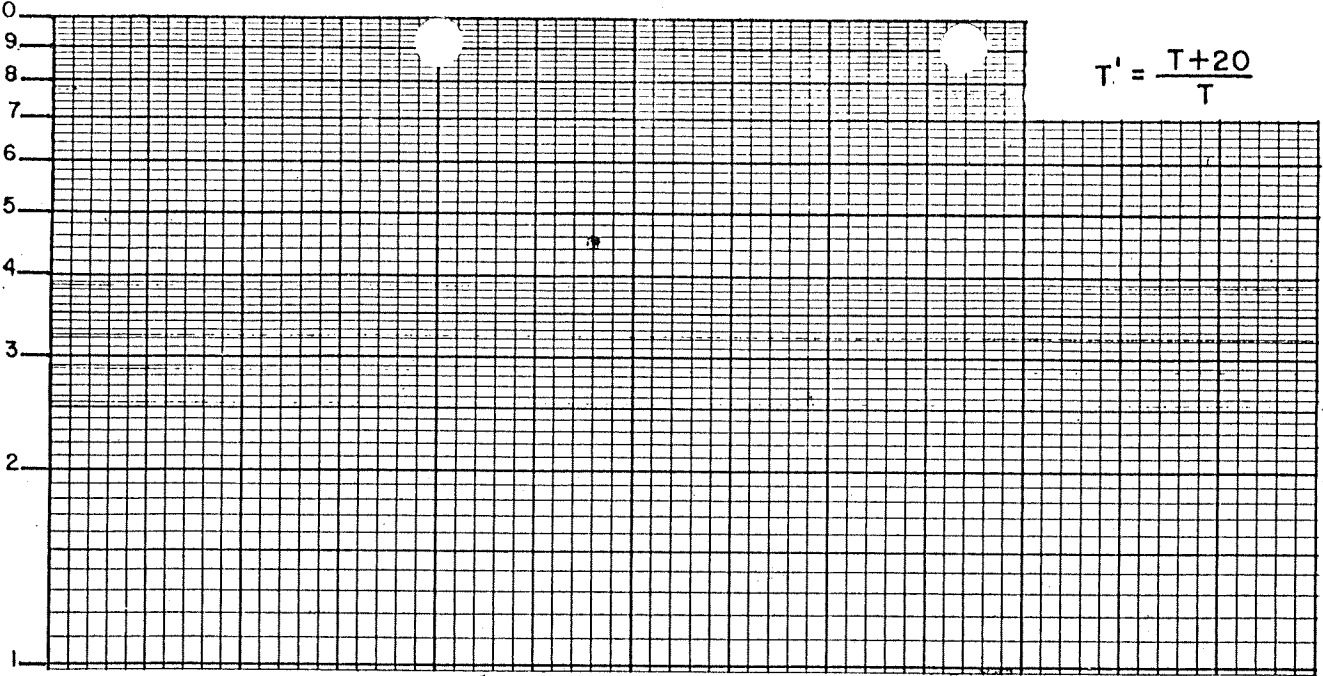
HOLE B-10

DEPTH
METERS



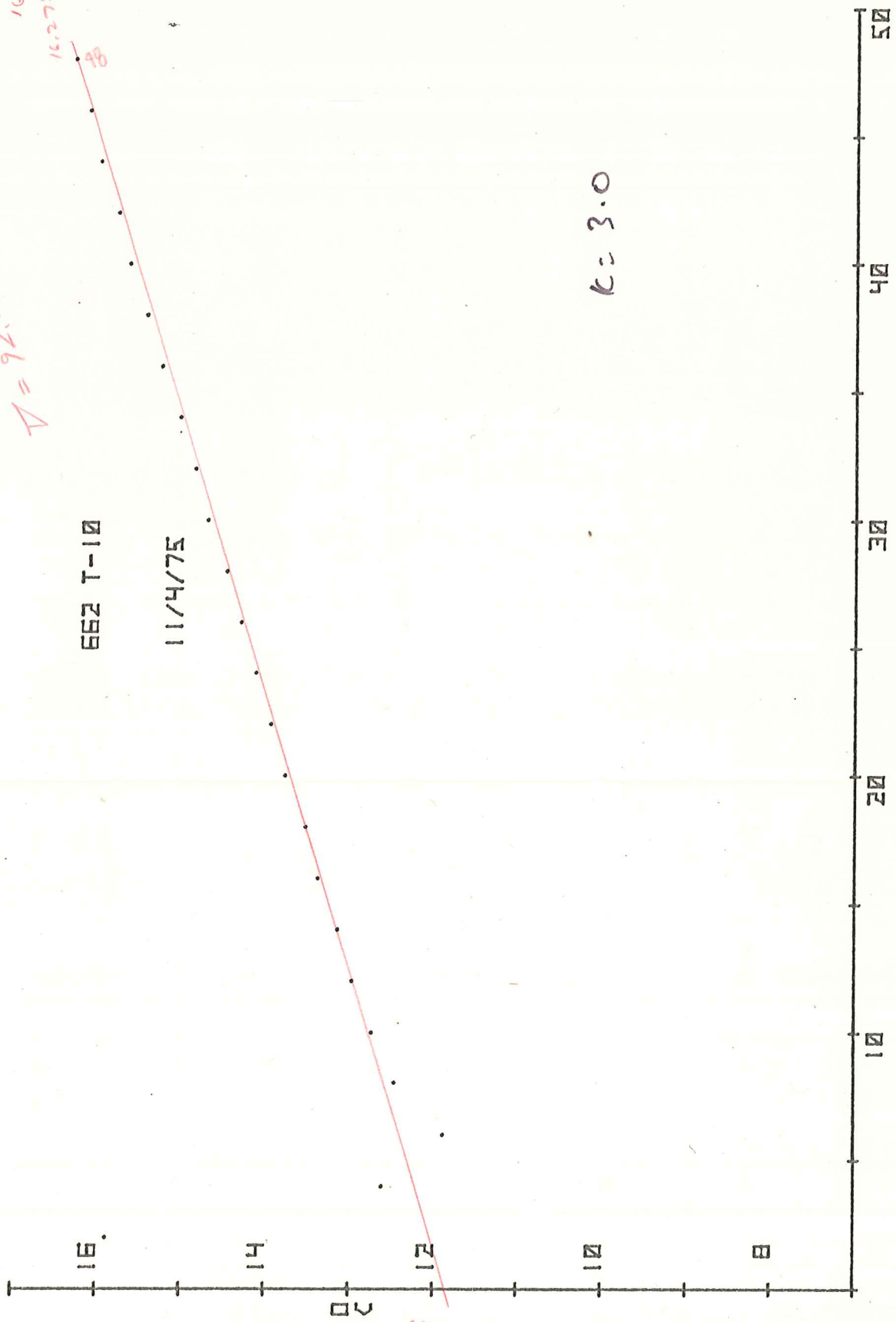
(21.15°C)
at 100m

TEMPERATURE °C →



TEMPERATURE VS DEPTH LOG FOR WELL-662 T-10
10/2/75

DEPTH METERS	TEMPERATURE DEGREES C	GRADIENT C/KM
2	15.875	-1630
4	12.615	-362.5
6	11.89	282.5
8	12.455	137.5
10	12.73	120
12	12.97	85
14	13.14	115
16	13.37	75
18	13.52	120
20	13.76	85
22	13.93	90
24	14.11	90
26	14.29	85
28	14.46	115
30	14.69	72.5
32	14.835	90
34	15.015	112.5
36	15.24	87.5
38	15.419	102.5
40	15.62	76
42	15.76	105
44	15.97	76
46	16.11	82.5
48	16.275	339.0625



$V = 92.2$

662 T-10

11/4/75

$k = 3.0$

16.46 @ 50m
16.275

METERS

TEMPERATURE DEPTH LOG

ΔT Well No. 11

Property-Project BEULAH Depth Logged _____

Map _____ Scale _____ Date: Drilled _____ Logged _____

State _____ County _____ Section _____ T _____ R _____

Instrument _____ Operator _____ Elevation _____ ft.

Comments _____

COMPUTER PROCESSING

RT JUSTIFY: Proj No Well No Date Logged

					DA		MO		YR		*								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
662					11		09		SEP		75	CM							

* 19- Write F if Fahrenheit, 20- Write F if Feet

Card A

Site Description																																													Operator					Editor				
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60															
4 KM NE OF COTTONWOOD RES																																													JED					GLN				

Scale Unit					Map Location ^Δ																																																																																																																																																
in					Map Size					N Lat					W Long																																																																																																																																						
cm					(7.5, 15., 60)					Degree					Degree																																																																																																																																						
21					22					23					24					25					26					27					28					29					30					31					32					33					34					35					36					37					38					39					40					41					42					43					44					45					46					47					48					49					50				
CM					15.					43.					45.					118.					30.																																																																																																																												

Card B

Northing										Easting										Elev										
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	
39.6										28.54540										F										

Write M if meters

	SEGMENT DEPTH																															
	Start										End										K		ΔK									
C	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50		
D	12.0										34.0										-3.0		-.5									
E																																
F																																
G																																

Continue each card below.

	SEGMENT DEPTH																															
	Start										End										K		ΔK									
C	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80		
D	.999																															
E																																
F																																
G																																

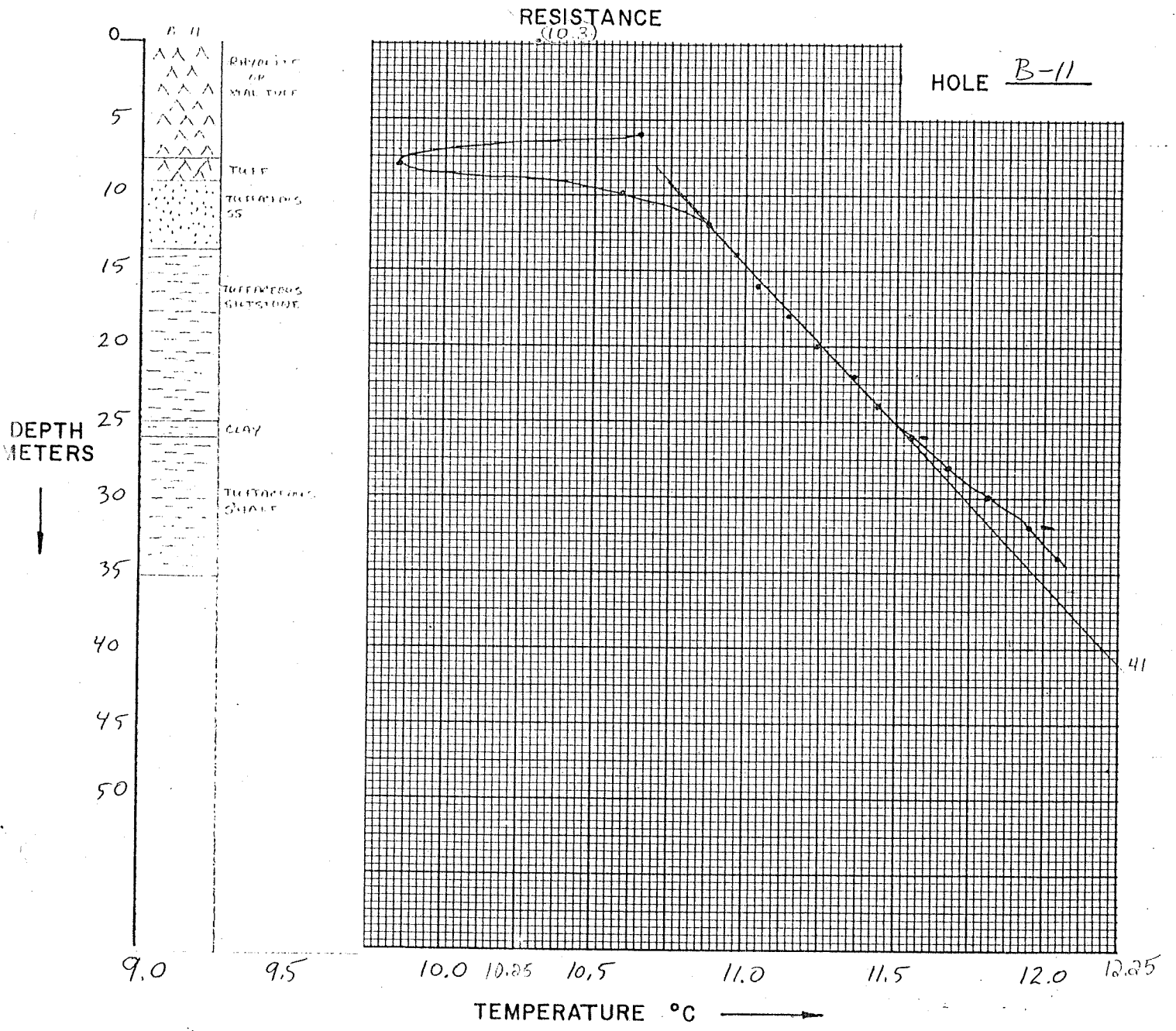
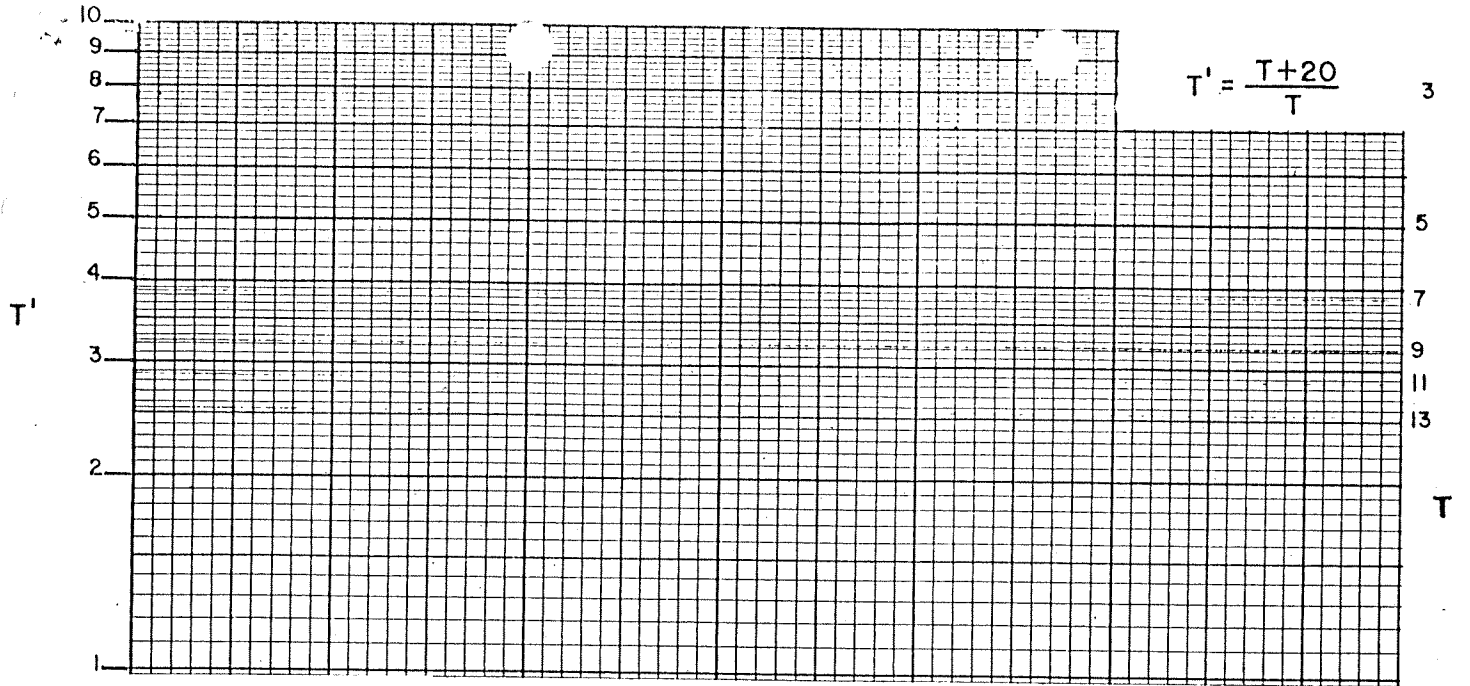
Final Segment: Start = .999

TEMPERATURE - DEPTH LOG

Location Beulah Date 9/10/75
 Map Drewsey Ore 15" Quad
 Property _____ T 185 R 36E sec 27 ^{NE 1/4 SW 1/4} 27
 Drill Hole B-11 Date Drilled _____ Elevation 4540 ft.
 Instrument _____ Operator JED
 Comments 3/4" PVC pipe 40 cm above ground

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
2	5126	15.925			
4	5815	12.790	-3.135	-1567.5	
6	6347	10.655	-2.135	-1067.5	
8	6564	9.840	-0.815	-407.5	
10	6365	10.585	0.745	372.5	
12	6290	10.870	0.285	142.5	
14	6265	10.970	0.10	50.0	
16	6248	11.035	0.065	32.5	AVE 12-34m
18	6224	11.130	0.095	47.5	53.5 °C/Km
20	6196	11.240	0.11	55.0	
22	6164	11.365	0.125	62.5	
24	6146	11.435	0.07	35.0	
26	6117	11.550	0.115	57.5	
28	6088	11.665	0.115	57.5	
30	6053	11.805	0.14	70.0	
32	6017	11.955	0.15	75.0	
34	5994	12.045	0.09	45.0	
36					
38					
40					
42					

Average gradient 12-34m = 53.5 °C/Km



B-11

0-5 m: BRIDGEMAN OR SANDSTONE

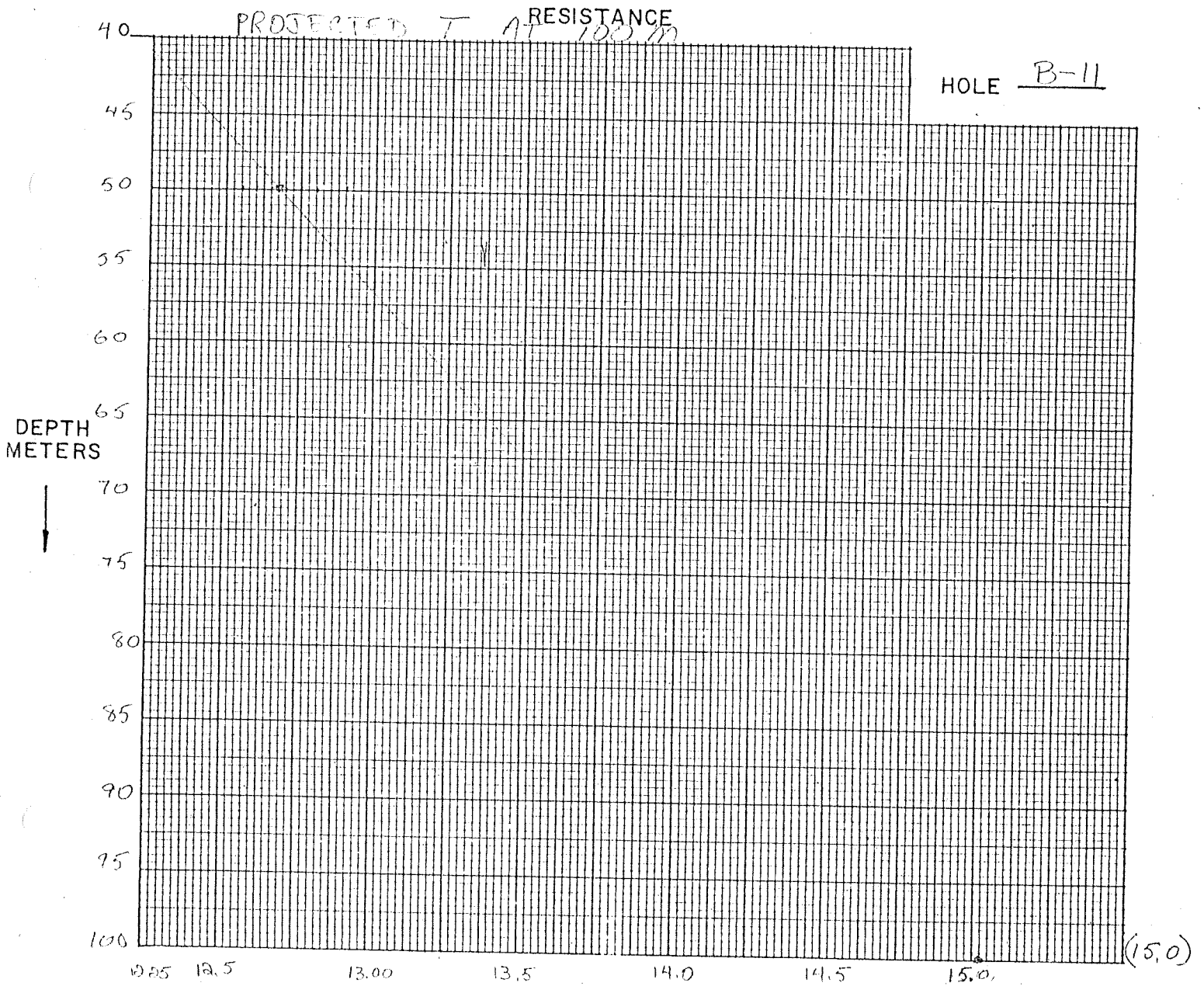
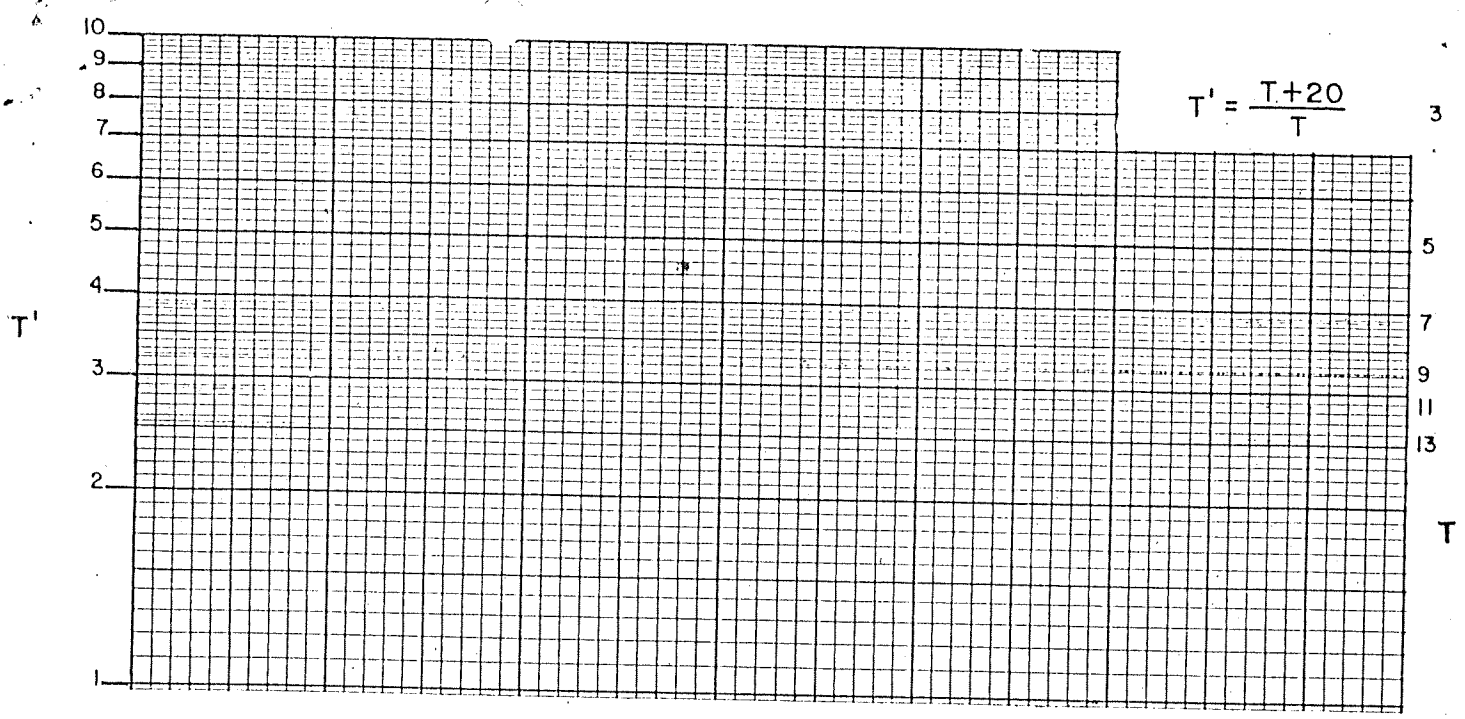
5-10 m: TUFF

10-15 m: TUFFaceous SAND

15-25 m: TUFFaceous SANDSTONE

25-30 m: CLAY

30-50 m: TUFFaceous SAND



TEMPERATURE VS DEPTH LOG FOR WELL-662 T-11
10/2/75

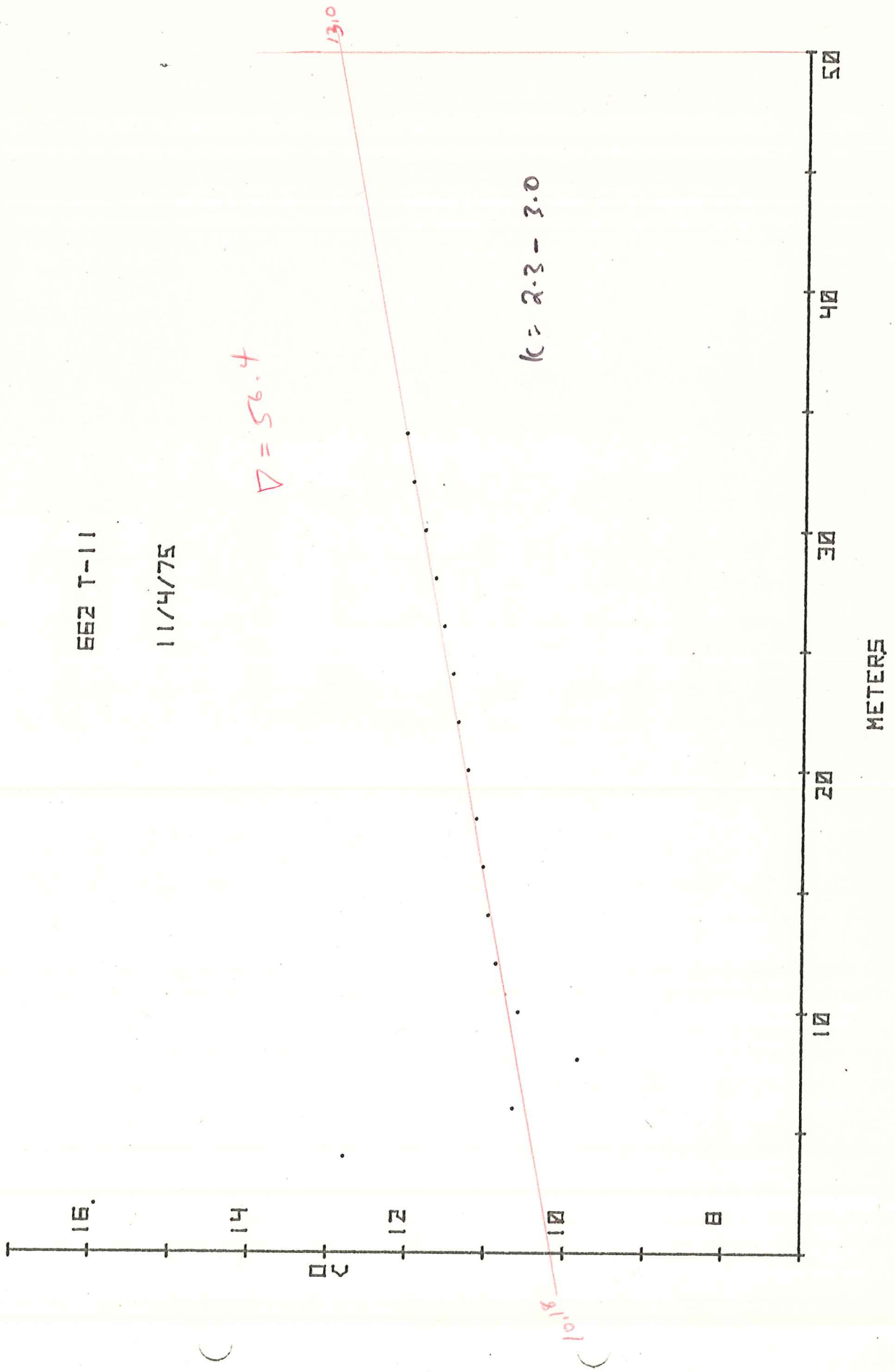
DEPTH METERS	TEMPERATURE DEGREES C	GRADIENT C/KM
2	15.925	-1567.5
4	12.79	-1067.5
6	10.655	-407.5
8	9.84	372.5
10	10.585	142.5
12	10.87	50
14	10.97	32.5
16	11.035	47.5
18	11.13	55
20	11.24	62.5
22	11.365	35
24	11.435	57.5
26	11.55	57.5
28	11.665	70
30	11.805	75
32	11.955	45
34	12.045	354.2647059

662 T-11

11/4/75

$\Delta = 56.4$

$k = 2.3 - 3.0$



TEMPERATURE VS DEPTH LOG FOR WELL-662 T-12
11/4/75

DEPTH METERS	TEMPERATURE DEGREES C	GRADIENT C/KM
1	12.295	935
2	13.23	40
3	13.24	-1115
4	12.125	-805
5	11.32	-565
6	10.755	-295
7	10.46	-120
8	10.34	-35
9	10.305	20
10	10.325	25
11	10.35	15
12	10.365	10
13	10.375	798.076923



662 T-12

11/4/75

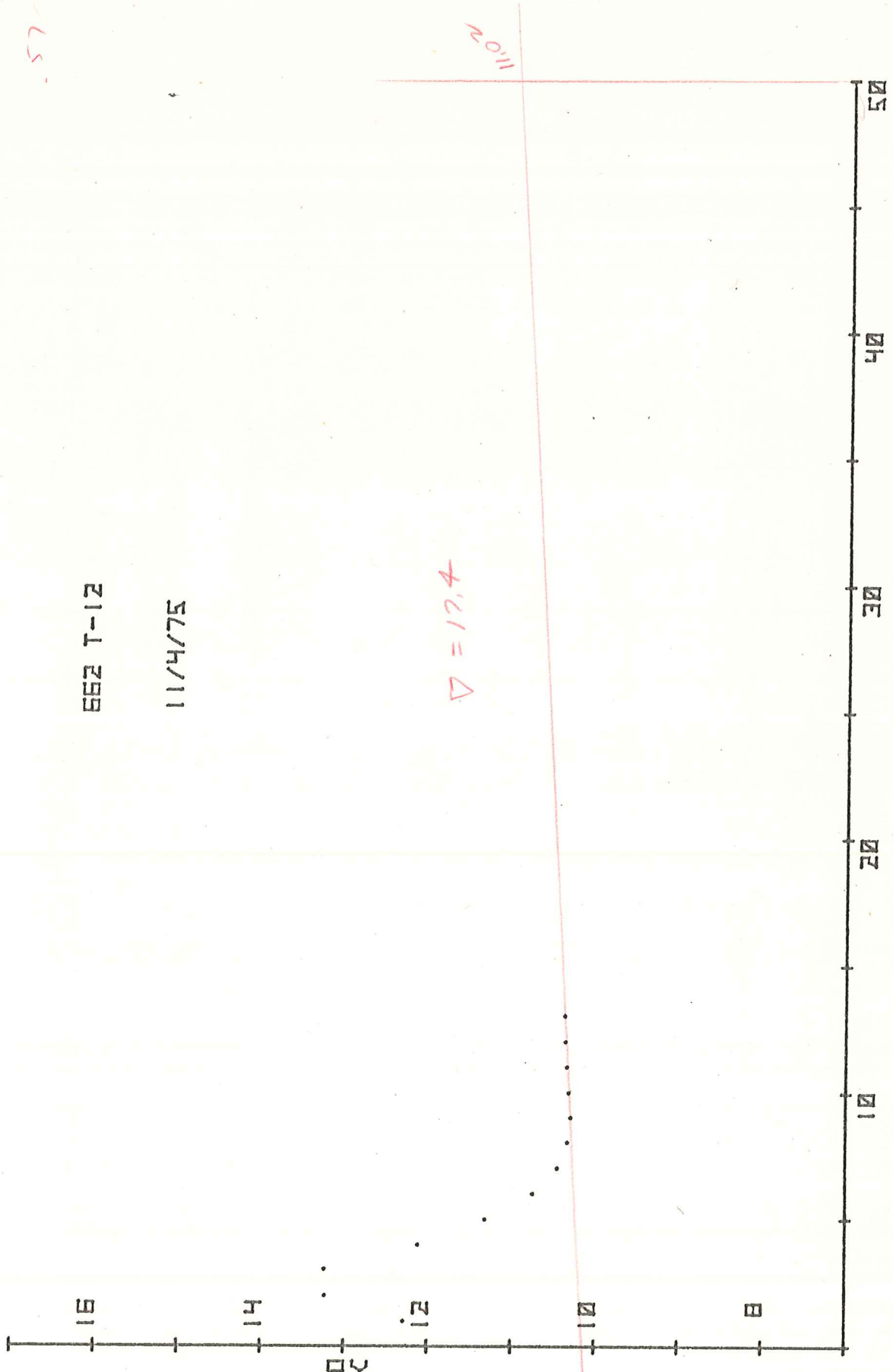
$\nabla = 12.4$

11.02

57



METERS



TEMPERATURE - DEPTH LOG

Location Bentlah, Oregon Date October 16, 1975

Map Bentlah Quadrangle

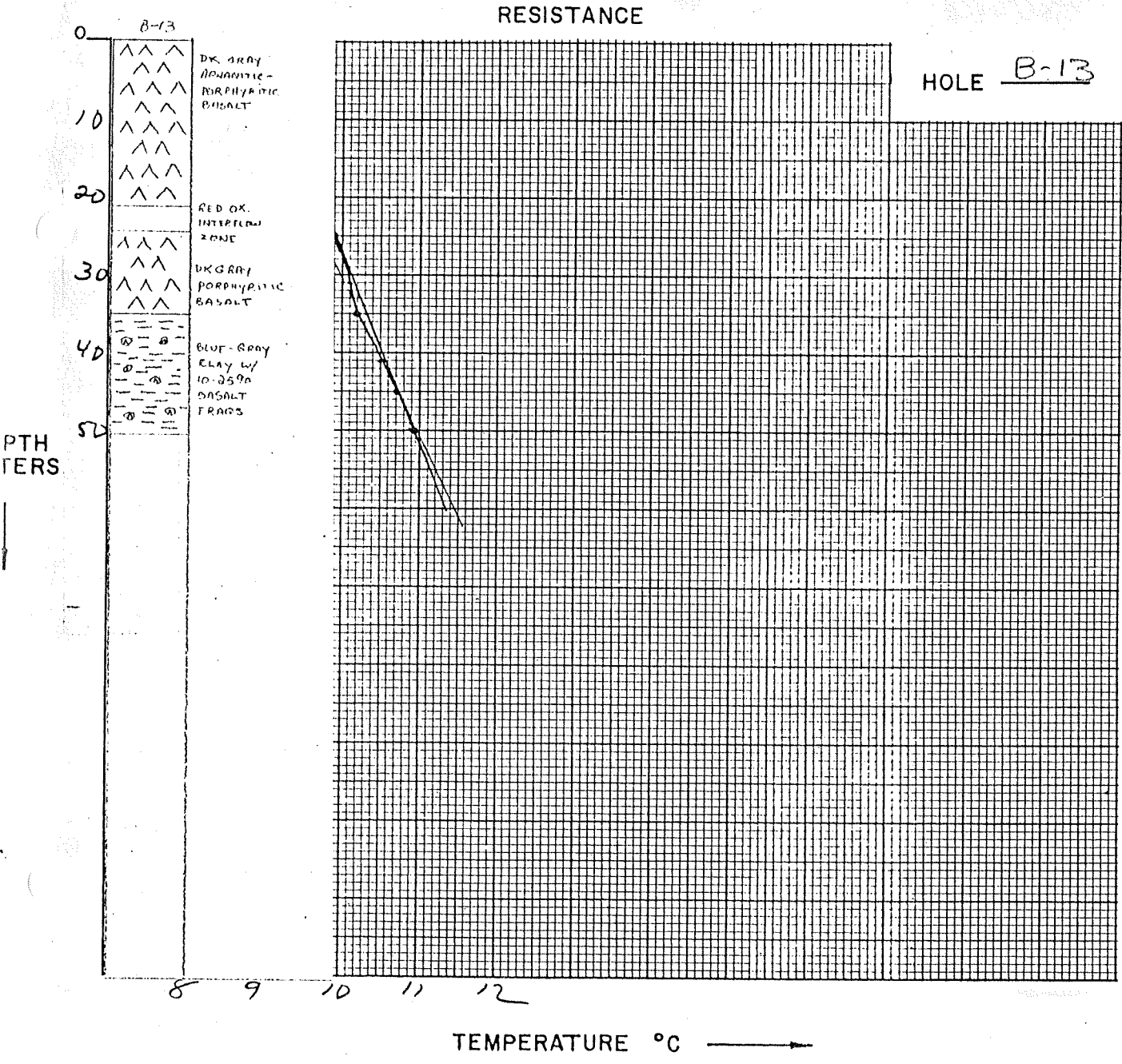
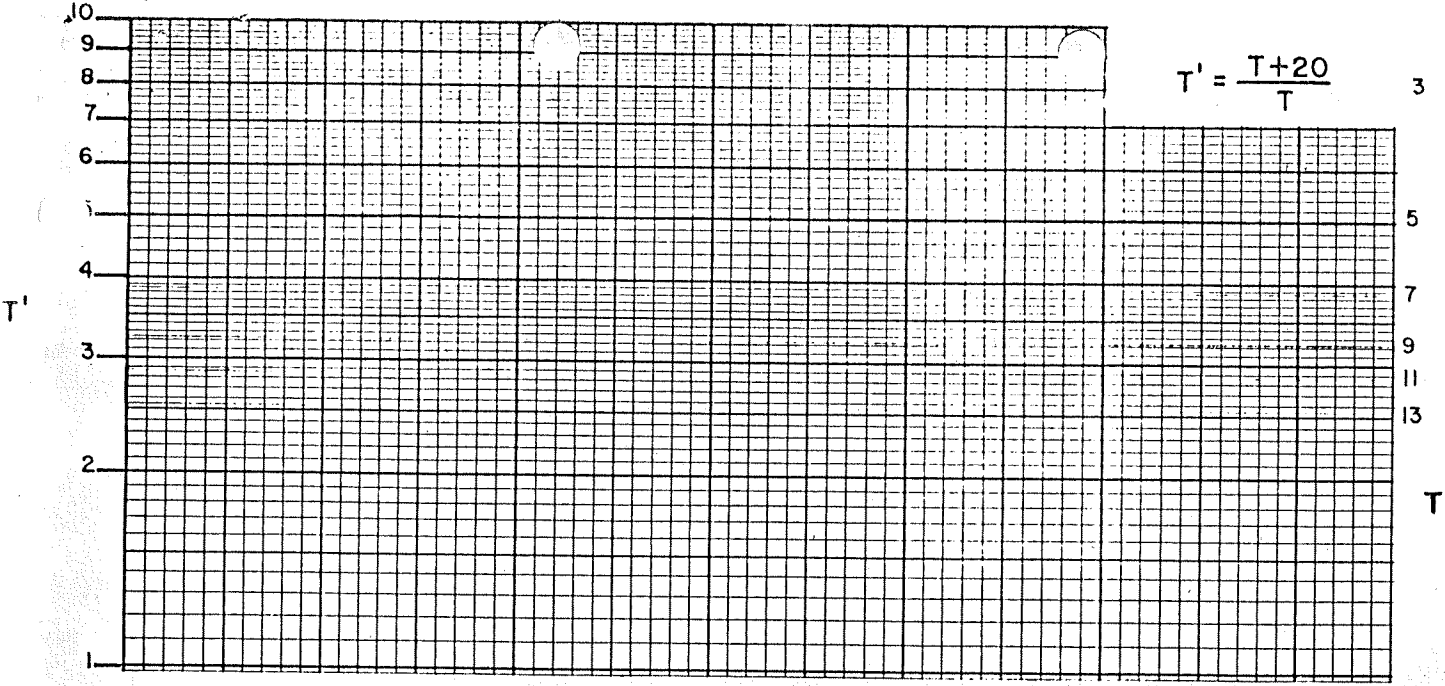
Property T 19S R 38E sec NE 1/4 NE 1/4 11

Drill Hole B-13 Date Drilled Oct 8, 1975 Elevation 5180 ft.

Instrument _____ Operator JOB

Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
1	5.927	12.320			
3	5.930	12.310	0.010	5.0	
5	6.125	11.960	-0.350	-175.0	
7	6.340	10.680	-1.280	-640	
9	6.475	10.170	-0.510	-255	
11	6.555	9.870	-0.300	-150	
13	6.557	9.865	-0.005	- 2.5	
15	6.585	9.760	-0.105	- 52.5	AVE 25-50 m
17	6.584	9.765	0.005	2.5	38.8 °C/km
19	6.576	9.795	0.030	15	
21	6.566	9.830	0.035	17.5	
23	6.552	9.885	0.055	27.5	
25	6.535	9.945	0.060	30.0	
27	6.521	10.000	0.055	27.5	
29	6.504	10.060	0.060	30.0	
31	6.489	10.115	0.055	27.5	
33	6.474	10.170	0.055	27.5	
35	6.464	10.210	0.040	20.0	
37	6.454	10.245	0.035	17.5	
39	6.396	10.460	0.215	107.5	
41	6.377	10.540	0.080	40.0	
			0.075	37.5	

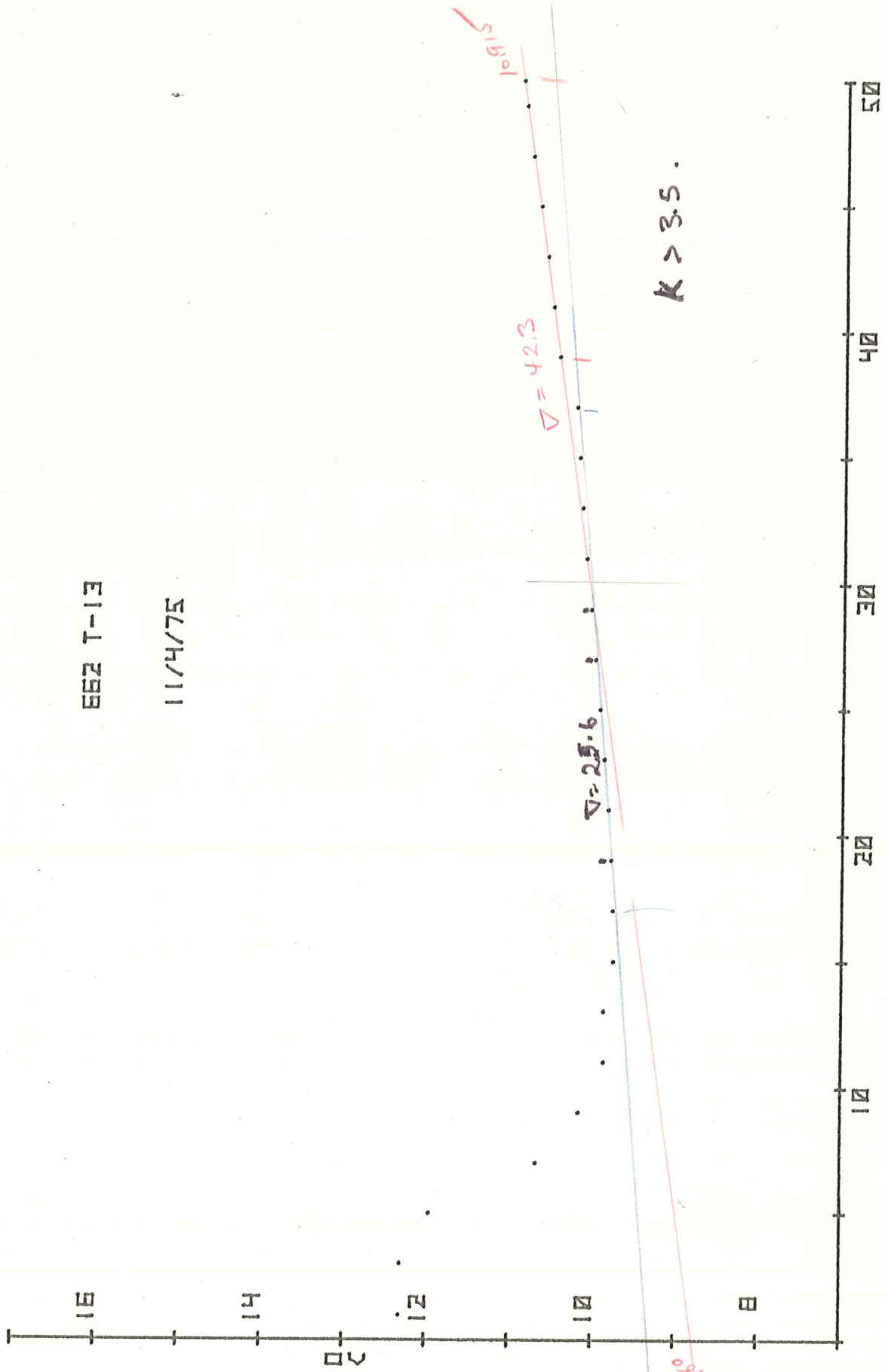


TEMPERATURE VS DEPTH LOG FOR WELL-662 T-13
11/4/75

DEPTH METERS	TEMPERATURE DEGREES C	GRADIENT C/KM
1	12.32	-5
3	12.31	-175
5	11.96	-640
7	10.68	-255
9	10.17	-150
11	9.87	-2.5
13	9.865	-52.5
15	9.76	2.5
17	9.765	15
19	9.795	17.5
21	9.83	27.5
23	9.885	30
25	9.945	27.5
27	10	30
29	10.06	27.5
31	10.115	27.5
33	10.17	20
35	10.21	17.5
37	10.245	107.5
39	10.46	40
41	10.54	37.5
43	10.615	42.5
45	10.7	47.5
47	10.795	42.5
49	10.88	35
50	10.915	218.3

662 T-13

11/4/75



METERS

TEMPERATURE DEPTH LOG

ΔT Well No. 14

Property-Project BEULAH Depth Logged _____
 Map _____ Scale _____ Date: Drilled _____ Logged _____
 State _____ County _____ Section _____ T _____ R _____
 Instrument _____ Operator _____ Elevation _____ ft.
 Comments _____

COMPUTER PROCESSING

RT JUSTIFY: → → → → *

Card A

Proj No										Well No										Date Logged			*
																				DA	MO	YR	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	11	03	75	CM

* 19- Write F if Fahrenheit, 20- Write F if Feet

Site Description																																																		Operator										Editor									
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	DP/MLW																													

Card B

Scale Unit										Map Size										Map Location ^Δ																			
in										(7.5, 15., 60)										N Lat					W Long														
cm																				Degree					Degree														
																				Min					Min														
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	15. 43. 45. 118. 15.									

Use decimals

Northing										Easting										Elev																			
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	31.3 4.6 45.20 F									

Use decimals

Δ Measure from SW corner of map; except AMS sheets measure from bottom center degree mark (W,-)(E,+)

Write M if meters

	SEGMENT DEPTH										K	ΔK																					
	Start						End																										
C	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50			
D	19.0										29.0																						
E	41.0										49.0																						
F																																	
G																																	

Continue each card below.

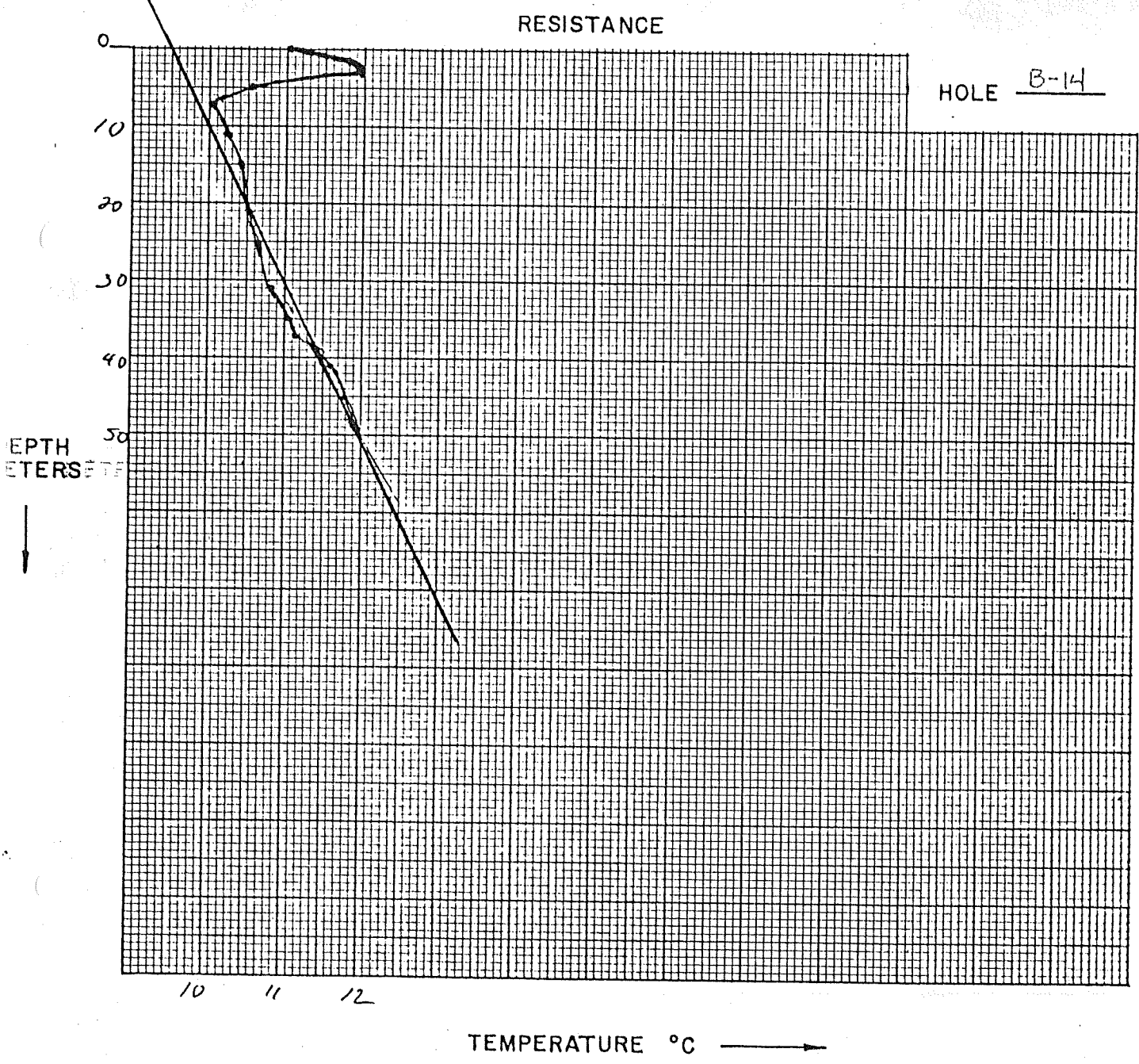
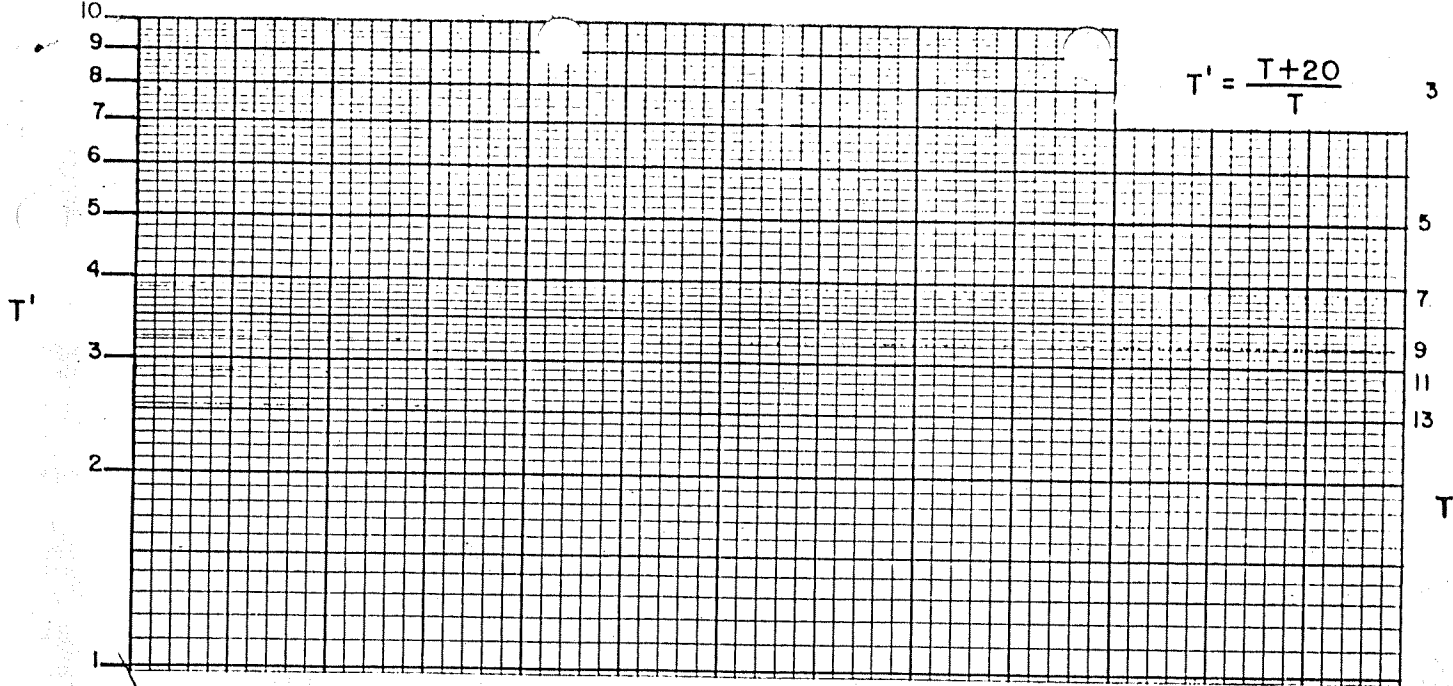
	SEGMENT DEPTH										K	ΔK																					
	Start						End																										
C	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80			
D	31.0										41.0																						
E	.999																																
F																																	
G																																	

Final Segment: Start = .999

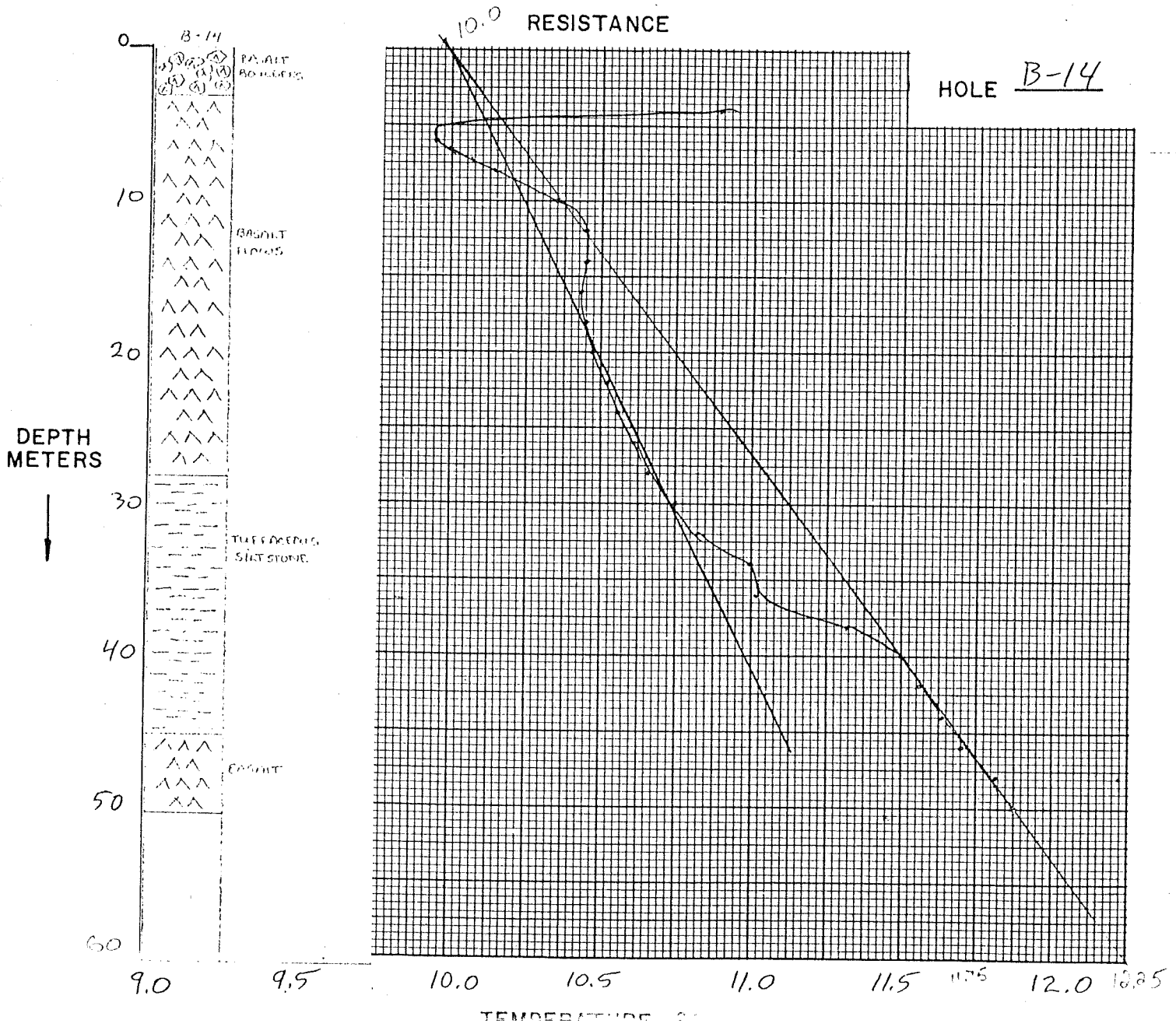
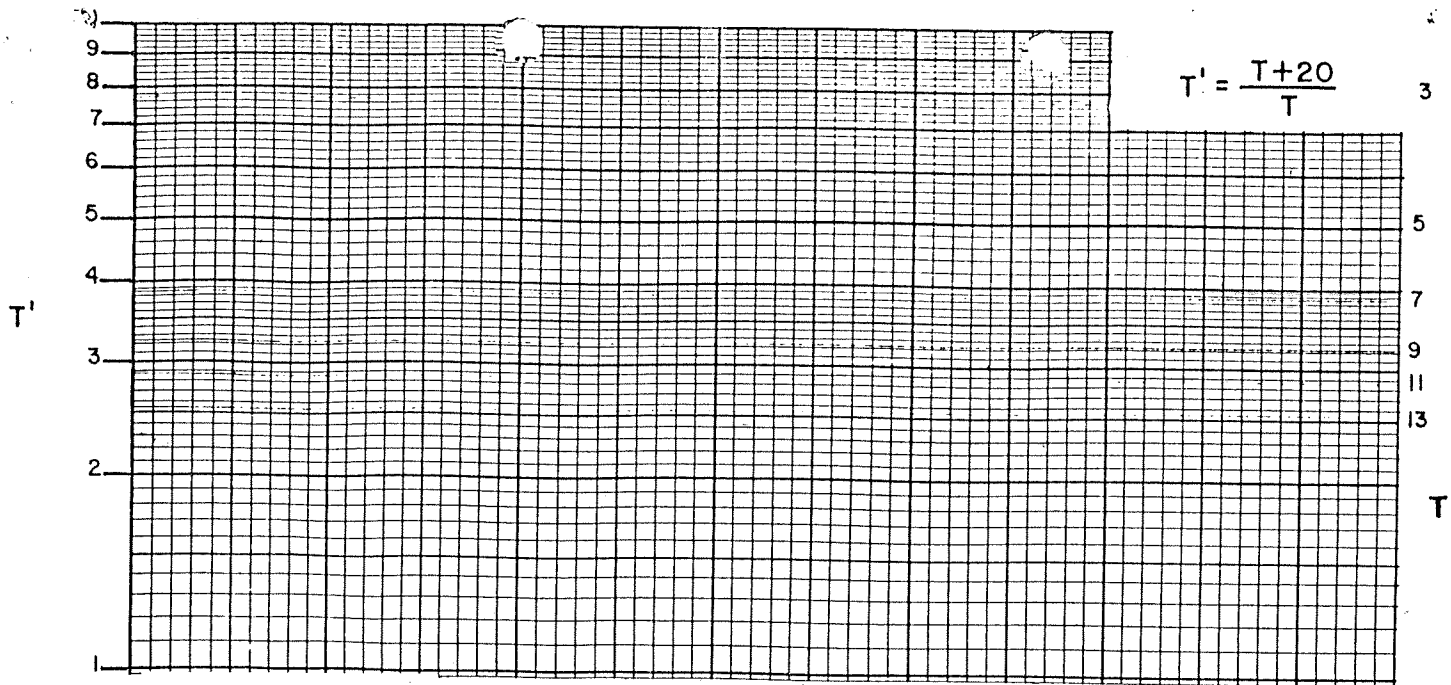
TEMPERATURE - DEPTH LOG

Location Bentah, Oregon Date Nov 13, 1975
 Map Bentah Quadrangle
 Property T 19S R 37E sec 5W/4SE/4 7
 Drill Hole B-14 Date Drilled Sept 6, 1975 Elevation 4520 ft.
 Instrument _____ Operator DP
 Comments _____

Depth (meters)	Instr. Reading	Temp. °C	ΔT	Gradient °C/Km Avg.	Comments
1	6.240	11.065			
			0.900	450	
3	6.014	11.965			
			-0.395	-197.5	
5	6.368	10.570			
			0.545	-272.5	
7	6.513	10.025			
			0.045	22.5	
9	6.501	10.070			
			0.155	77.5	
11	6.460	10.225			
			0.100	50.0	
13	6.433	10.325			
			0.065	32.5	
15	6.416	10.390			
			0.050	25.0	
17	6.403	10.440			
			0.045	22.5	
19	6.391	10.485			
			0.055	27.5	
21	6.376	10.540			
			0.055	27.5	
23	6.362	10.595			
			0.045	22.5	
25	6.350	10.640			
			0.035	17.5	
27	6.341	10.675			
			0.100	50.0	
29	6.315	10.795			
			0.045	22.5	
31	6.303	10.820			
			0.090	45.0	
33	6.280	10.910			
			0.115	57.5	
35	6.250	11.025			
			0.140	70.0	
37	6.215	11.165			
			0.300	150.0	
39	6.138	11.465			
			0.145	72.5	
41	6.103	11.605			
			0.115	57.5	



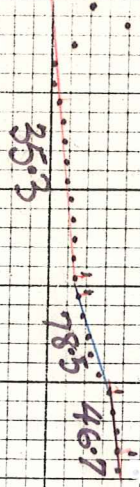
$$T' = \frac{T+20}{T}$$



5 10 15 20 25 30 35 40°C

B-14

Depth
in
Metres.



46 0780

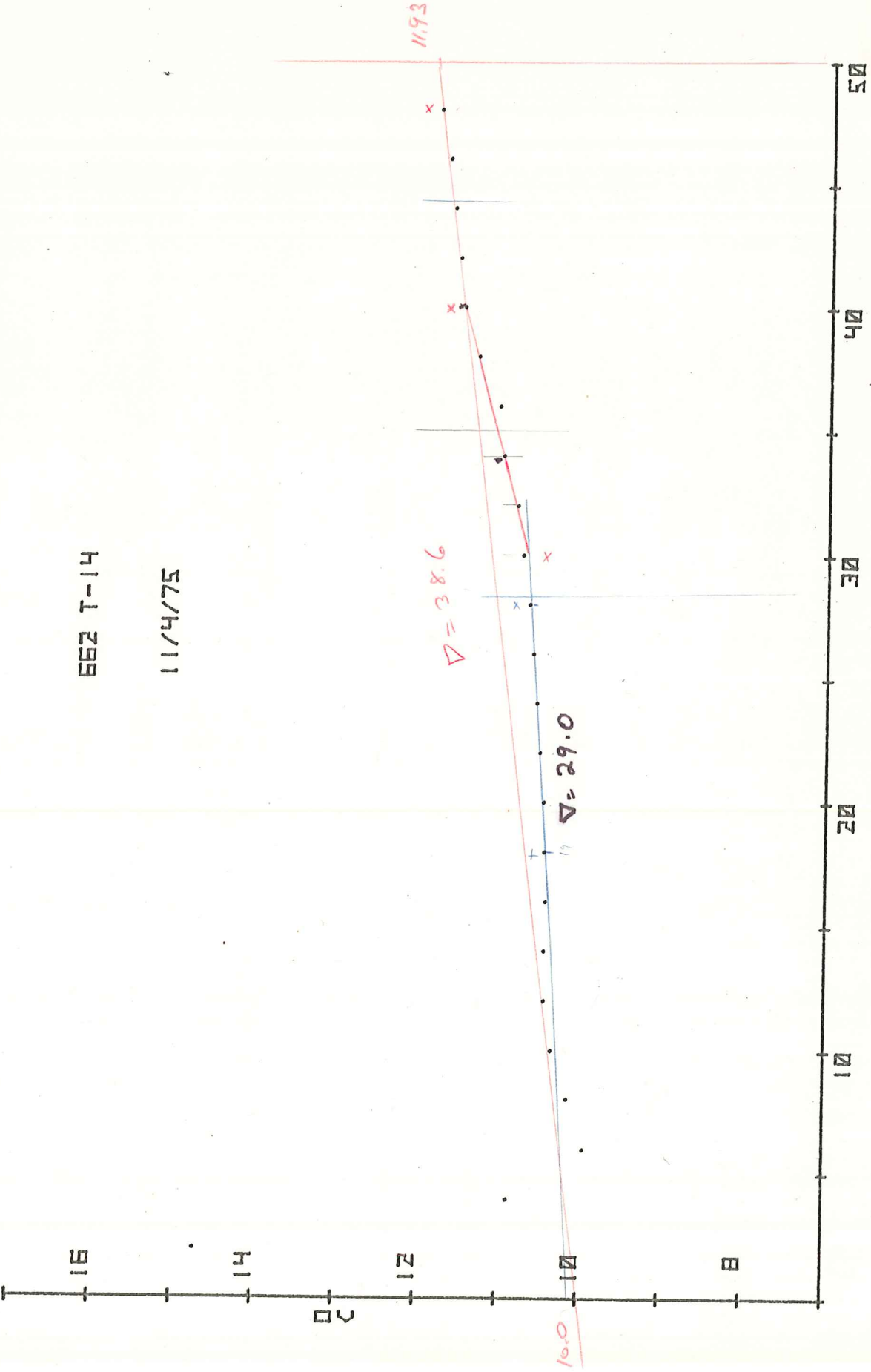
$$\frac{(13.5) \cdot 35.3 - 78.5}{4.67} = 1.94 @ 5.5$$

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200


662 T-14

11/4/75



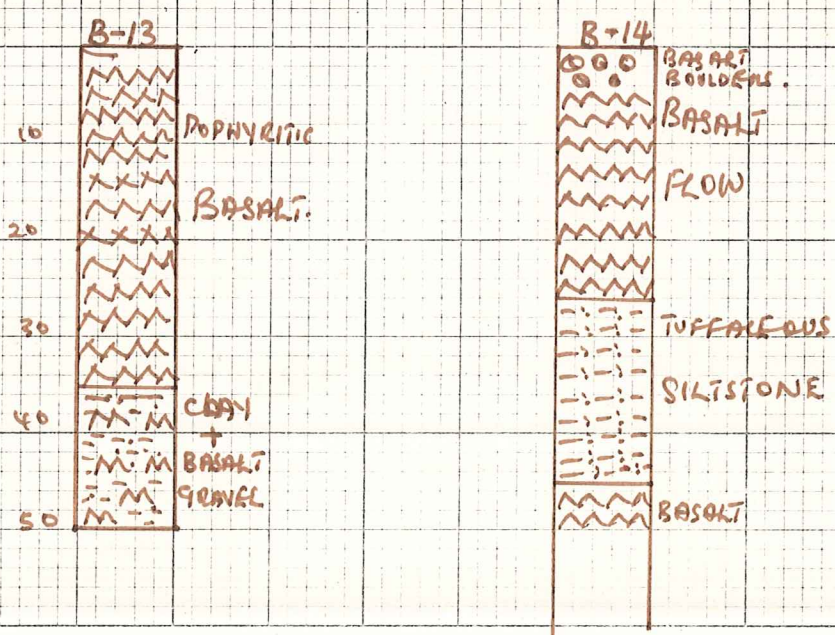
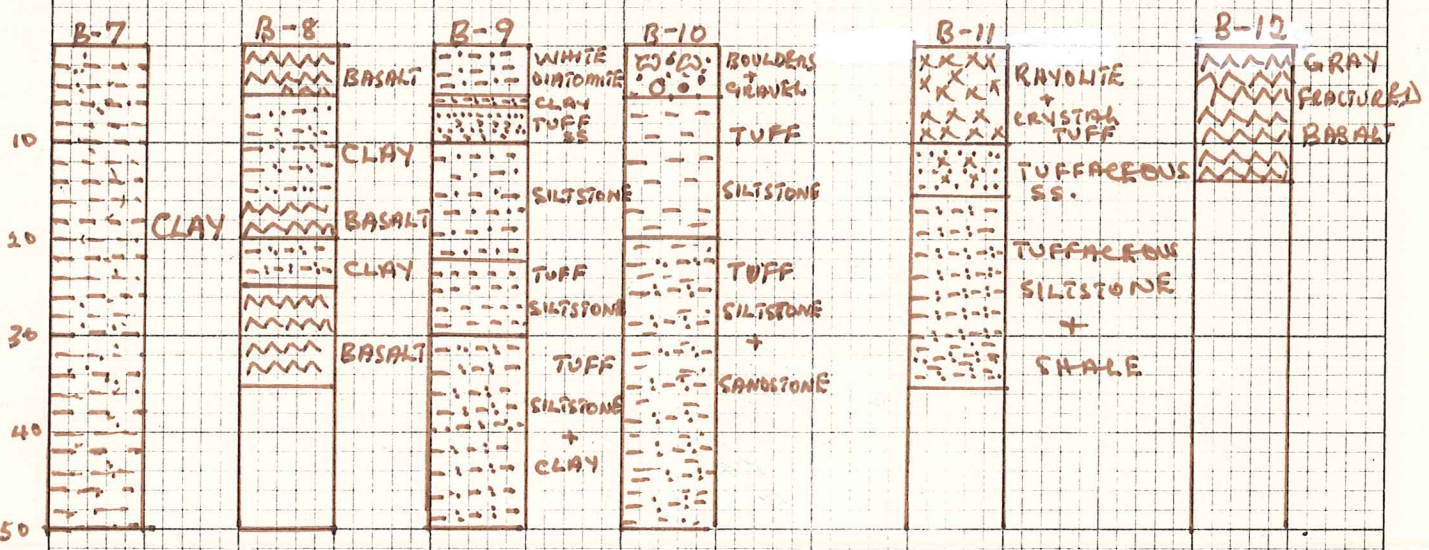
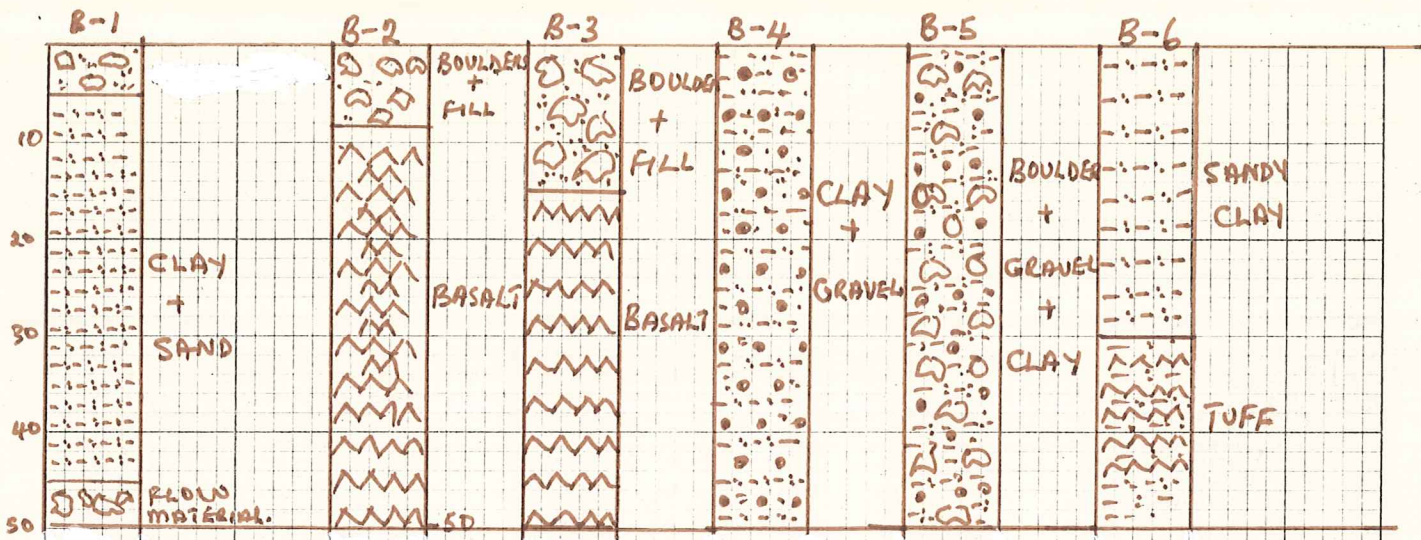
TEMPERATURE VS DEPTH LOG FOR WELL-662 T-14
12/1/75

DEPTH METERS	TEMPERATURE DEGREES C	GRADIENT C/KM
1	11.065	450
3	11.965	-697.5
5	10.57	-272.5
7	10.025	22.5
9	10.07	77.5
11	10.225	50
13	10.325	32.5
15	10.39	25
17	10.44	22.5
19	10.485	27.5
21	10.54	27.5
23	10.595	22.5
25	10.64	17.5
27	10.675	50
29	10.775	22.5
31	10.82	45
33	10.91	57.5
35	11.025	70
37	11.165	150
39	11.465	70
41	11.605	57.5
43	11.72	42.5
45	11.805	40
47	11.885	27.5
49	11.94	243.6734694

4 To. 

THERMAL DATA FOR BUELLAH.

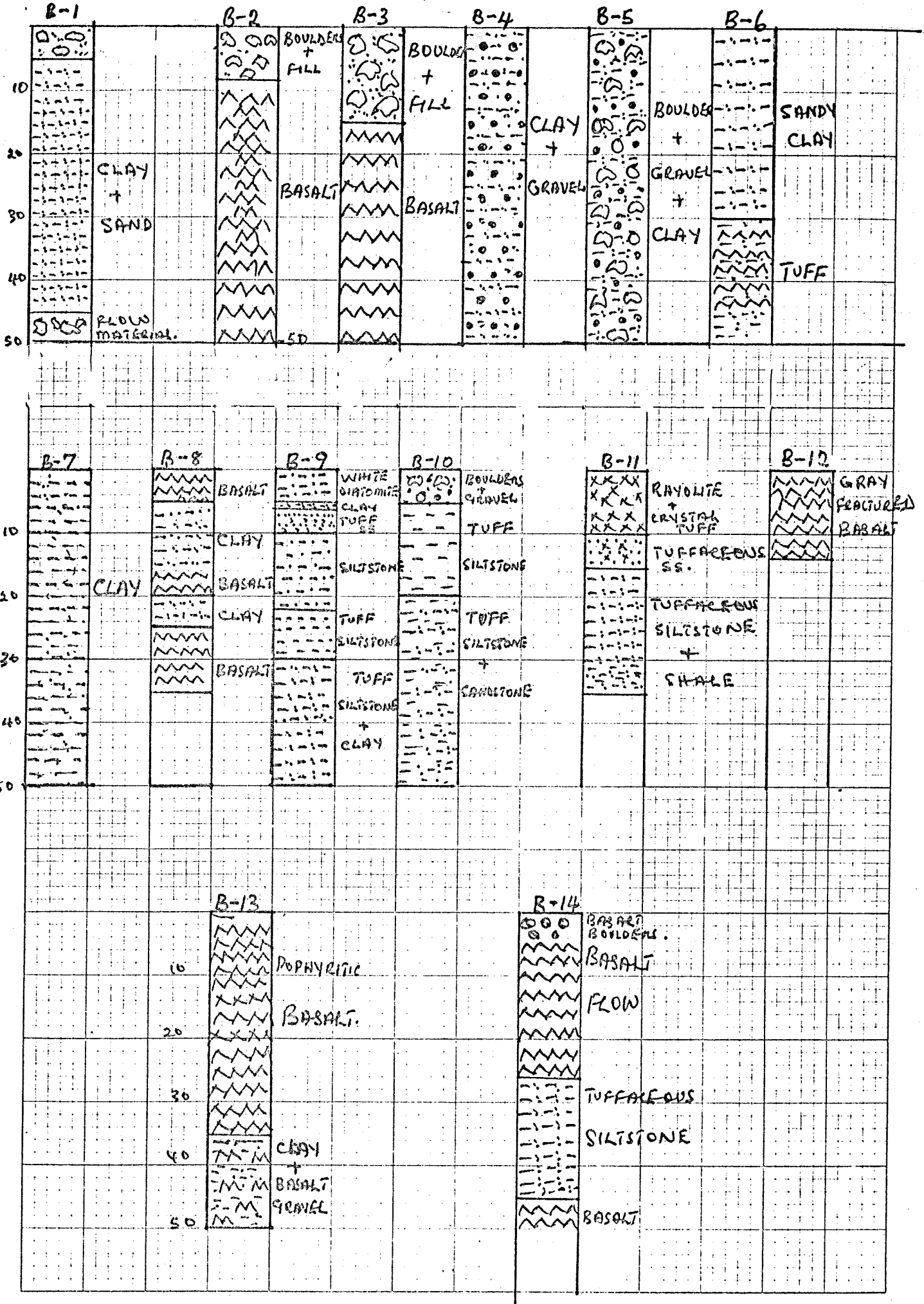
HOLE NO	THERMAL DATA		
B-1	$\frac{(15.5) \cdot 46.6}{4.06 \quad 1.21 @ 2.6}$	B-10	$\frac{21.1}{\cancel{(21.1)}} \cdot 92.2$ $2.04 \quad 2.77 @ 3.0$
B-2	$\frac{(18.4) \cdot 39.0 - 71.9}{2.63 \quad 3.60 @ 5.0}$	B-11	$\frac{(15.8) \cdot 56.4}{3.37 \quad 1.55 @ 3.0}$
B-3	$\frac{(17.1) \cdot 22.3 - 103.3}{1.86 \quad 3.10 @ 3.0}$	B-12	$\frac{(11.9) \cdot 17.4}{10.91 \quad \text{INSUFFICIENT DATA}}$
B-4	$\frac{20.5 \quad 63.8}{\cancel{(15.6)} \cdot 20.0 - 46.5}$ $\frac{7.32 \quad 1.91 @ 3.0}{2.91}$	B-13	$\frac{(13.0) \cdot 25.6 - 42.3}{4.52 \quad 1.54 @ 3.63}$
B-5	$\frac{(13.5) \cdot 25.9}{7.30 \quad 0.67 @ 2.6}$	B-14	$\frac{(13.5) \cdot 35.3 - 78.5}{4.52 \quad 1.94 @ 5.5}$
B-6	$\frac{(20.7) \cdot 81.9}{2.29 \quad 2.45 @ 3.0}$		
B-7	$\frac{(19.0) \cdot 45.8 - 85.0}{2.23 \quad 2.55 @ 3.0}$		
B-8	$\frac{(20.2) \cdot 87.0}{2.17 \quad 4.35 @ 5.0}$		
B-9	$\frac{(19.90) \cdot 58.8}{3.16 \quad \cancel{1.39} @ 3.0}$ 1.26		



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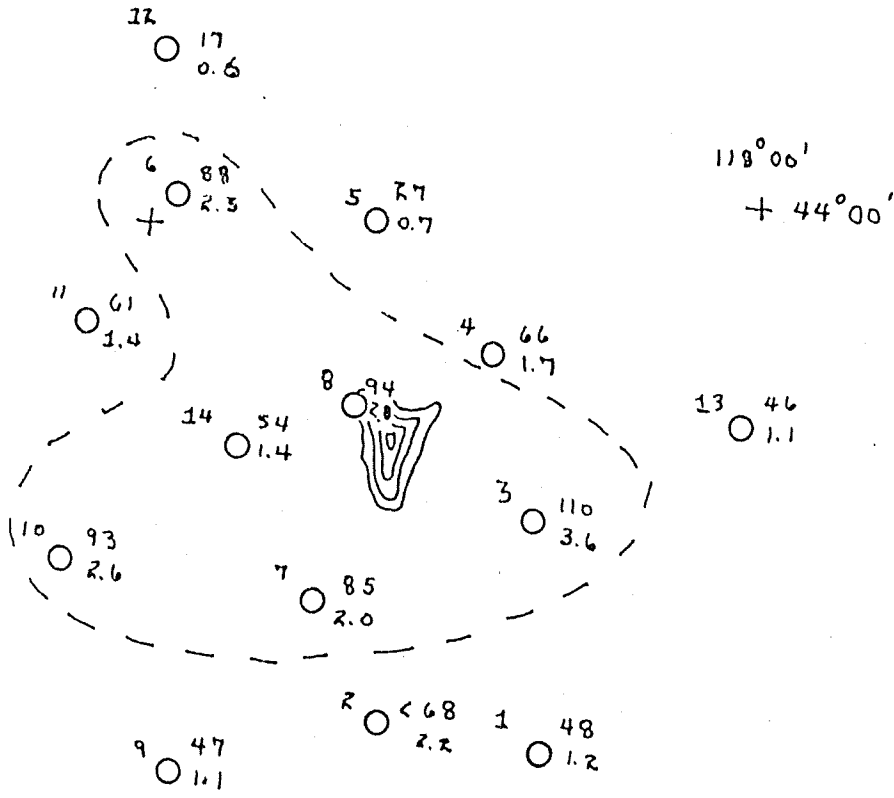


BEULAH LITHOLOGY AND DEPTH TO WATER ZONES

B-1	0-20 boulders and fill 20-145 clay/sand 145-165 boulders and fill	---
B-2	0-25 boulders and fill 25-170 basalt	
B-3	0-50 boulders and fill 50-160 basalt	50'
B-4	clays and some gravel	40'
B-5	boulders gravel and some clay	
B-6	0-100 sandy clay, 100-150 tuff, 150-165 sandy clay	---
B-7	clay	50'
B-8	0-2 sand and clay 2-18 basalt 18-36 clay 36-40 basalt 40-55 clay 55-65 basalt 65-80 clay (weathered vol) 80-120 basalt	55'

BEULAH, OREGON

Thermal conductivity measurements were made on 8 samples from the vicinity of Beulah, Oregon as shown in the accompanying table. The sample identifier and the approximate corresponding hole location is also shown in the table. Most of the rocks measured were igneous rocks, including four tuffs or rhyolites and three basalts. From measurements in the tuffs it would appear that three of them are essentially glass and one is a rhyolite similar to the welded tuffs in the Harney Basin. The bulk values of thermal conductivity for the basalts are also reasonable average values for basalt. As in the case of samples from the Harney Basin, the in situ porosity for each of these units is unknown and I've shown a range of values in the table with a corresponding range of values of thermal conductivity. In any given hole the thermal conductivity can probably scatter at least over values as different as the ranges shown but the average values over the whole hole may not be too different from the averages shown. Values of thermal conductivity for sedimentary rocks in the area are assumed to be similar to those of the Burns area and thus would be approximately 2.6 ± 0.3 mcal/cmsec⁰C for siltstones and tuffaceous siltstones and approximately 2.3 ± 0.3 mcal/cmsec⁰C for rocks identified as clays or shales.



Hole No. ○ Gradient, °C/km
Heat Flow, H.F. U.

Benlah, Oregon

1:250,000

gradient curve and B-5 has a slight residual apparent drilling disturbance. Agreement of calculated and measured values of thermal conductivities is found in holes B-11 and B-13 and disagreement is found in drill holes B-4, B-7, and B-14. In general it appears that in shallow parts of some of these holes there are anomalously low gradients. This occurrence of low gradients is not atypical of 50 m holes in an area with the type of relief seen in the Beulah area.

Terrain corrections were not made in these holes, but the direction and an estimate of the magnitude of the terrain correction measurements are shown. The heat flow values are plotted on the attached map along with geothermal gradients (where possible in the sedimentary units) and the number of the drill hole. The regional background for this area is 1.5 to 2.0 $\mu\text{cal}/\text{cm}^2\text{sec}$. Many of the values on the margin of the area are below these values, probably more than can be explained by the lack of a topographic correction. Either the values are low because of surface temperature effects or because of water recharge in the areas of low heat flow. All of the high values are in valleys where significant terrain corrections are to be expected, probably on the order of 10-20% and if allowance is made for these corrections, the observed values are barely anomalous. The gradients are fairly high because of the low thermal conductivities. If there is a contrast in heat flow, it seems to be between low and normal, not between normal and high values. The area of higher heat flow is circular and centered about Beulah reservoir. This pattern may or may not be significant and if there is further interest in the area, detailed terrain corrections should be made and more sampling for detailed thermal conductivity values for the holes in this region of higher heat flow are recommended.

Hoie Number	Depth Interval meters	Gradient °C/km	Thermal Conductivity mcal/cmsec°C	Heat Flow μcal/cm ² sec	Direction of Terrain Corr.	Lithology
B-8	12-36	94.2 10.4	3.3	2.8	-	Basalt
B-9	10-50	46.9 10.1	2.6	1.2	(-)	Tuffaceous Siltstone
B-10	10-48	93.3 4.1	2.6	2.4	-	Tuffaceous Siltstone
B-11	12-24	47.1 5.8	(3.0) +	1.2		Tuffaceous Siltstone
	24-34	61.0 6.8	2.3	1.4		Shale
B-12	10-13	16.7	3.3	(.6)	?	Basalt
B-13	17-35	24.7 2.1	(4.3) +			Basalt
	35-49	46.3 10.8	2.3	1.1	?	Clay
B-14	16-28	16.3 5.1	(8.5) x			Basalt
	28-44	53.5 12.9	2.6	1.4	-	Tuffaceous Siltstone
	44-48	45	(3.1) +			Basalt

BEULAH, OREGON

Heat Flow, Geothermal Gradient, and Thermal Conductivity. The thermal conductivity used in calculating the heat flow is not in parentheses. The thermal conductivity values in parentheses were calculated from a ratio of the gradients and are indicated by a + if they are consistent and a x if they are inconsistent with measured values. If the terrain correction will probably be less than 10% the "Direction of Terrain Correction" is shown in parentheses.

Hole Number	Depth Interval meters	Gradient °C/km	Thermal Conductivity mcal/cmsec°C	Heat Flow µcal/cm ² sec	Direction of Terrain Corr.	Lithology
B-1	14-48	47.5 2.2	2.6	1.2	(-)	Clay and Sand
B-2	18-32	35.4 3.4	(6.3) x			Basalt
B-3	32-50	67.9 10.1	3.3	2.2	-	Basalt
B-3	22-46	110?	3.3	3.6	-	Basalt
B-4	14-44	24.7 2.8	2.6 (6.2) x			Clay and Gravel
B-5	44-48	66	2.6	1.7	(-)	Clay and Gravel
B-5	12-48	27.4 6.6	2.6	0.7	?	Gravel and Clay
B-6	10-50	88.0 5.0	2.6	2.3	? -	Tuff and Clay
B-7	12-30	45.0 3.6	(4.3) x			Clay
B-7	32-50	85.0 11.1	2.3	2.0	(-)	Clay

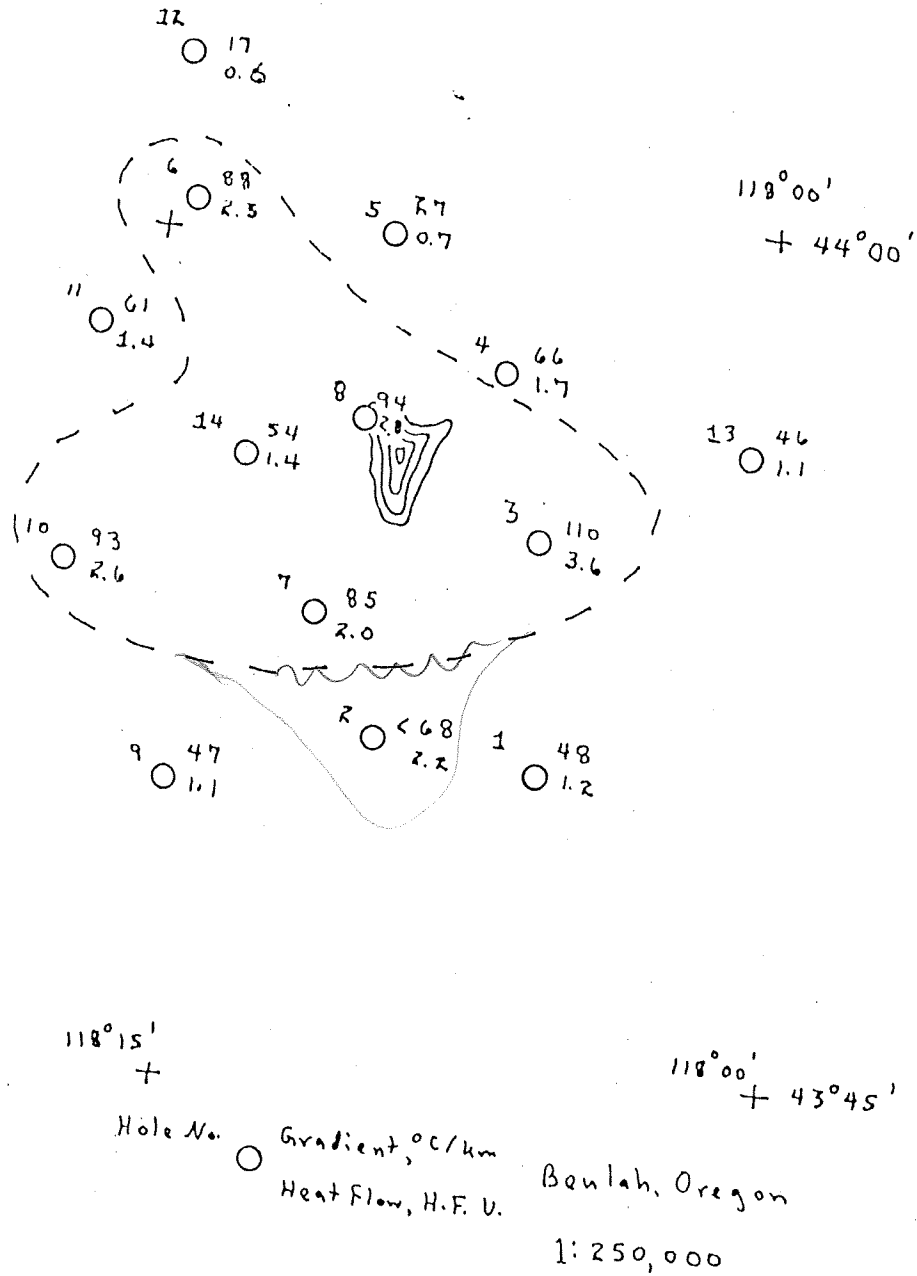


Figure 4. Thermal gradients and heatflow at Beulah according to Blackwell (private communication).

INTER-OFFICE MEMORANDUM

SUBJECT: Beulah, Oregon: Heat Flow Results to Date

DATE March 19, 1976

TO: W. M. Dolan, H. J. Olson, H. D. Pilkington, J. Roth, G/T Staff

FROM: A. L. Lange

The accompanying figures represent the latest compilation of thermal data from the Beulah Reservoir area, adding data from five recent holes to that of the 8 holes logged in Summer 1975. The results incorporate also conductivity values supplied by D. Blackwell.

Thermal gradients (Figure 1)

In computing thermal gradients, I rechecked the logs previously analysed by Joe Meigs and Dean Pilkington. In most cases I found little or no disagreement with their values; in one or two, however, I favored a slightly different portion of the log - the deepest portion, when there were discontinuities. The gradients supplied by Blackwell sometimes varied from mine, but fell within his standard deviation figure. The log of Station 3 was erratic, probably due to circulation locally in the hole. Two alternate values (of each parameter) were computed, but were ignored in the drawing of contours. Because gradients are a composite effect of both heat flow and lithology, they are not the best quantity to interpret; hence, my comments will be made in connection with Figure 3 instead.

Depth to 200° isotherm (Figure 2)

A quantity that I feel is instructive is the depth below surface to a particular isotherm, in this case 200°, under the assumption that the thermal gradient remains constant with depth; i.e., increases linearly. Depths are computed from the formula:

$$\text{Depth (km)} = \frac{200^\circ - T_{\text{surface intercept}}}{\text{Gradient } (^\circ\text{C/km)}} .$$

The plot would be effectively the reciprocal of the gradient, except for the fact that the surface intercept varies from hole to hole. The resulting surface is depicted with depressions contoured. It is evident from the map that a 2km-boomerang-shaped ridge follows the western edge of the Malheur River in the vicinity of the reservoir.

Heat Flow (Figure 3)

Values are computed from the formula:

$$\text{Heat Flow (h.f.u.)} = \text{Conductivity} \times \text{Gradient}/100.$$

Conductivities were supplied by Dave Blackwell. In the case of changes of lithology within the hole, I employed the value corresponding to the thermal gradient used. Heat flow values computed from measured conductivities are shown without parentheses. Values in parentheses used conductivities extrapolated by Blackwell from measured values in similar lithologies in the Harney Basin to the south. The minus sign following the value indicates that a terrain correction (10-20% of the value) should be subtracted. Terrain corrections have not been determined.

Based on a world mean of 1.5hfu, and a regional background of 1.5-2.0hfu, the values at Beulah are not unusual. When slight corrections are applied for terrain effects, the thermal highs will all fall below 3. Nevertheless, structural expressions are evident in the plot, notably the "boomerang" referred to above. In terms of geology, its northwest leg follows the axis of a major syncline, while the south leg is aligned along the graben's west-bounding fault extending along the west side of the reservoir. A 16-ohmmeter .05hz MT anomaly and a 10-ohmmeter 8hz anomaly fall directly upon the thermal high in the vicinity of Station 6 and they are linearly aligned with it (see my memo, 16 March 1976). This is the locality of mapped alteration. The trends displayed in the boomerang feature correspond to those revealed in the gravity plot of the earlier memo. The thermal high represented by Station 10 falls on a positive gravity lobe, but we have no telluric coverage in that region.

Blackwell determined a gradient of 110°C/km for Station 3, resulting in a heat flow value of 3.6⁻, but he places a question mark on these figures. The best I could see in the data was a value of 1.9⁻. His anomalous area therefore is broader-based or "ghost-shaped" (Figure 4). I feel that another hole is needed before the pattern can be defined in the region of Station 3.

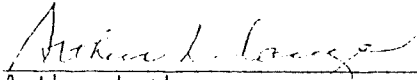
Conclusions

The heat flow high bordering Beulah Reservoir on the west expresses circulating thermal fluids along the graben-bounding fault and faults associated with the syncline controlling the Malheur River valley to the northwest. The latter circulation effect is borne out by the telluric lows on that same structure. Heat flow values are 10 to 20% less than shown at many sites, due to terrain. In Blackwell's words:

"All of the high values are in valleys where significant terrain corrections are to be expected, probably on the order of 10-20% and if allowance is made for these corrections, the observed values are barely anomalous. The gradients are fairly high because of the low thermal conductivities. If there is a contrast in heat flow, it seems to be between low and normal, not between normal and high values. The area of higher heat flow is circular and centered about Beulah reservoir."

Recommendations

Additional gradient holes are needed in the vicinity of Beulah Reservoir, particularly near Station 3. Perhaps one additional hole is warranted in the vicinity of Station 10. If higher values than those already found do not turn up, the property should be regarded as being of marginal interest.



Arthur L. Lange

ALL:d

BEULAH, OREGON

Geothermal gradient, thermal conductivity, and heat flow values for the wells in the Beulah vicinity are shown in the attached table. Also shown is the depth interval of calculation of the geothermal gradient and the lithology penetrated by the well. Measurements of thermal conductivity were made on some of the igneous units and these data are shown on a separate attachment. The thermal conductivities for the sedimentary rocks are assumed to be similar to those observed for the sedimentary rocks of the Harney Basin (see the discussion of the Burns thermal conductivity and heat flow values).

In order to calculate the heat flow value, the thermal conductivity and gradient from the best sections of the hole (most linear gradient interval, or interval with most reliable thermal conductivity value) are combined. The thermal conductivity for other lithologic units or gradient segments in each hole is calculated by a ratio of the gradients in the two units multiplied by the thermal conductivity of the "known" section. If the inferred thermal conductivity is consistent with the measured value, the thermal conductivity is indicated with a plus. If it is not consistent, the thermal conductivity value is indicated by a minus. In holes where the thermal conductivity values have pluses, the heat flow values should be reliable.

In general the data from the Beulah area is not so satisfactory as the data from the Burns area. There are numerous apparent disturbances to the geothermal gradient values in the holes and there is not as good a correlation between the calculated thermal conductivity values and the assumed thermal conductivity values for the sedimentary units. In particular holes B-3 and B-9 show water disturbances. Drill hole B-4 has a very irregular geothermal

BEULAH, OREGON - CUTTINGS THERMAL CONDUCTIVITY MEASUREMENTS

Sample No.	Approx. Hole Equivalent	Porosity (assumed)	Bulk and In Situ Thermal Conductivity *	Lithology
			$\frac{\text{mcal}}{\text{cmsec}^\circ\text{C}}$	
JT-2-75	B-14, 45-50 ft	0.1 ± 0.1	3.47 3.2 ± 0.3	Basalt
JT-1-75	B-14, 145-164 ft	0.1 ± 0.1	3.64 3.3 ± 0.3	Basalt
DP-22-75	B-14, 10-20 ft	0.1 ± 0.1	3.70 3.4 ± 0.3	Basalt
DP-23-75	B-14, 120-150 ft; B-9, B-10		1.88	White Tuff
DP-24-75	B-11, 20 ft	0.1 ± 0.1	5.33 4.7 ± 0.6	Rhyolite
DP-25-75	B-11, 40-50 ft	0 - 0.5	2.99 2.5 ± 0.5	Tuff
DP-26-75	B-10, 100-120 ft	0 - 0.5	3.04 2.5 ± 0.5	Tuff
DP-27-75	B-4 and B-7	0 - 0.5	3.98 3.1 ± 0.7	Tuff

$$K_{IS} = (K_B)^{1-\phi} (1.4)^\phi$$

S.M.U. Geothermal Laboratory
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