

## PCGK - Pressure Case Gamma

[illegible]

## WELL INFORMATION

MWD Run Number	100				
Date run completed	20-Sep-15				
Rig Bit Number	2				
Bit Size (in)	8.750				
Tool Nominal OD (in)	6.750				
Log Start Depth (MD, ft)	633.00				
Log End Depth (MD, ft)	6,995.00				
Drill or Wipe	Drill				
Drill/Wipe Start Date and Time	18-Sep-15 22:48				
Drill/Wipe End Date and Time	20-Sep-15 05:27				
Min Inc (deg) @ Depth (MD, ft)	0.06 @ 1,767.00				
Max Inc (deg) @ Depth (MD, ft)	84.04 @ 6,939.00				
Bit TFA(in2) / Bit Type	0.98 / PDC				
Flow Rate (gpm)	589.71				
Max AV (fpm) / CV (fpm) @ MWD	N/A / N/A				
Fluid Type	Native/Spud Mud				
Density (ppg) / Viscosity (spqt)	9.55 / 42.00				
Filtrate CL (ppm)	2,500.00				
pH / Fluid Loss (mptm)	10.00 / 8				
PV (cP) / YP (lbf2)	9 / 10.00				
% Solids / % Sand	10.80 / 0.45				
% Oil / Oil:Water Ratio	N/A / N/A				
Rm @ Measured Temp (degF)	N/A @ N/A				
Rmf @ Measured Temp (degF)	N/A @ N/A				
Rmc @ Measured Temp (degF)	N/A @ N/A				
Max Tool Temp (deg F) @ Depth (MD, ft)	174.00 / 2034				

Max Tool Temp (degF) / Source	171.20 / PCM				
Rm @ Max Tool Temp (degF)	N/A @ 171.20				
Lead MWD Engineer	Robert Barnes				
Customer Representative	Jeremy Stolz				

## SENSOR INFORMATION

### Downhole Processor Information

Tool Type	PCM				
Software Version	5.93				
Sub Serial Number	11341335				
Insert Serial Number	11400992				
Date and Time Initialized	17-Sep-15 14:46				
Date and Time Read	20-Sep-15 11:44				
ECMB SW Version	N/A				

### Directional Sensor Information

Tool Type	PCDC				
Distance From Bit (ft)	56.00				
Software Version	6.21				
Sub Serial Number	11341335				
Sonde Serial Number	11297516				
Sensor ID Number	N/A				
Toolface Offset (deg)	32.30				

### Gamma Ray Sensor Information

Tool Type	PCG				
Distance From Bit (ft)	48.90				
Recorded Sample Period (sec)	10				
Software Version	8.15				
Sub Serial Number	11341335				
Insert/Sonde Serial Number	12037420				

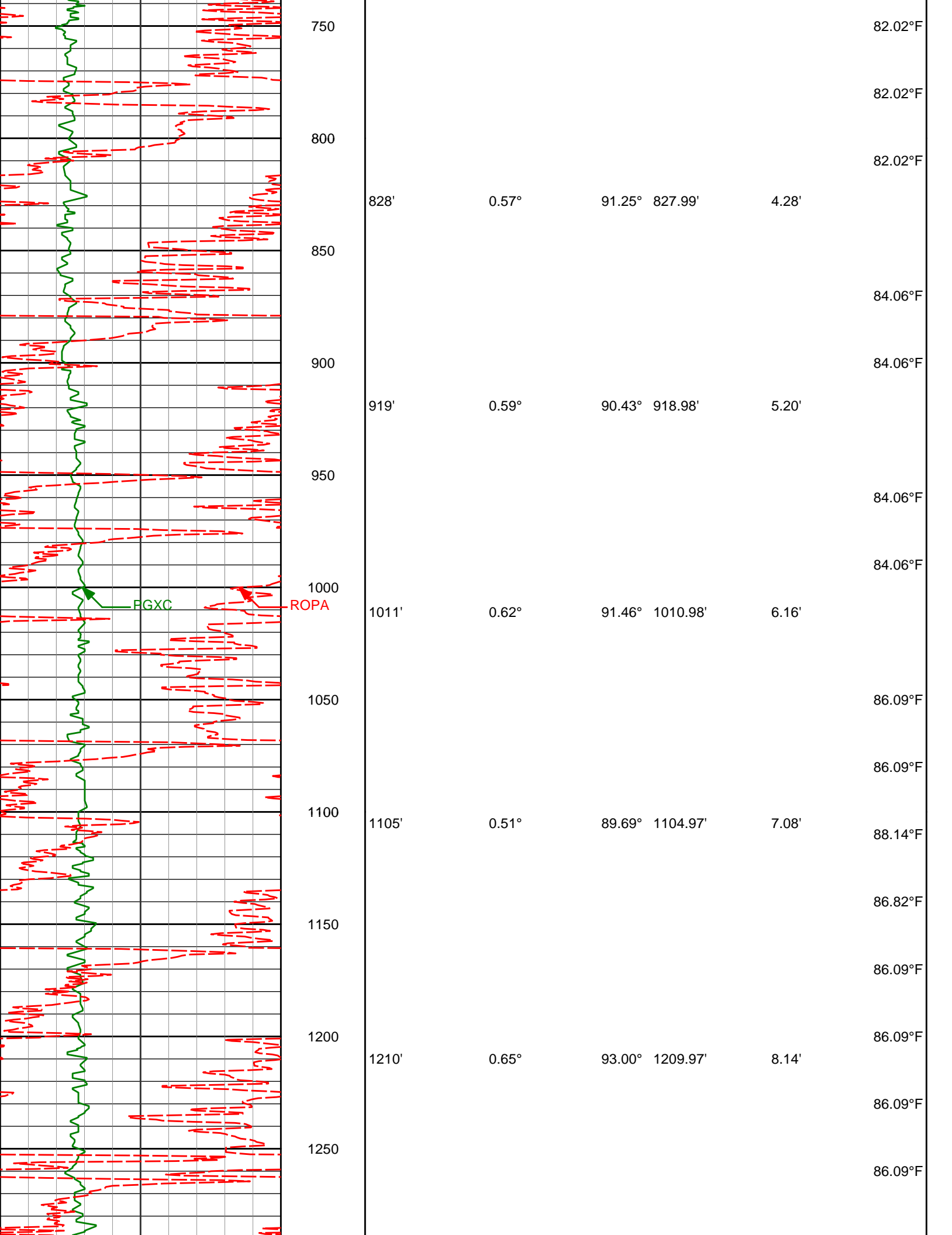
## REMARKS

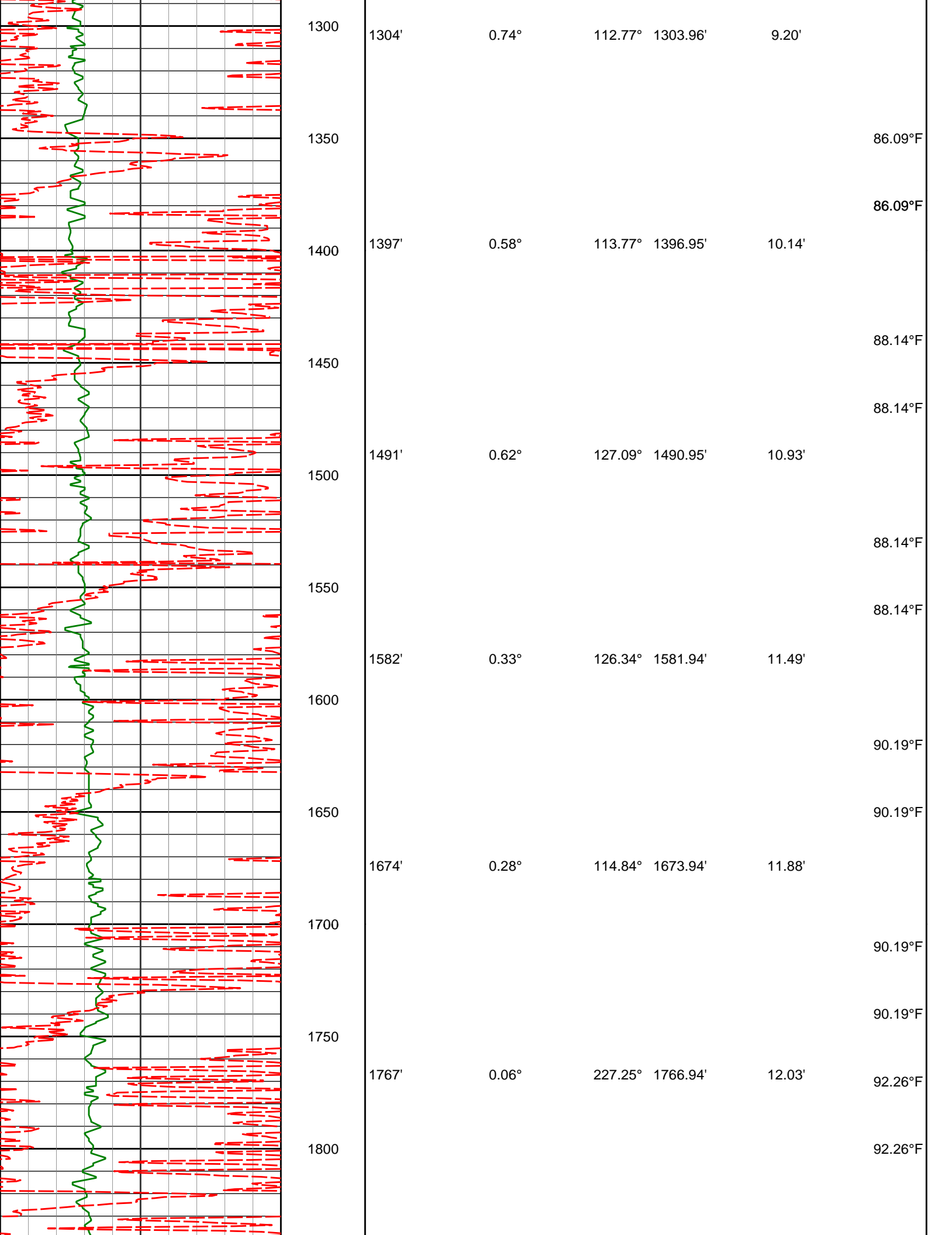
1. All depths are calibrated to driller's pipe tally and are true vertical depth from the Drill Floor.
2. No depth corrections have been made for pipe stretch or compression.
3. All data presented is recorded data unless otherwise specified.
4. The following smoothing parameters have been applied to the data:  
1:600 Log  
PGRC (Gamma CG) and ROPA (Average Rate of Penetration)  
Interval Resolution: 1.0 ft  
Interval Distance: 3.0 ft  
  
1:240 Log  
PGRC (Gamma CG):  
Interval Resolution: 0.5 ft  
Interval Distance: 0.6 ft  
  
ROPA (Average Rate Of Penetration):  
Interval Resolution: 0.5 ft  
Interval Distance: 1.2 ft

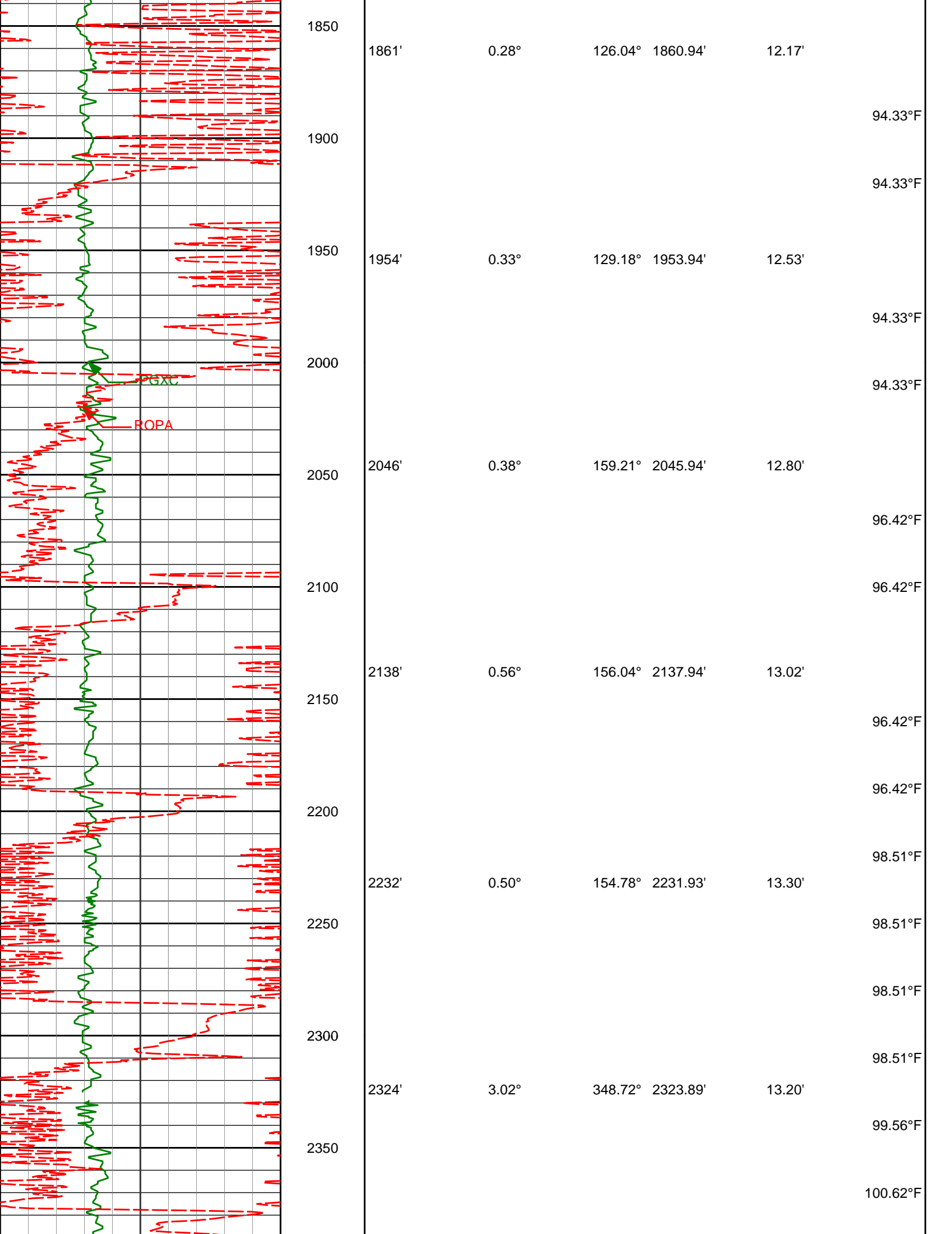
5. Insite Version v8.3

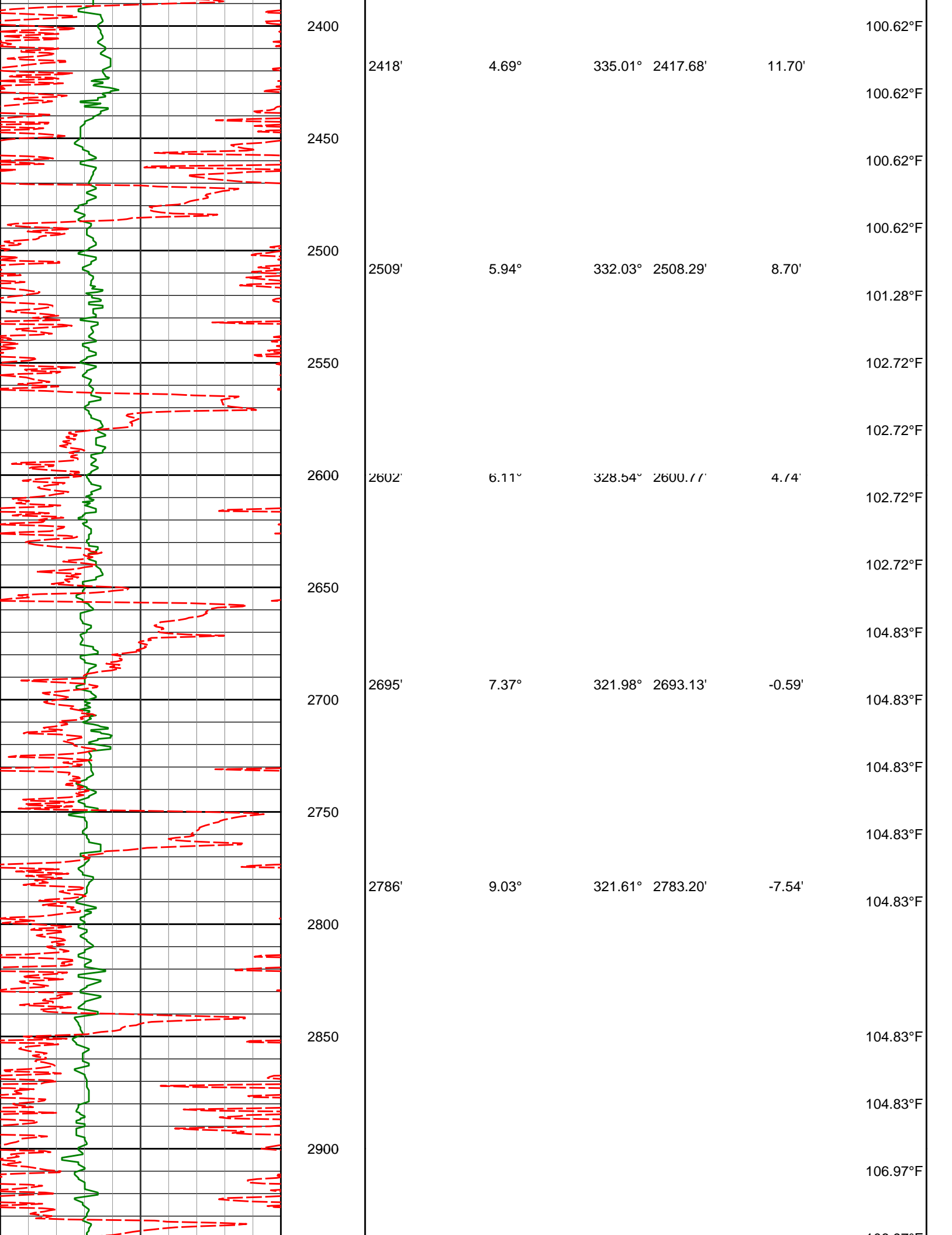
# TVD Detail 1:600 Scale

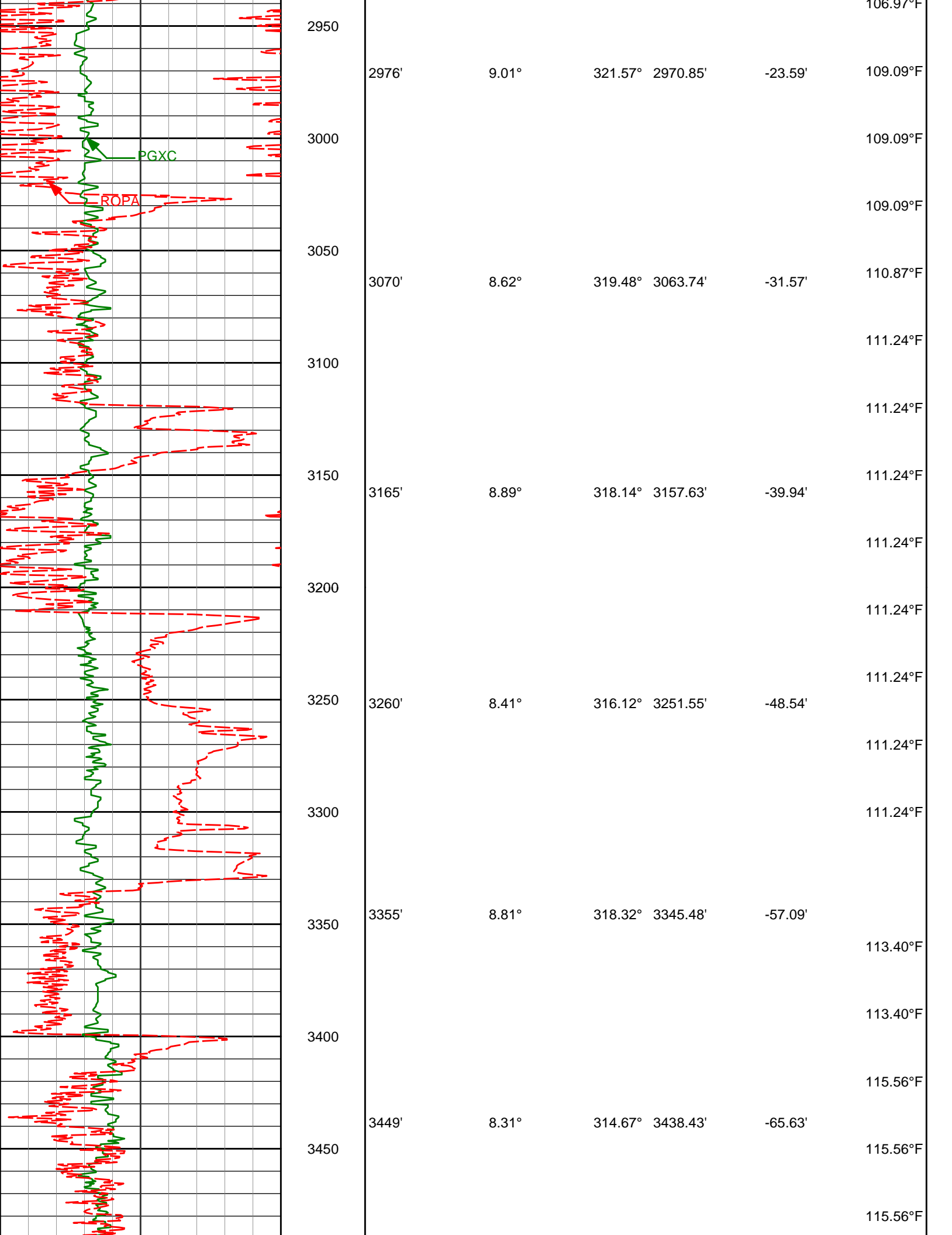
PCG GR XHi-Range RT BCor PGXRC-T api								
0	300							
Avg Rate of Penetration ROPA feet per hr		Depth TVD ft	Depth	Inc	Azi	TVD	V.S.	Temp
1K	0							
		500						80.68°F
								79.03°F
		550						79.30°F
								78.35°F
		600						
								77.99°F
		100						
		650						80.01°F
		700						80.01°F
			734'	0.53°	79.66°	733.99'	3.38'	



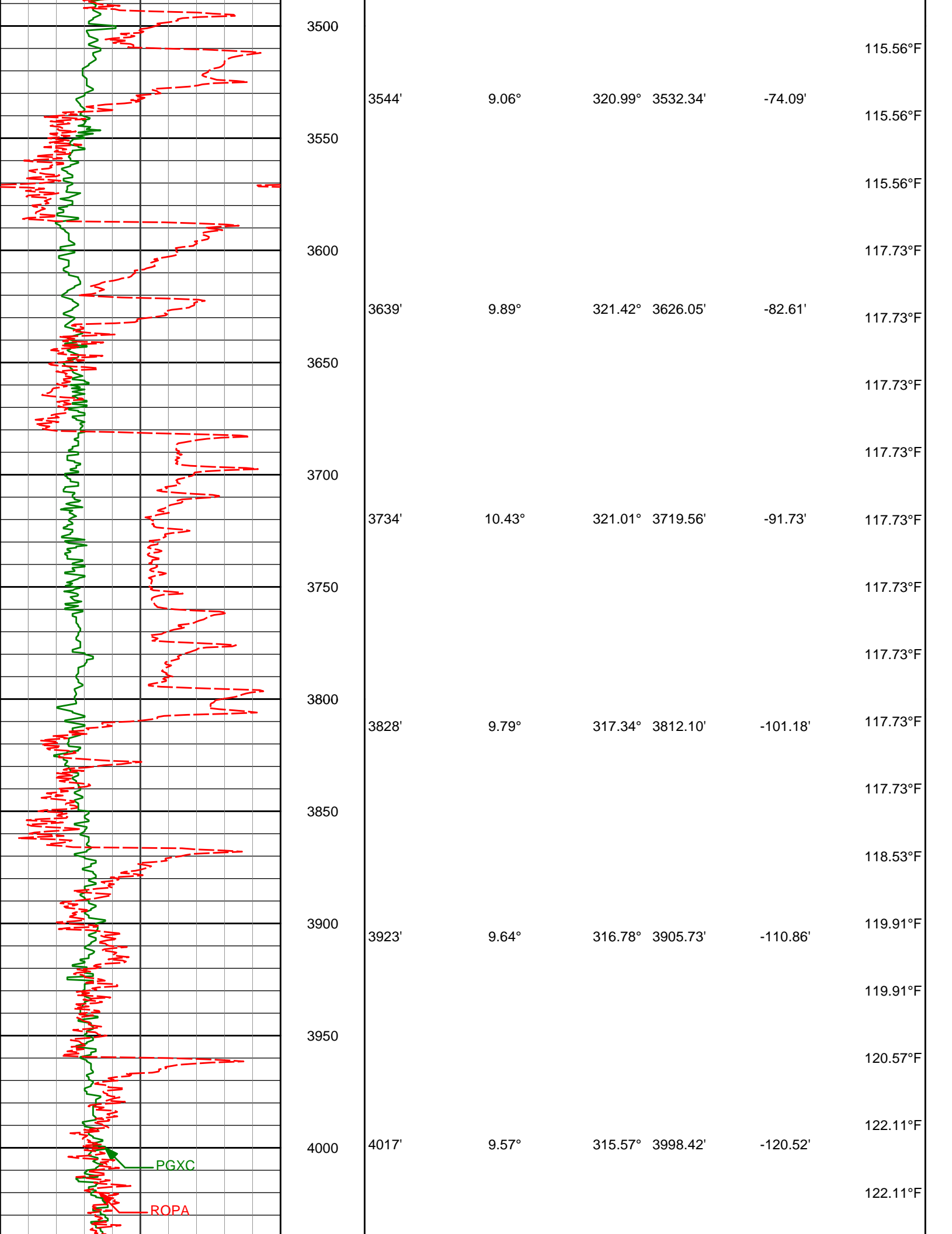


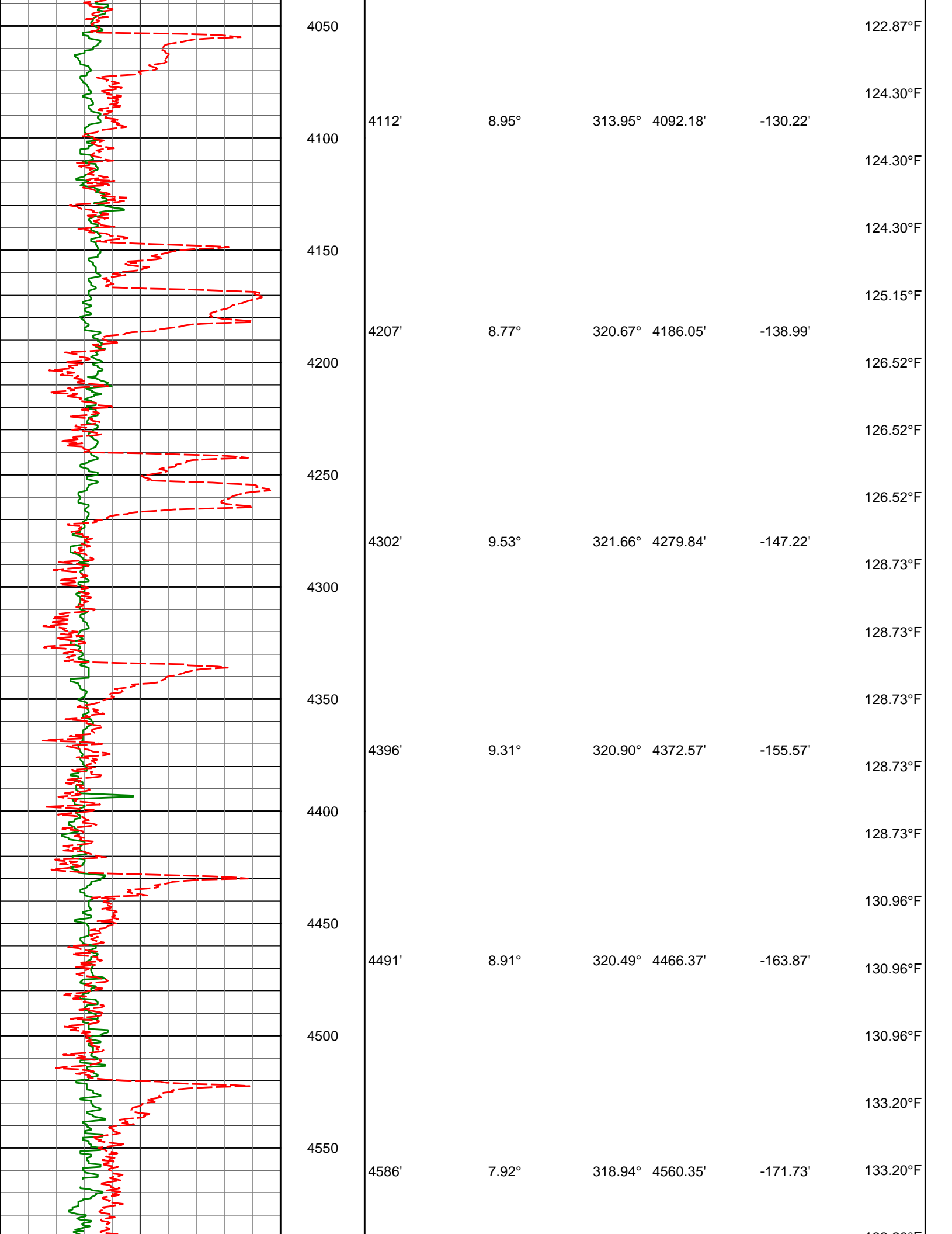


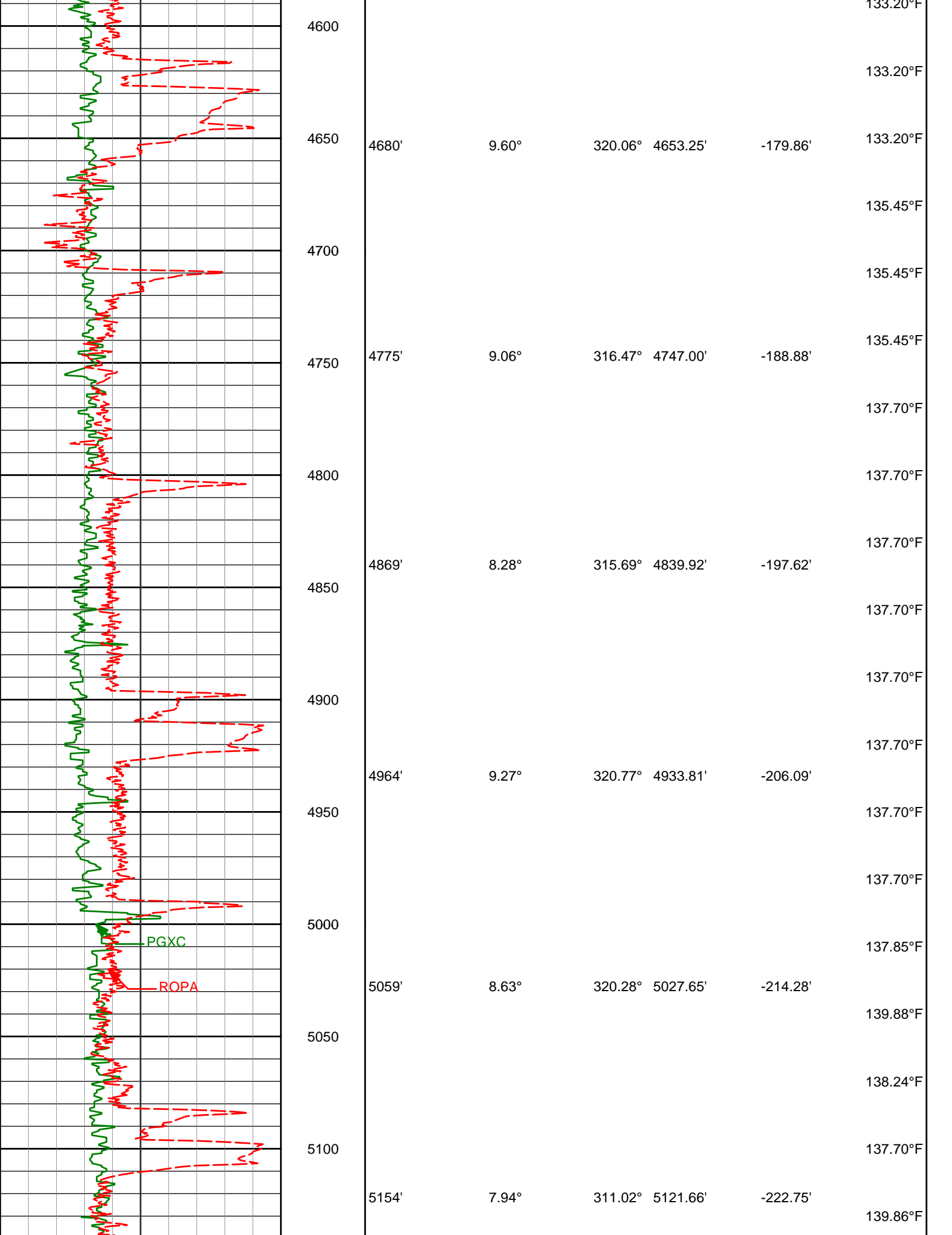


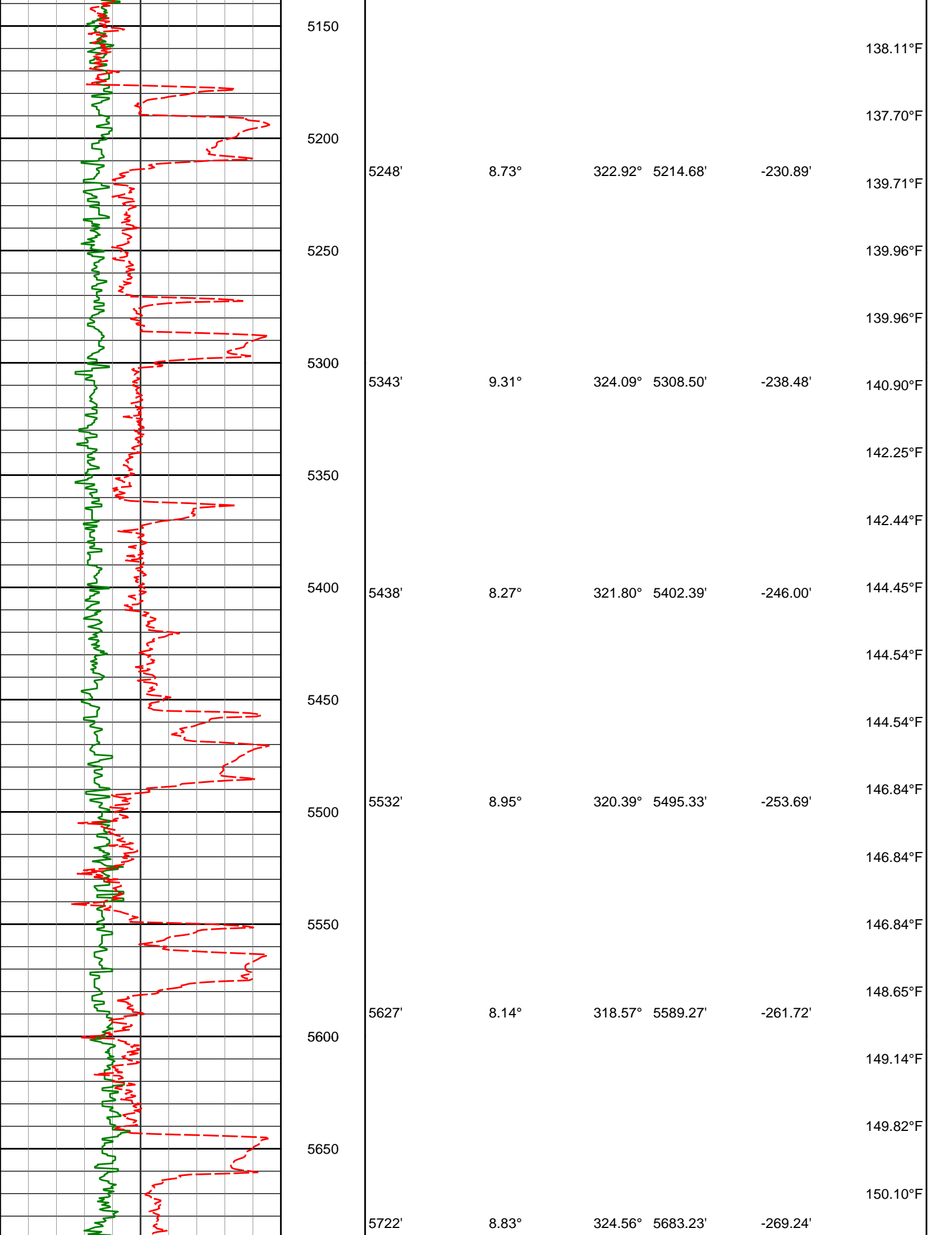


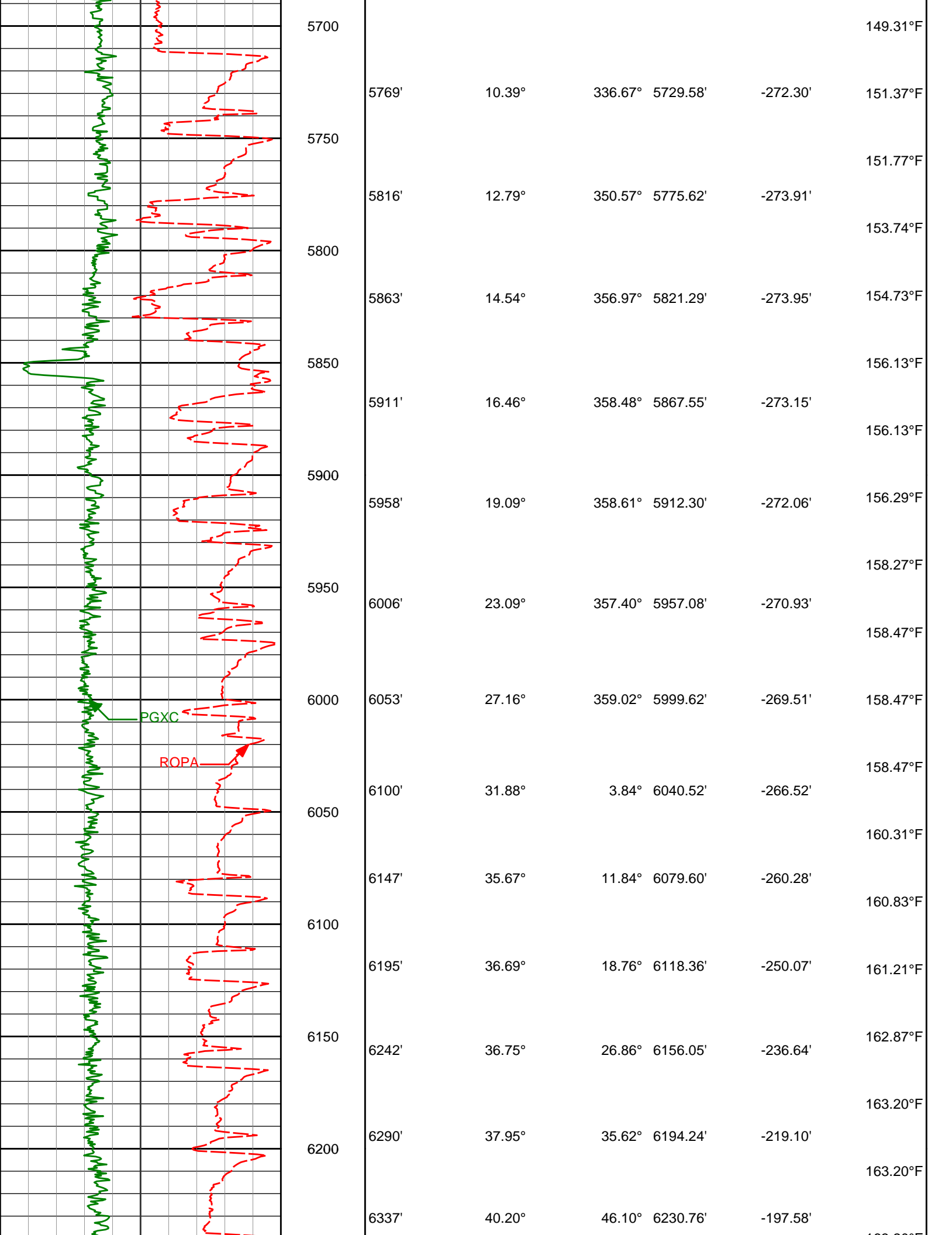


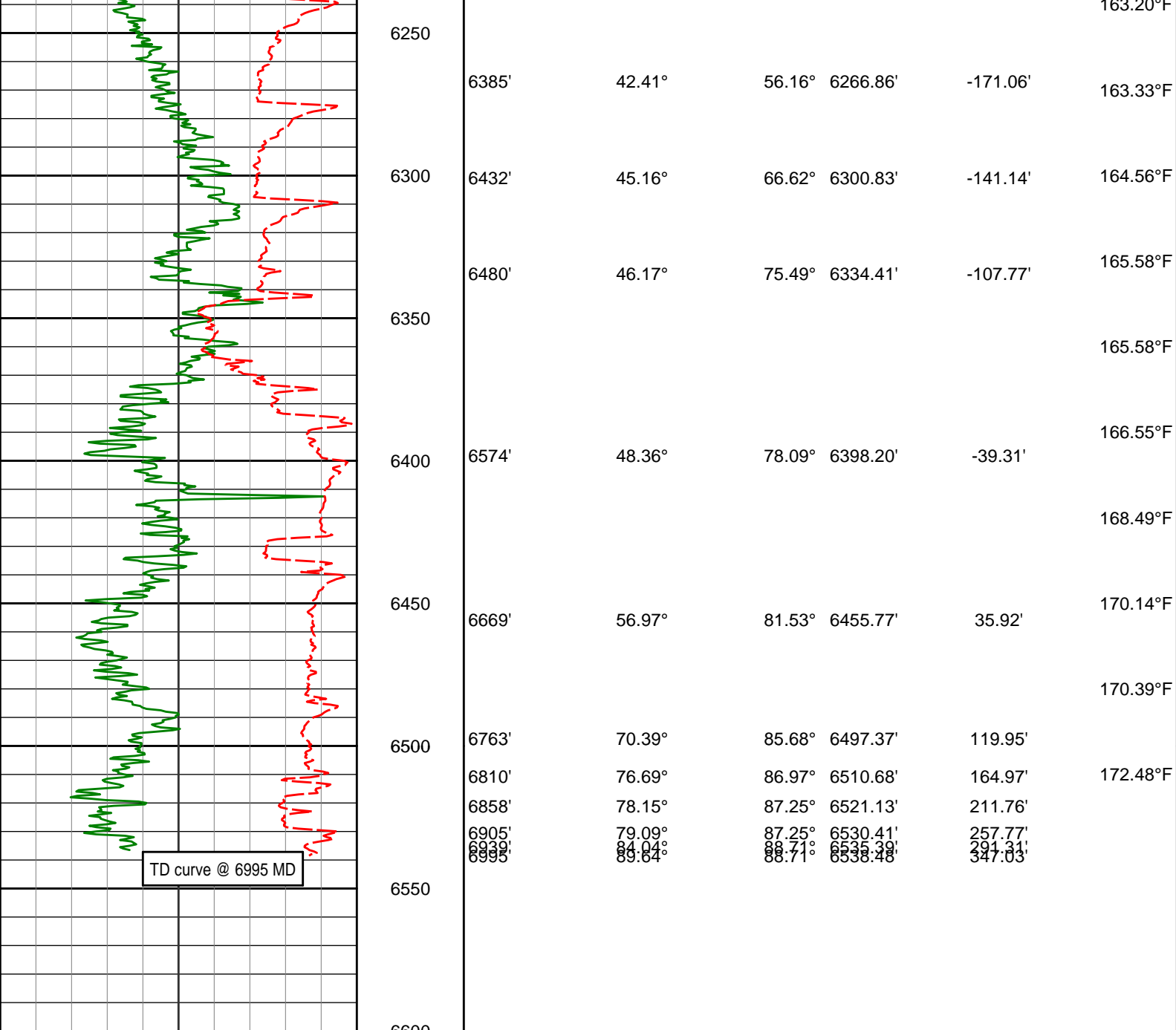








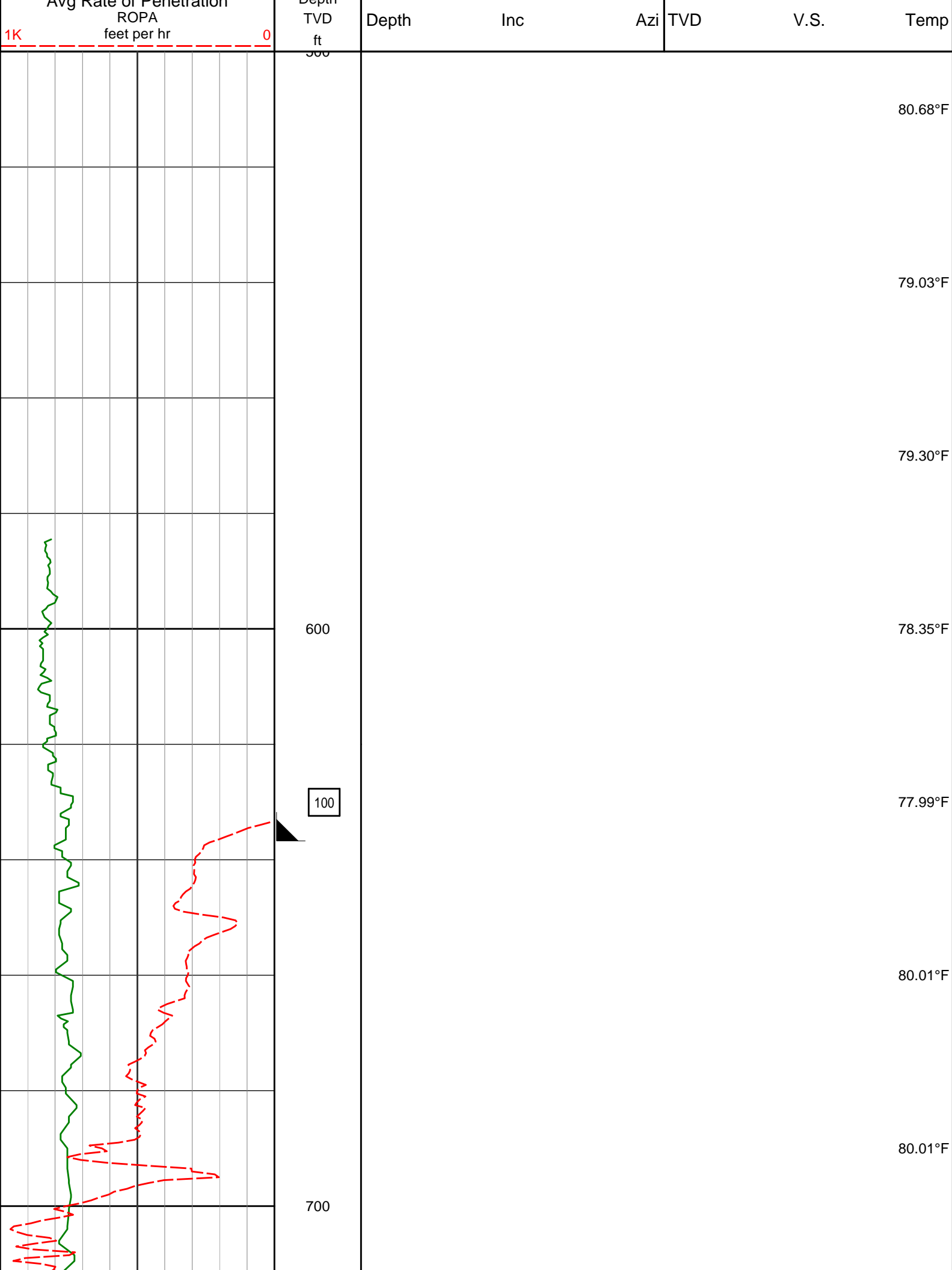


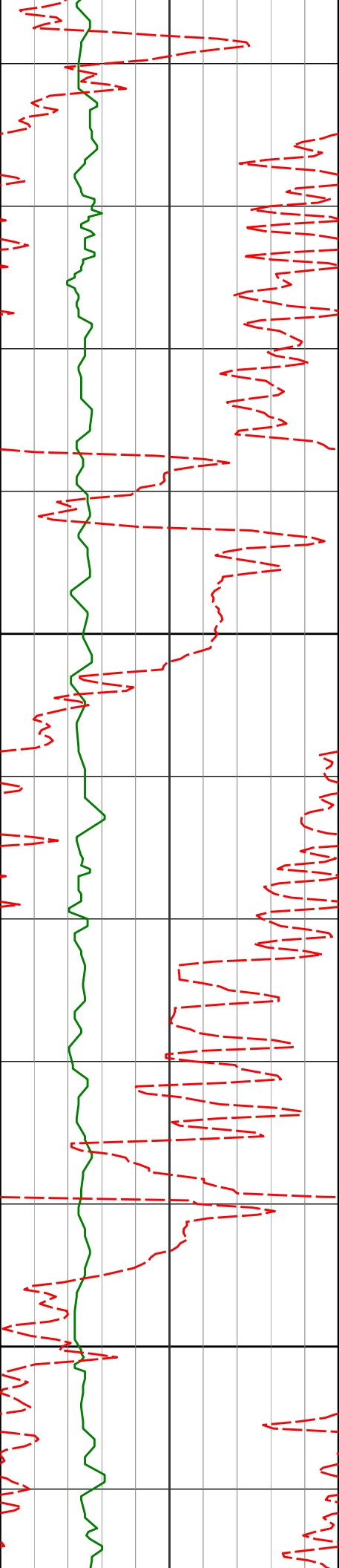


Avg Rate of Penetration ROPA feet per hr		Depth TVD ft	Depth	Inc	Azi	TVD	V.S.	Temp
1K 0								
PCG GR XHi-Range RT BCor PGXRC-T api								
0 300								

TVD Detail 1:240 Scale

PCG GR XHi-Range RT BCor PGXRC-T api								
0 300								
Avg Rate of Penetration		Depth						





734'

0.53°

79.66° 733.99'

3.38'

82.02°F

82.02°F

800

82.02°F

828'

0.57°

91.25° 827.99'

4.28'

84.06°F

900

84.06°F

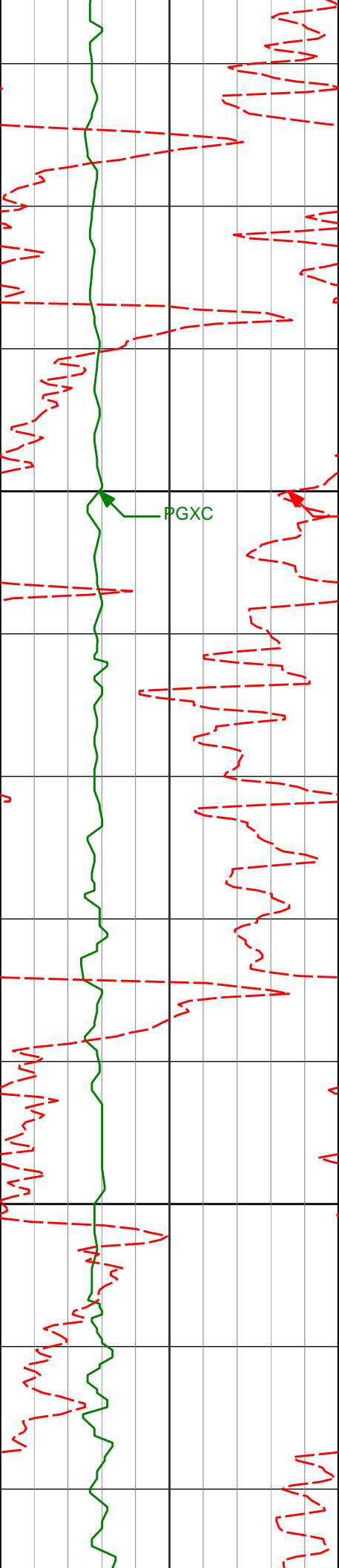
919'

0.59°

90.43° 918.98'

5.20'





1000

PGXC

ROPA

1011'

0.62°

91.46°

1010.98'

6.16'

84.06°F

84.06°F

86.09°F

86.09°F

1100

1105'

0.51°

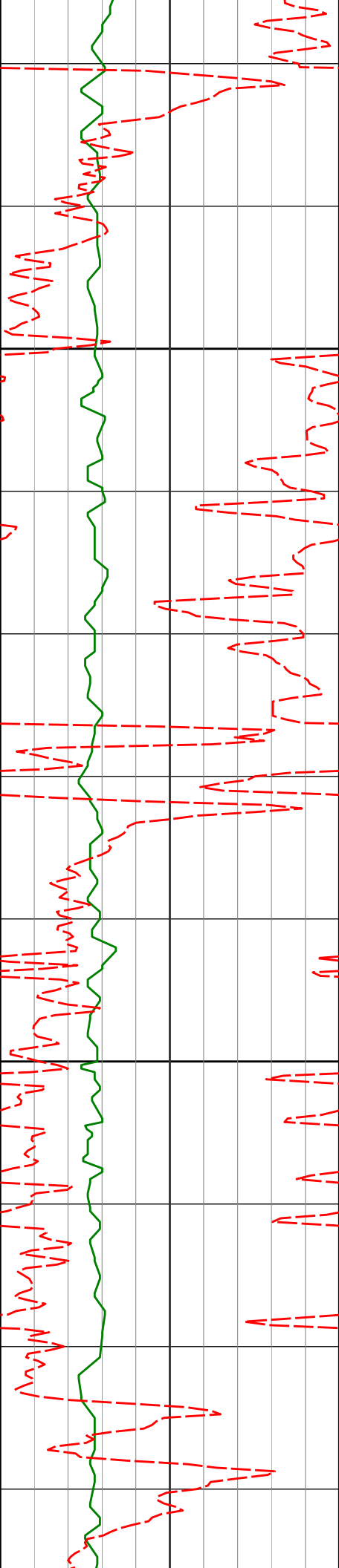
89.69°

1104.97'

7.08'

88.14°F

86.82°F



1200

1210'

0.65°

93.00°

1209.97'

8.14'

1300

1304'

0.74°

112.77°

1303.96'

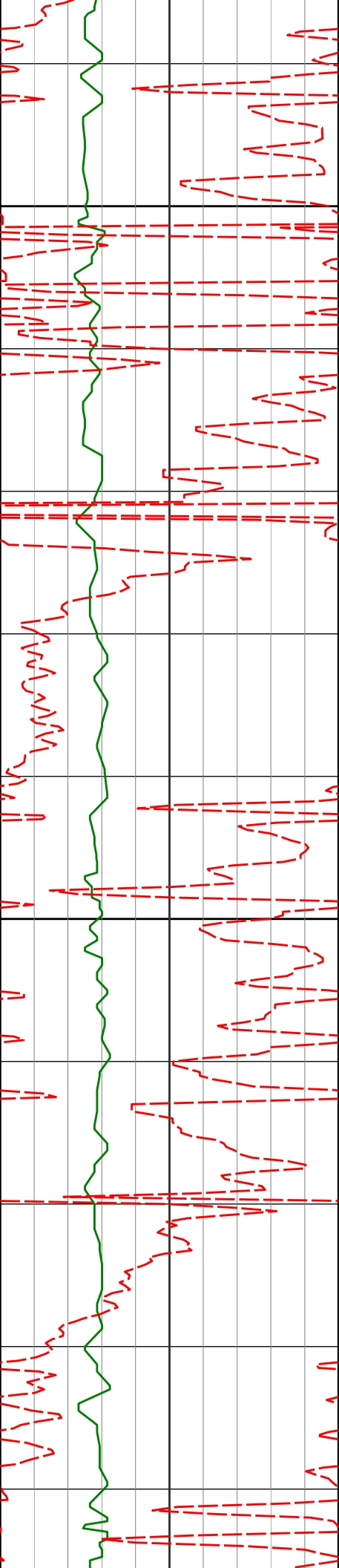
9.20'

86.09°F

86.09°F

86.09°F

86.09°F



1400

1397'

0.58°

113.77°

1396.95'

10.14'

86.09°F

88.14°F

88.14°F

1500

1491'

0.62°

127.09°

1490.95'

10.93'

88.14°F

88.14°F

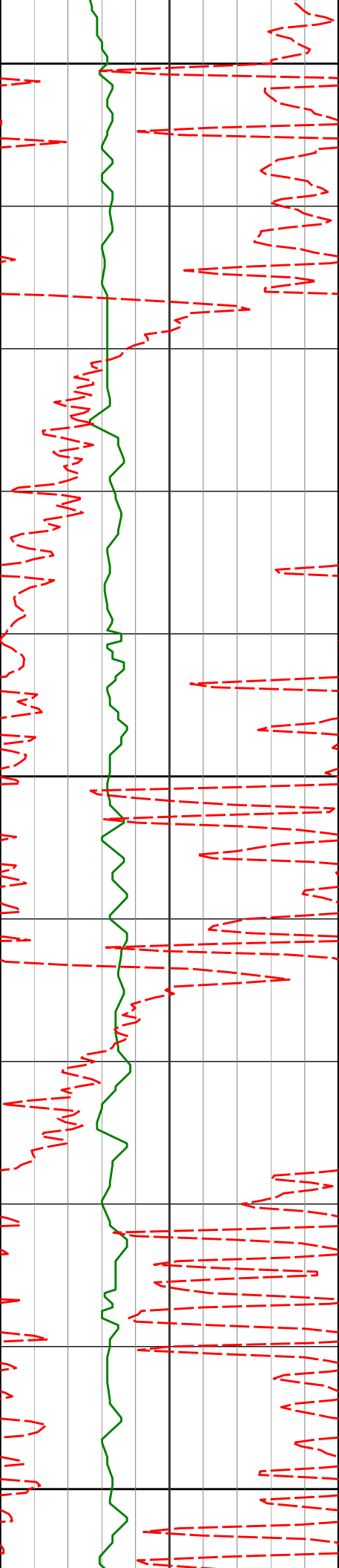
1582'

0.33°

126.34°

1581.94'

11.49'



1600

90.19°F

90.19°F

1674'

0.28°

114.84°

1673.94'

11.88'

1700

90.19°F

90.19°F

1767'

0.06°

227.25°

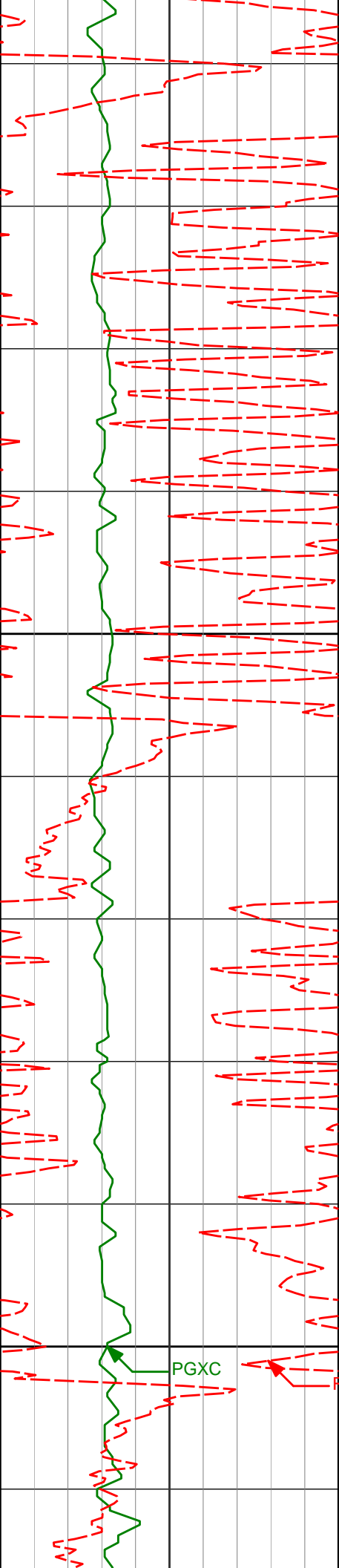
1766.94'

12.03'

92.26°F

1800

92.26°F



1861'

0.28°

126.04°

1860.94'

12.17'

1900

94.33°F

94.33°F

1954'

0.33°

129.18°

1953.94'

12.53'

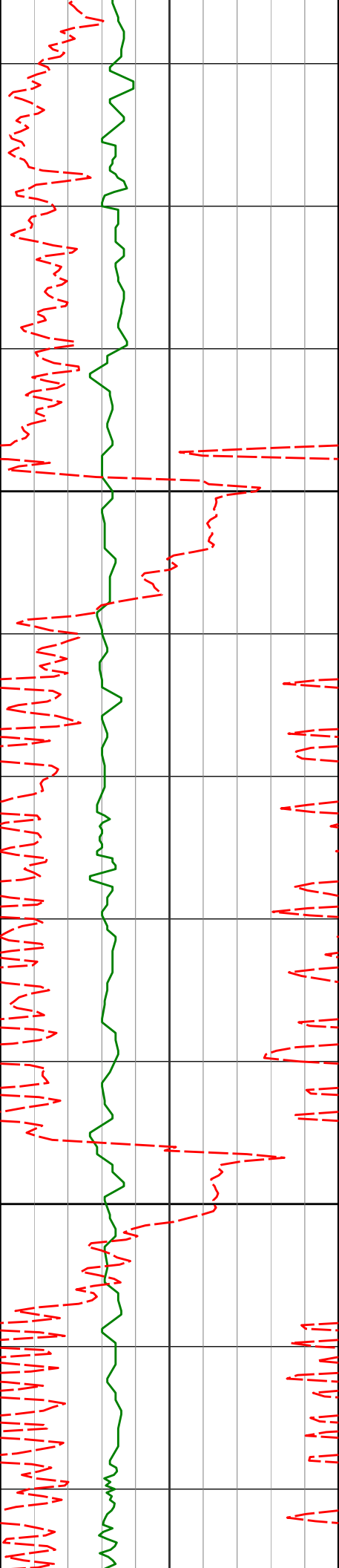
94.33°F

2000

PGXC

ROPA

94.33°F



2046'

0.38°

159.21°

2045.94'

12.80'

96.42°F

2100

96.42°F

2138'

0.56°

156.04°

2137.94'

13.02'

96.42°F

96.42°F

2200

98.51°F

2232'

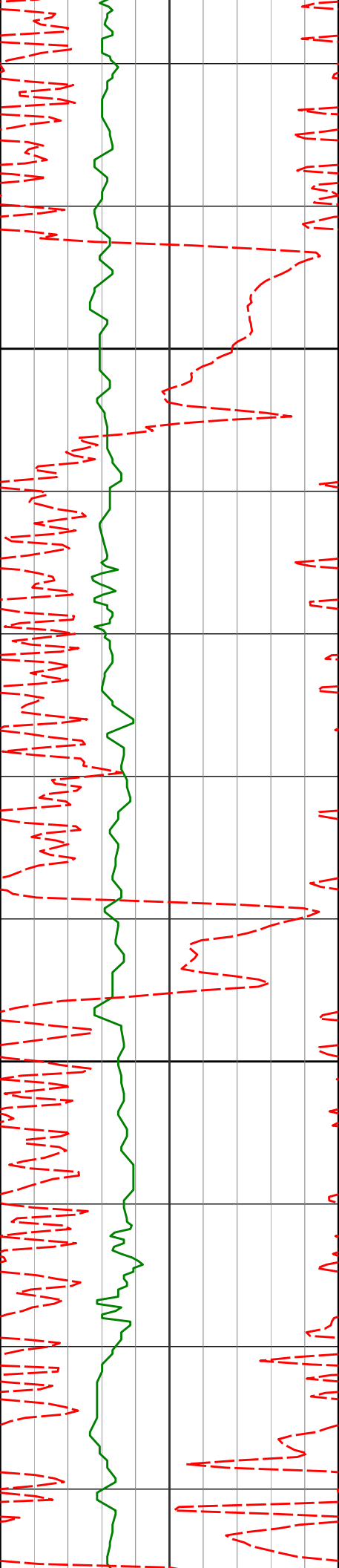
0.50°

154.78°

2231.93'

13.30'

98.51°F



2300

2324'

3.02°

348.72°

2323.89'

13.20'

2400

2418'

4.69°

335.01°

2417.68'

11.70'

98.51°F

98.51°F

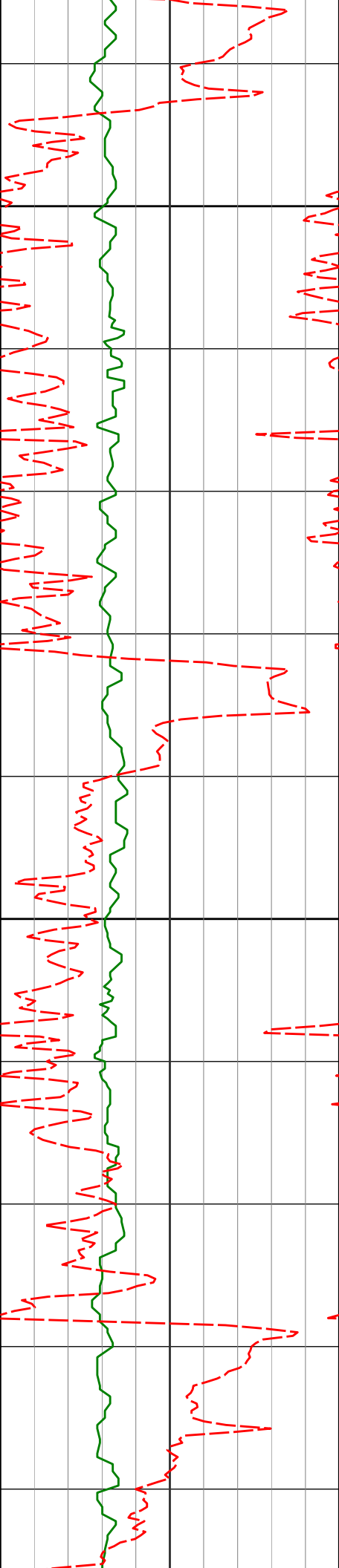
99.56°F

100.62°F

100.62°F

100.62°F

100.62°F



2500

2600

2509'

2602'

5.94°

6.11°

332.03°

328.54°

2508.29'

2600.77'

8.70'

4.74'

100.62°F

101.28°F

102.72°F

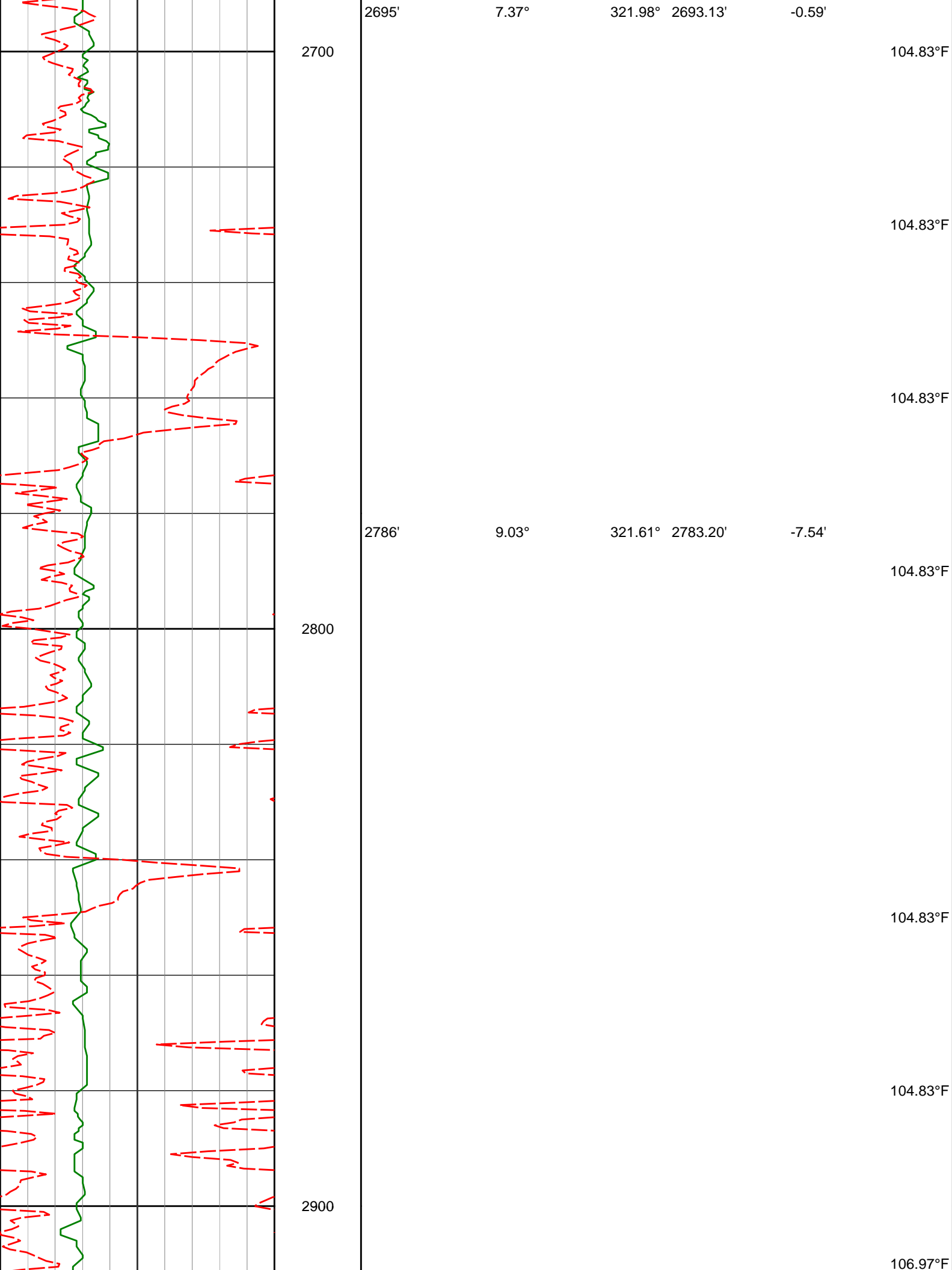
102.72°F

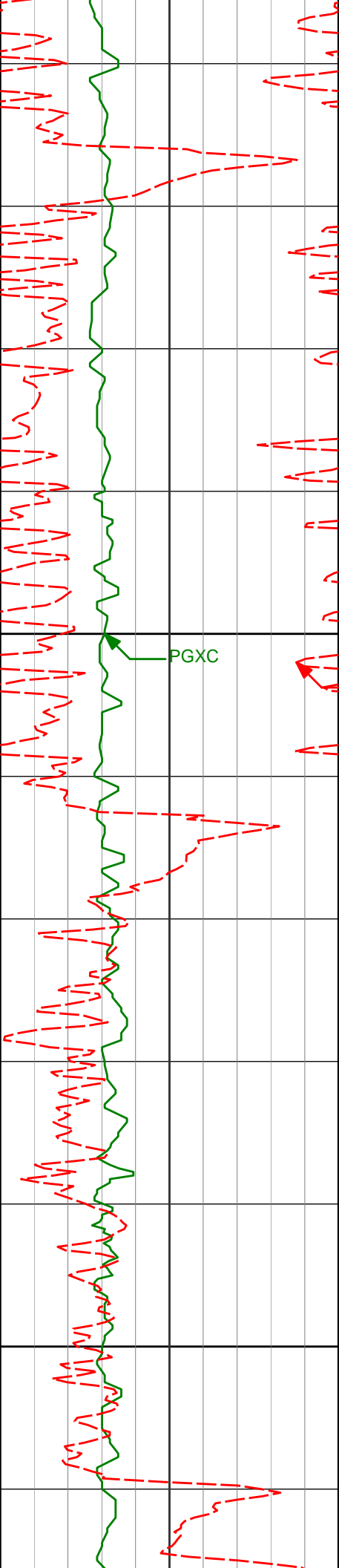
102.72°F

102.72°F

104.83°F







2976'

9.01°

321.57°

2970.85'

-23.59'

106.97°F

109.09°F

3000

109.09°F

PGXC

ROPA

109.09°F

3070'

8.62°

319.48°

3063.74'

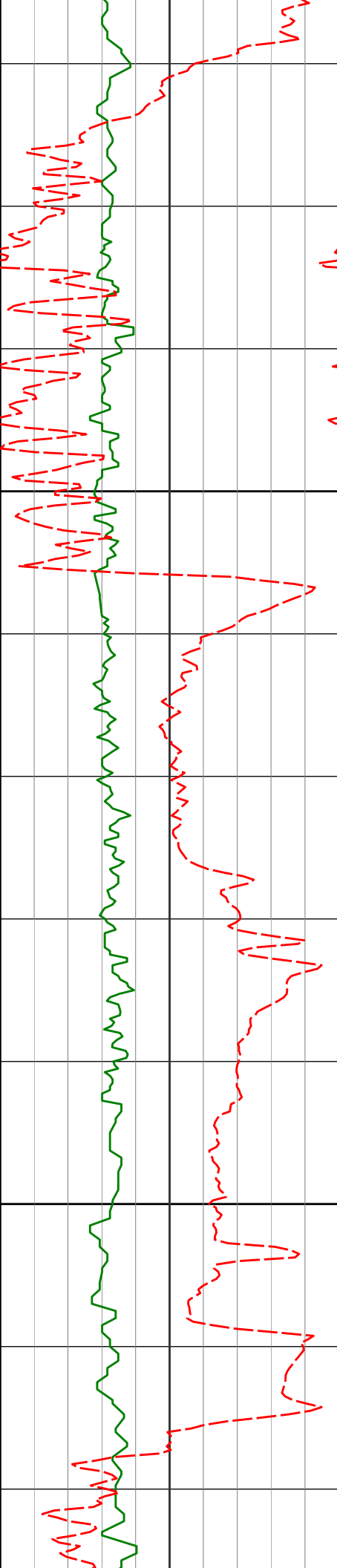
-31.57'

110.87°F

111.24°F

3100

111.24°F



3200

3300

3165'

8.89°

318.14°

3157.63'

-39.94'

3260'

8.41°

316.12°

3251.55'

-48.54'

3355'

8.81°

318.32°

3345.48'

-57.09'

111.24°F

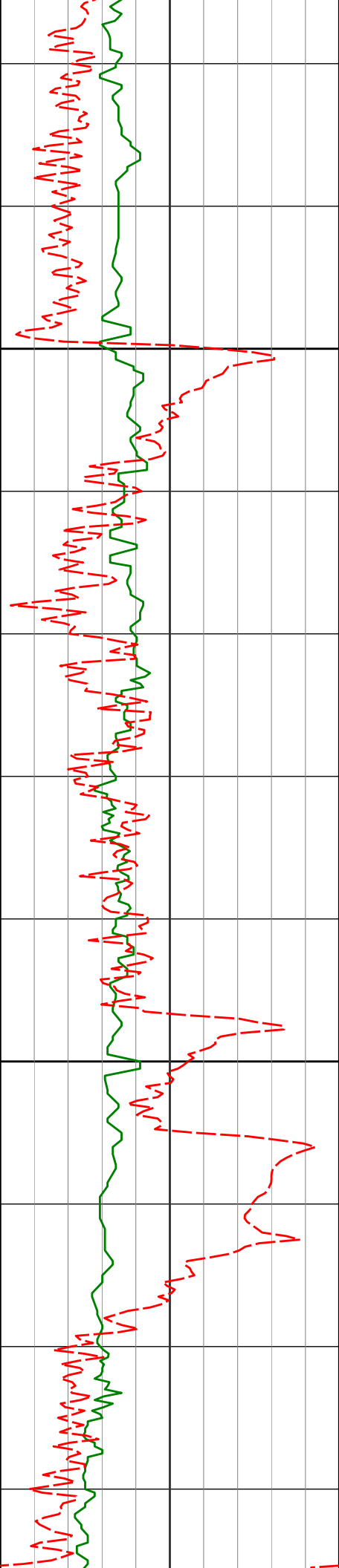
111.24°F

111.24°F

111.24°F

111.24°F

111.24°F



3400

3500

3449'

8.31°

314.67°

3438.43'

-65.63'

3544'

9.06°

320.99°

3532.34'

-74.09'

113.40°F

113.40°F

115.56°F

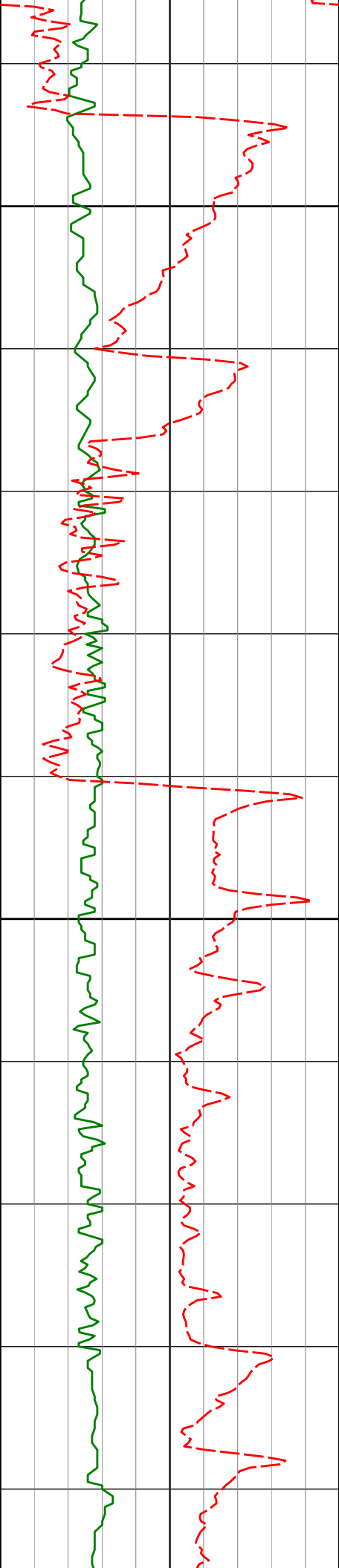
115.56°F

115.56°F

115.56°F

115.56°F

115.56°F



3600

3639'

9.89°

321.42°

3626.05'

-82.61'

117.73°F

117.73°F

117.73°F

117.73°F

3700

3734'

10.43°

321.01°

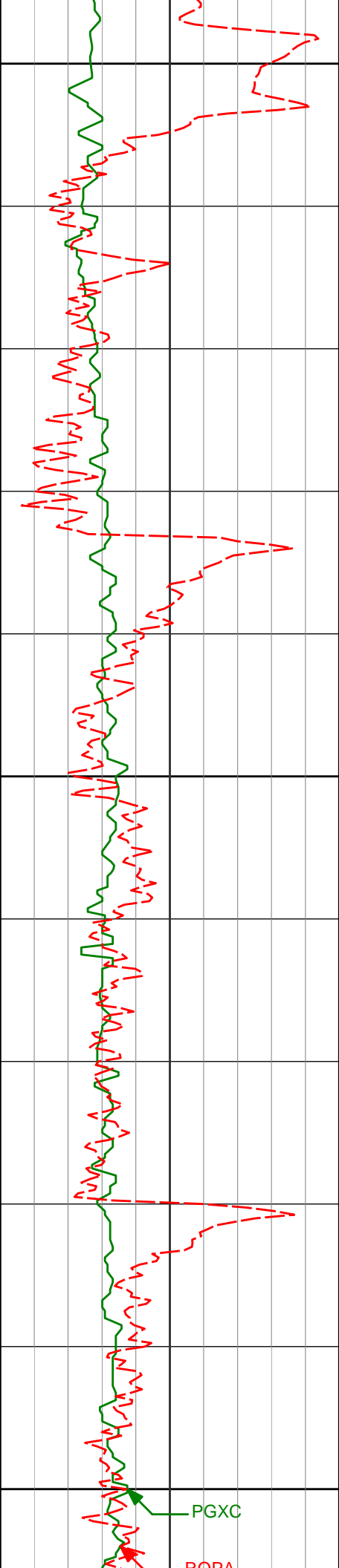
3719.56'

-91.73'

117.73°F

117.73°F

117.73°F



3800

3828'

9.79°

317.34°

3812.10'

-101.18'

117.73°F

117.73°F

118.53°F

3900

3923'

9.64°

316.78°

3905.73'

-110.86'

119.91°F

119.91°F

120.57°F

4000

4017'

9.57°

315.57°

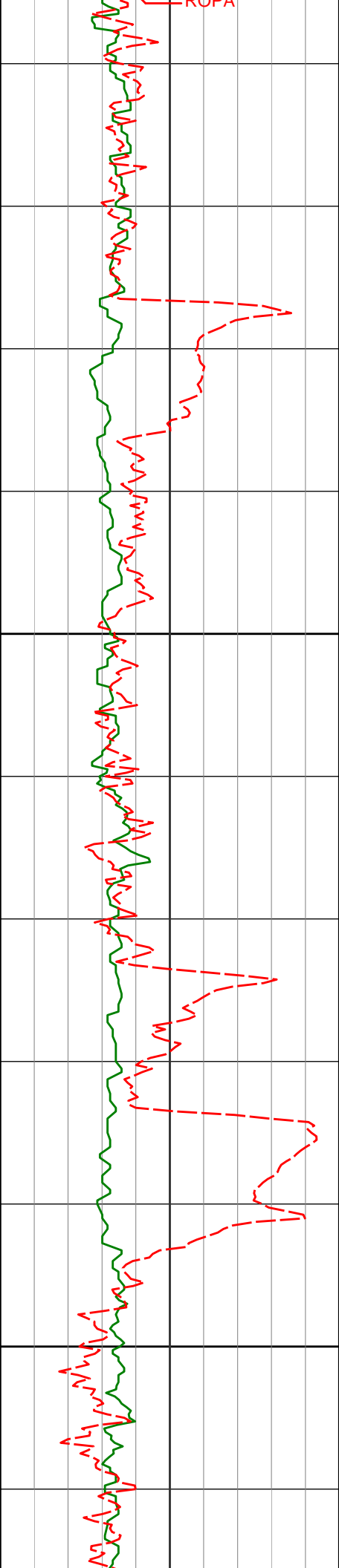
3998.42'

-120.52'

122.11°F

PGXC

BOBA



4100

4112'

8.95°

313.95°

4092.18'

-130.22'

4200

4207'

8.77°

320.67°

4186.05'

-138.99'

122.11°F

122.87°F

124.30°F

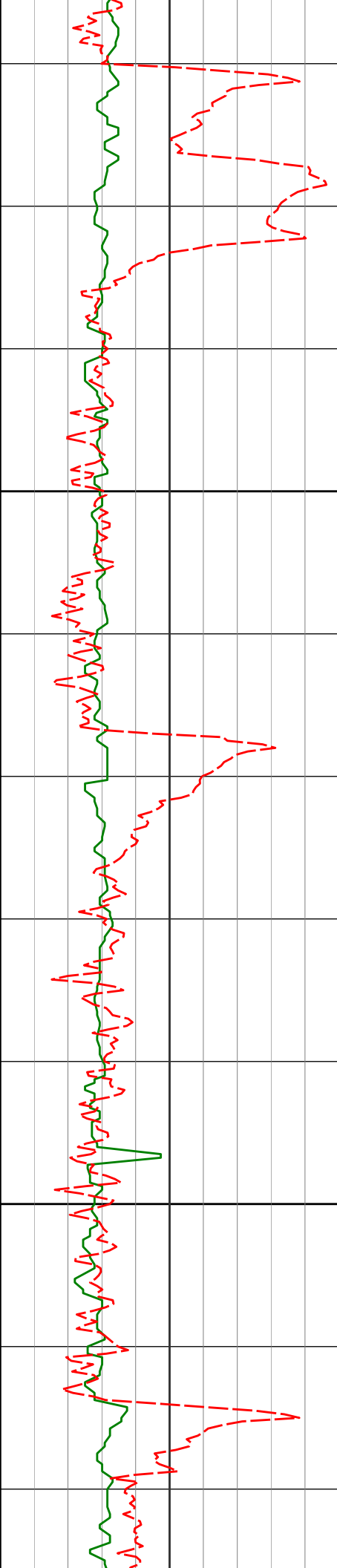
124.30°F

124.30°F

125.15°F

126.52°F

126.52°F



4300

4400

4302'

4396'

9.53°

9.31°

321.66° 4279.84'

320.90° 4372.57'

-147.22'

-155.57'

126.52°F

128.73°F

128.73°F

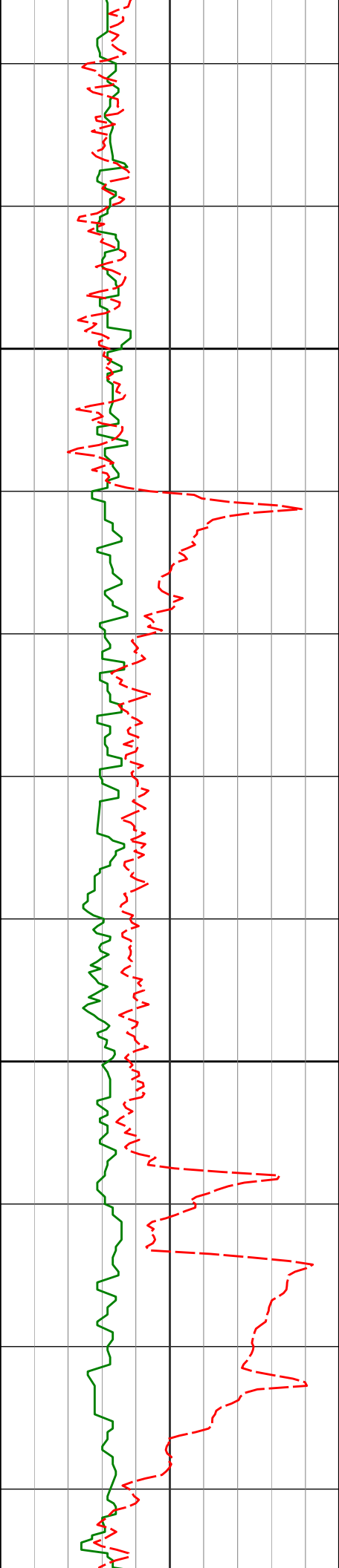
128.73°F

128.73°F

128.73°F

130.96°F





4491'

8.91°

320.49°

4466.37'

-163.87'

130.96°F

4500

130.96°F

133.20°F

4586'

7.92°

318.94°

4560.35'

-171.73'

133.20°F

133.20°F

4600

133.20°F

4680'

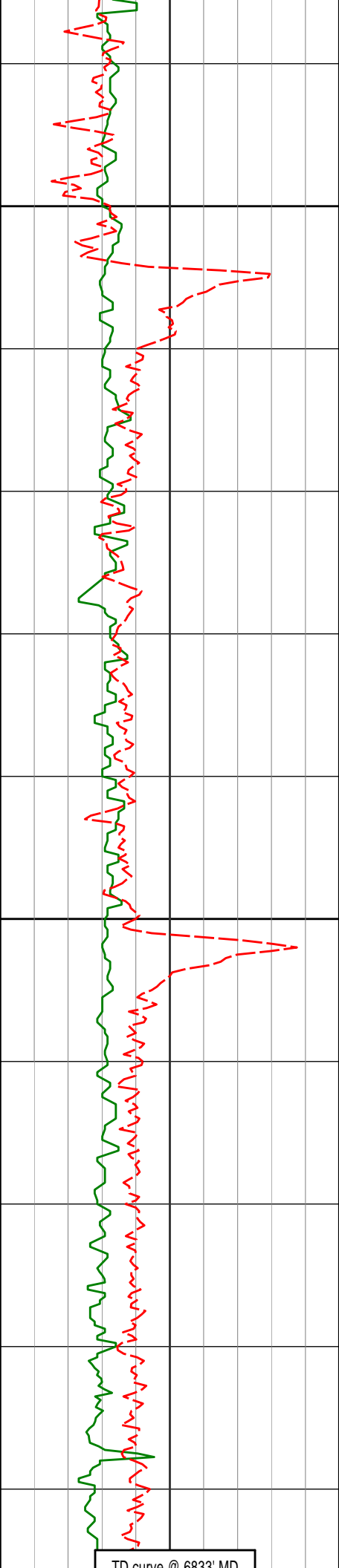
9.60°

320.06°

4653.25'

-179.86'

133.20°F



4700

4775'

9.06°

316.47° 4747.00'

-188.88'

4800

4869'

8.28°

315.69° 4839.92'

-197.62'

135.45°F

135.45°F

135.45°F

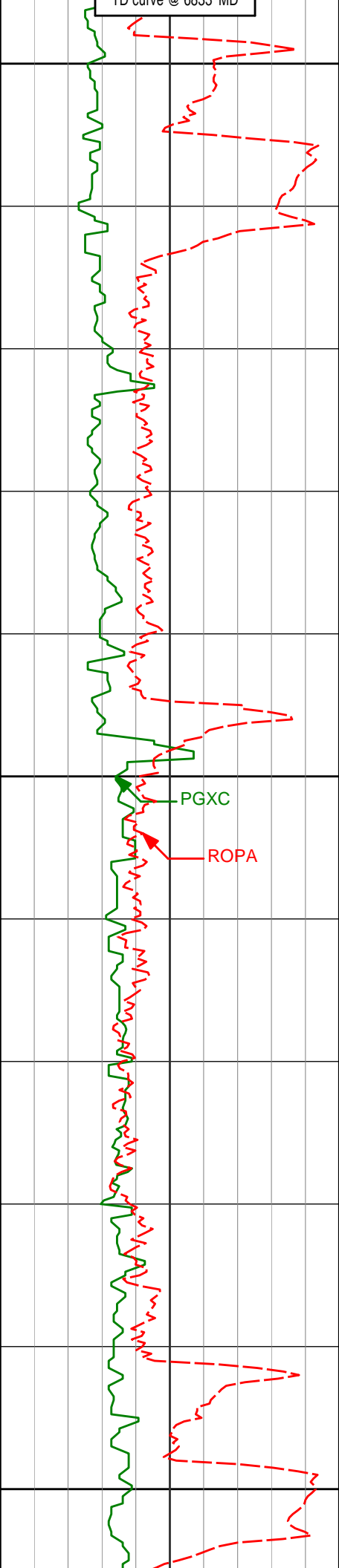
137.70°F

137.70°F

137.70°F

137.70°F

137.70°F



4900

4964'

9.27°

320.77°

4933.81'

-206.09'

137.70°F

137.70°F

137.70°F

5000

5059'

8.63°

320.28°

5027.65'

-214.28'

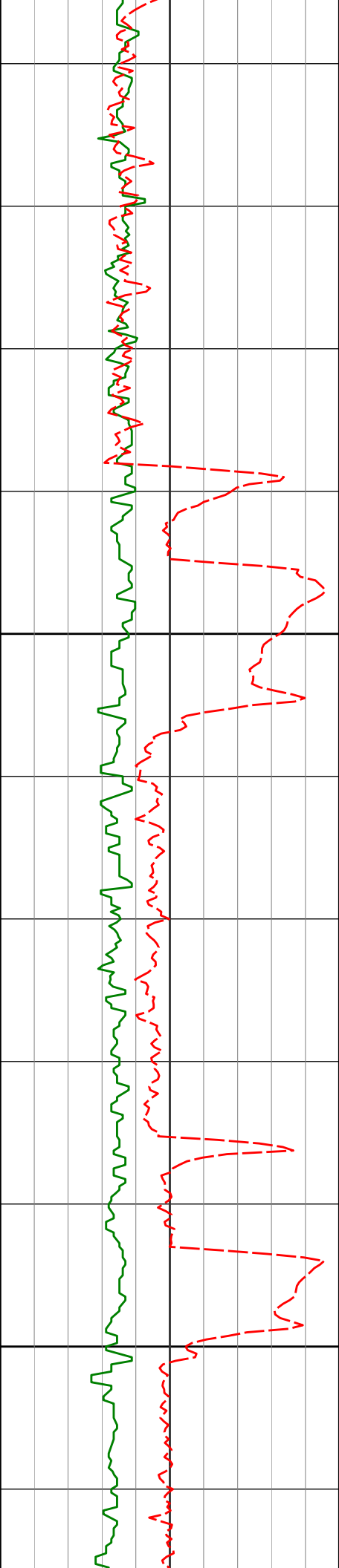
137.85°F

139.88°F

138.24°F

5100

137.70°F



5200

5300

5154'

7.94°

311.02° 5121.66'

-222.75'

139.86°F

138.11°F

137.70°F

5248'

8.73°

322.92° 5214.68'

-230.89'

139.71°F

139.96°F

139.96°F

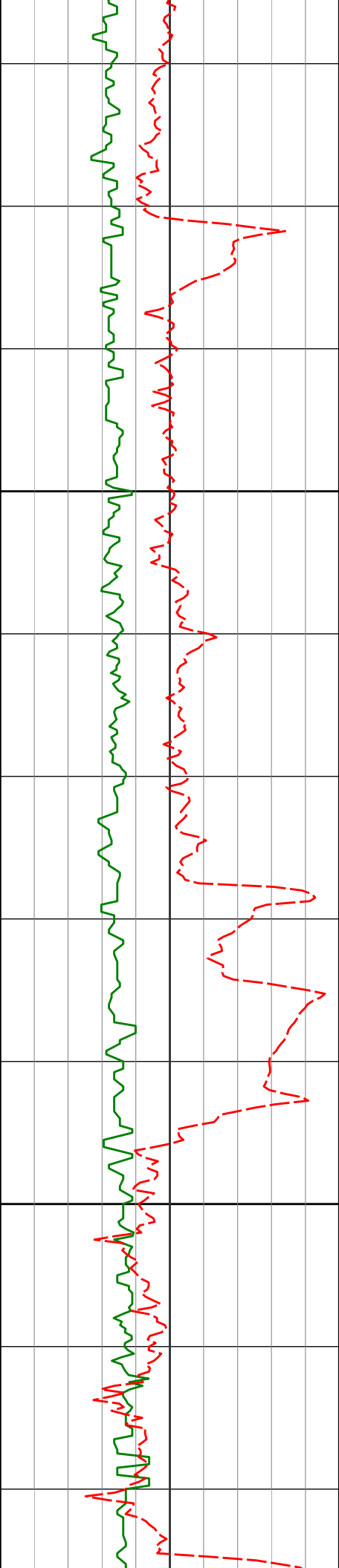
5343'

9.31°

324.09° 5308.50'

-238.48'

140.90°F



5400

5438'

8.27°

321.80°

5402.39'

-246.00'

144.45°F

144.54°F

144.54°F

5500

5532'

8.95°

320.39°

5495.33'

-253.69'

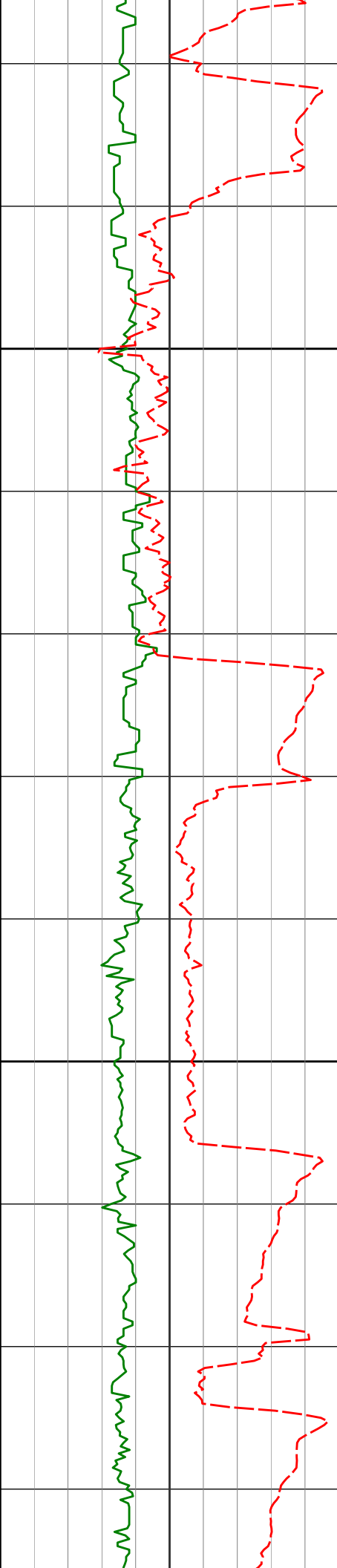
146.84°F

146.84°F

146.84°F

142.25°F

142.44°F



5600

5700

5627'

8.14°

318.57°

5589.27'

-261.72'

148.65°F

149.14°F

149.82°F

150.10°F

5722'

8.83°

324.56°

5683.23'

-269.24'

149.31°F

5769'

10.39°

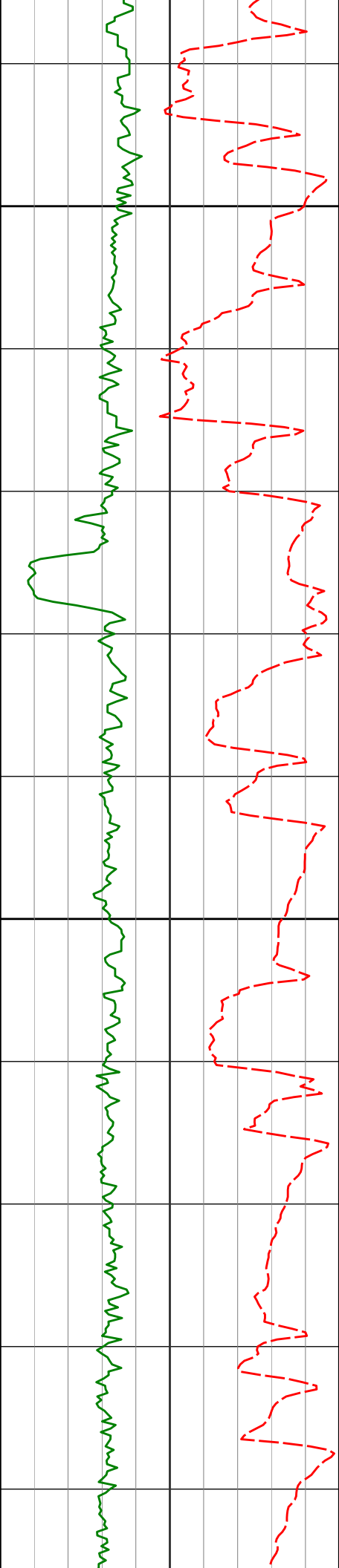
336.67°

5729.58'

-272.30'

151.37°F

151.77°F



5800

5900

5816'

12.79°

350.57°

5775.62'

-273.91'

153.74°F

5863'

14.54°

356.97°

5821.29'

-273.95'

154.73°F

5911'

16.46°

358.48°

5867.55'

-273.15'

156.13°F

156.13°F

5958'

19.09°

358.61°

5912.30'

-272.06'

156.29°F

158.27°F

6006'

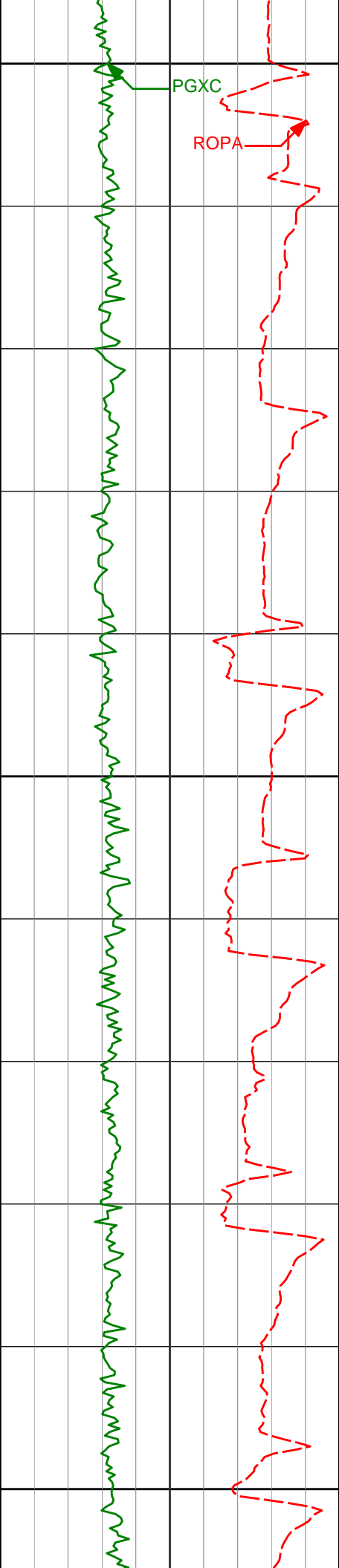
23.09°

357.40°

5957.08'

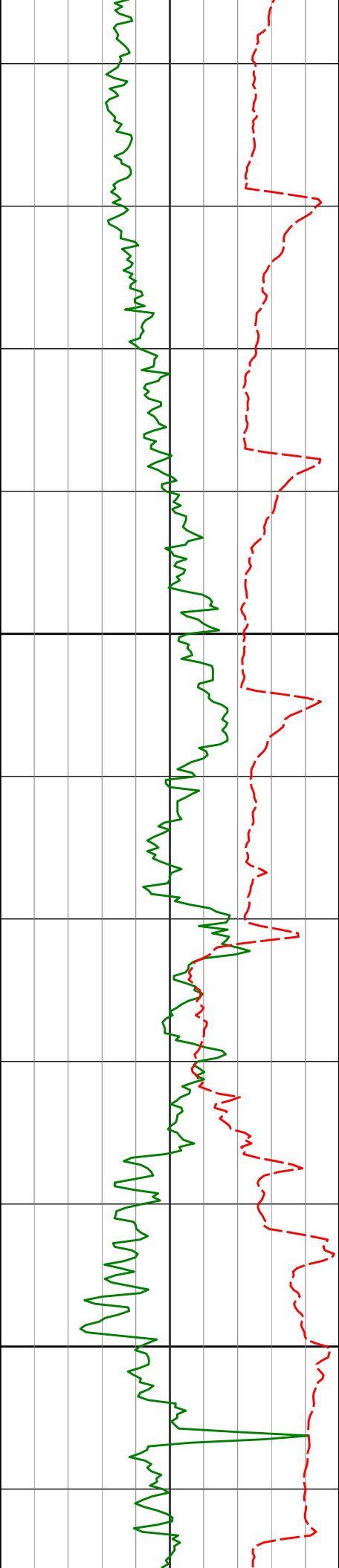
-270.93'

158.47°F

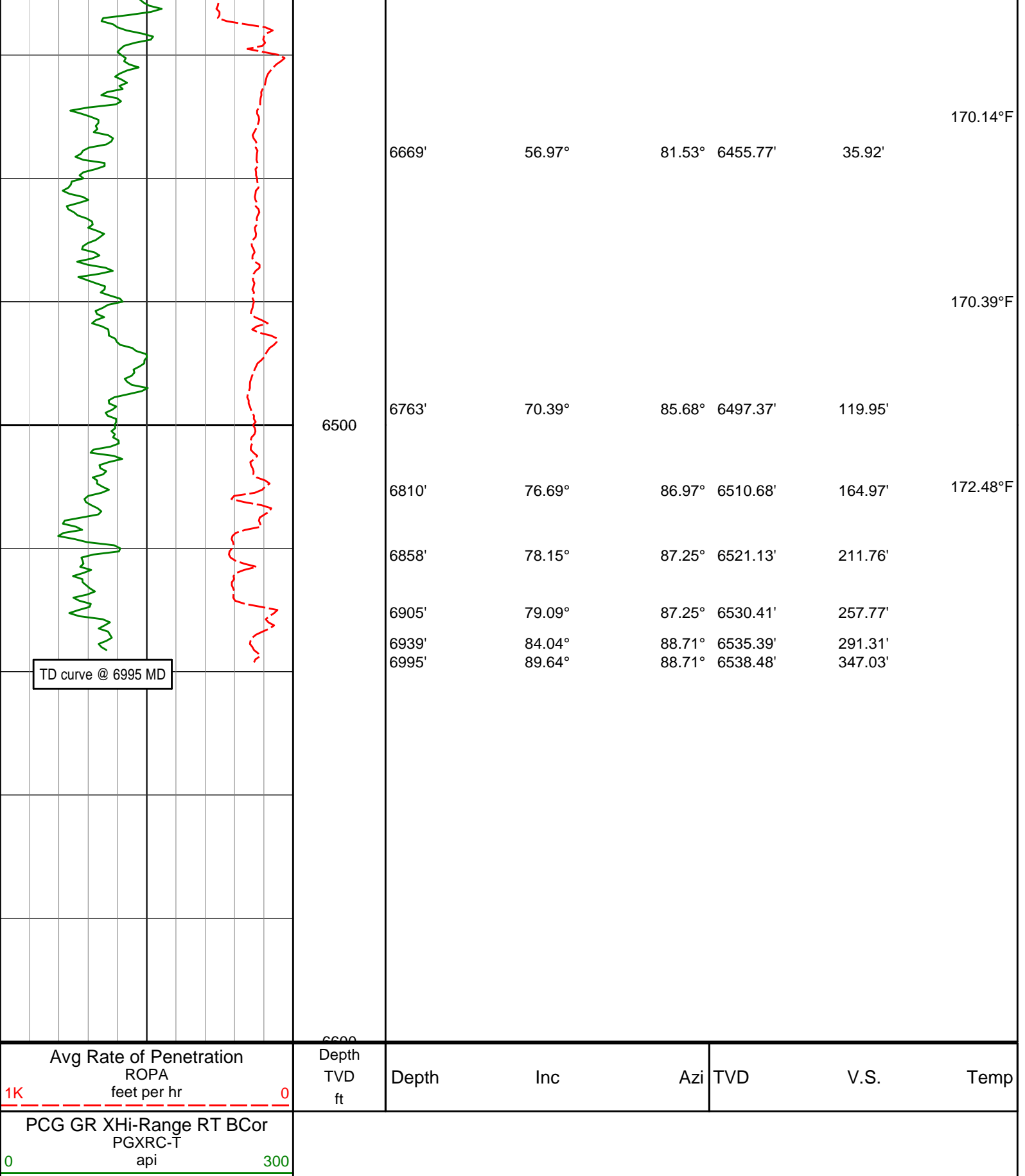


6000	6053'	27.16°	359.02°	5999.62'	-269.51'	158.47°F
						158.47°F
	6100'	31.88°	3.84°	6040.52'	-266.52'	
						160.31°F
	6147'	35.67°	11.84°	6079.60'	-260.28'	
						160.83°F
6100						
	6195'	36.69°	18.76°	6118.36'	-250.07'	161.21°F
						162.87°F
	6242'	36.75°	26.86°	6156.05'	-236.64'	
						163.20°F
	6290'	37.95°	35.62°	6194.24'	-219.10'	
6200						
						163.20°F





6300	6337'	40.20°	46.10°	6230.76'	-197.58'	163.20°F
	6385'	42.41°	56.16°	6266.86'	-171.06'	163.33°F
6300	6432'	45.16°	66.62°	6300.83'	-141.14'	164.56°F
	6480'	46.17°	75.49°	6334.41'	-107.77'	165.58°F
6400	6574'	48.36°	78.09°	6398.20'	-39.31'	166.55°F
						168.49°F



# HALLIBURTON

## DIRECTIONAL SURVEY REPORT

**Noble Energy**  
**Wells Ranch AE32-670**

Wells Ranch AESZ-070  
Wattenberg  
Weld Colorado  
USA  
CA-XX-0902678336  
Tied in @ Surface

Final survey projected to bit.

Measured Depth (feet)	Inclination (degrees)	Direction (degrees)	Vertical Depth (feet)	Latitude (feet)	Departure (feet)	Vertical Section (feet)	Dogleg (deg/100ft)
0.00	0.00	0.00	0.00	0.00 N	0.00 E	0.00	TIE-IN
734.00	0.53	79.66	733.99	0.61 N	3.34 E	3.38	0.07
828.00	0.57	91.25	827.99	0.68 N	4.24 E	4.28	0.13
919.00	0.59	90.43	918.98	0.66 N	5.16 E	5.20	0.02
1011.00	0.62	91.46	1010.98	0.65 N	6.13 E	6.16	0.04
1105.00	0.51	89.69	1104.97	0.64 N	7.06 E	7.08	0.12
1210.00	0.65	93.00	1209.97	0.61 N	8.12 E	8.14	0.14
1304.00	0.74	112.77	1303.96	0.34 N	9.22 E	9.20	0.27
1397.00	0.58	113.77	1396.95	0.08 S	10.20 E	10.14	0.17
1491.00	0.62	127.09	1490.95	0.58 S	11.05 E	10.93	0.16
1582.00	0.33	126.34	1581.94	1.03 S	11.66 E	11.49	0.32
1674.00	0.28	114.84	1673.94	1.29 S	12.07 E	11.88	0.09
1767.00	0.06	227.25	1766.94	1.41 S	12.24 E	12.03	0.33
1861.00	0.28	126.04	1860.94	1.59 S	12.39 E	12.17	0.32
1954.00	0.33	129.18	1953.94	1.89 S	12.79 E	12.53	0.06
2046.00	0.38	159.21	2045.94	2.34 S	13.10 E	12.80	0.20
2138.00	0.56	156.04	2137.94	3.04 S	13.39 E	13.02	0.20
2232.00	0.50	154.78	2231.93	3.83 S	13.75 E	13.30	0.07
2324.00	3.02	348.72	2323.89	1.82 S	13.45 E	13.20	3.82
2418.00	4.69	335.01	2417.68	4.10 N	11.34 E	11.70	2.02
2509.00	5.94	332.03	2508.29	11.63 N	7.56 E	8.70	1.41
2602.00	6.11	328.54	2600.77	20.11 N	2.72 E	4.74	0.43
2695.00	7.37	321.98	2693.13	29.03 N	3.54 W	-0.59	1.59
2786.00	9.03	321.61	2783.20	39.23 N	11.58 W	-7.54	1.82
2976.00	9.01	321.57	2970.85	62.57 N	30.08 W	-23.59	0.01
3070.00	8.62	319.48	3063.74	73.69 N	39.23 W	-31.57	0.54
3165.00	8.89	318.14	3157.63	84.57 N	48.75 W	-39.94	0.35
3260.00	8.41	316.12	3251.55	95.05 N	58.47 W	-48.54	0.60
3355.00	8.81	318.32	3345.48	105.48 N	68.12 W	-57.09	0.55
3449.00	8.31	314.67	3438.43	115.64 N	77.74 W	-65.63	0.79
3544.00	9.06	320.99	3532.34	126.28 N	87.33 W	-74.09	1.28
3639.00	9.89	321.42	3626.05	138.47 N	97.12 W	-82.61	0.88
3734.00	10.43	321.01	3719.56	151.53 N	107.62 W	-91.73	0.57
3828.00	9.79	317.34	3812.10	164.02 N	118.39 W	-101.18	0.96
3923.00	9.64	316.78	3905.73	175.76 N	129.31 W	-110.86	0.19
4017.00	9.57	315.57	3998.42	187.08 N	140.17 W	-120.52	0.23
4112.00	8.95	313.95	4092.18	197.85 N	151.02 W	-130.22	0.71
4207.00	8.77	320.67	4186.05	208.57 N	160.93 W	-138.99	1.11
4302.00	9.53	321.66	4279.84	220.34 N	170.40 W	-147.22	0.82
4396.00	9.31	320.90	4372.57	232.34 N	180.02 W	-155.57	0.27
4491.00	8.91	320.49	4466.37	243.98 N	189.54 W	-163.87	0.43
4586.00	7.92	318.94	4560.35	254.59 N	198.52 W	-171.73	1.06
4680.00	9.60	320.06	4653.25	265.49 N	207.80 W	-179.86	1.79
4775.00	9.06	316.47	4747.00	276.98 N	218.04 W	-188.88	0.83
4869.00	8.28	315.69	4839.92	287.19 N	227.86 W	-197.62	0.84
4964.00	9.27	320.77	4933.81	298.01 N	237.48 W	-206.09	1.32
5059.00	8.63	320.28	5027.65	309.42 N	246.88 W	-214.28	0.68
5154.00	7.94	311.02	5121.66	319.21 N	256.38 W	-222.75	1.58
5248.00	8.73	322.92	5214.68	329.16 N	265.57 W	-230.89	2.01
5343.00	9.31	324.09	5308.50	341.13 N	274.43 W	-238.48	0.65
5438.00	8.27	321.80	5402.39	352.73 N	283.16 W	-246.00	1.15
5532.00	8.95	320.39	5495.33	363.68 N	292.01 W	-253.69	0.75
5627.00	8.14	318.57	5589.27	374.41 N	301.17 W	-261.72	0.89
5722.00	8.83	324.56	5683.23	385.40 N	309.85 W	-269.24	1.18
5769.00	10.39	336.67	5729.58	392.23 N	313.62 W	-272.30	5.42
5816.00	12.79	350.57	5775.62	401.25 N	316.15 W	-273.91	7.80
5863.00	14.54	356.97	5821.29	412.28 N	317.31 W	-273.95	4.92
5911.00	16.46	358.48	5867.55	425.09 N	317.81 W	-273.15	4.09
5958.00	19.09	358.61	5912.30	439.43 N	318.18 W	-272.06	5.59

5938.00	19.09	338.81	5912.39	439.43 N	318.18 W	-272.68	3.39
6006.00	23.09	357.40	5957.08	456.68 N	318.79 W	-270.93	8.39
6053.00	27.16	359.02	5999.62	476.62 N	319.40 W	-269.51	8.77
6100.00	31.88	3.84	6040.52	499.75 N	318.75 W	-266.52	11.24
6147.00	35.67	11.84	6079.60	525.56 N	315.10 W	-260.28	12.42
6195.00	36.69	18.76	6118.36	552.85 N	307.62 W	-250.07	8.77
6242.00	36.75	26.86	6156.05	578.71 N	296.74 W	-236.64	10.30
6290.00	37.95	35.62	6194.24	603.53 N	281.65 W	-219.10	11.34
6337.00	40.20	46.10	6230.76	625.83 N	262.28 W	-197.58	14.84
6385.00	42.41	56.16	6266.86	645.61 N	237.64 W	-171.06	14.56
6432.00	45.16	66.62	6300.83	661.07 N	209.14 W	-141.14	16.47
6480.00	46.17	75.49	6334.41	672.18 N	176.72 W	-107.77	13.38
6574.00	48.36	78.09	6398.20	687.92 N	109.52 W	-39.31	3.09
6669.00	56.97	81.53	6455.77	701.14 N	35.24 W	35.92	9.51
6763.00	70.39	85.68	6497.37	710.33 N	48.30 E	119.95	14.81
6810.00	76.69	86.97	6510.68	713.21 N	93.25 E	164.97	13.66
6858.00	78.15	87.25	6521.13	715.57 N	140.04 E	211.76	3.09
6905.00	79.09	87.25	6530.41	717.78 N	186.06 E	257.77	2.00
6939.00	84.04	88.71	6535.39	718.96 N	219.66 E	291.31	15.17
6995.00	89.64	88.71	6538.48	720.22 N	275.54 E	347.03	10.00

**CALCULATION BASED ON MINIMUM CURVATURE METHOD**

**SURVEY COORDINATES RELATIVE TO WELL SYSTEM REFERENCE POINT  
TVD VALUES GIVEN RELATIVE TO DRILLING MEASUREMENT POINT**

**VERTICAL SECTION RELATIVE TO WELL HEAD  
VERTICAL SECTION IS COMPUTED ALONG A DIRECTION OF 84.19 DEGREES (GRID)  
A TOTAL CORRECTION OF 7.56 DEG FROM MAGNETIC NORTH TO GRID NORTH HAS BEEN APPLIED**

**HORIZONTAL DISPLACEMENT IS RELATIVE TO THE WELL HEAD.  
HORIZONTAL DISPLACEMENT(CLOSURE) AT 6995.00 FEET  
IS 771.13 FEET ALONG 20.94 DEGREES (GRID)**