



**Weatherford**

**COMPACT PHOTO DENSITY  
COMPENSATED NEUTRON**

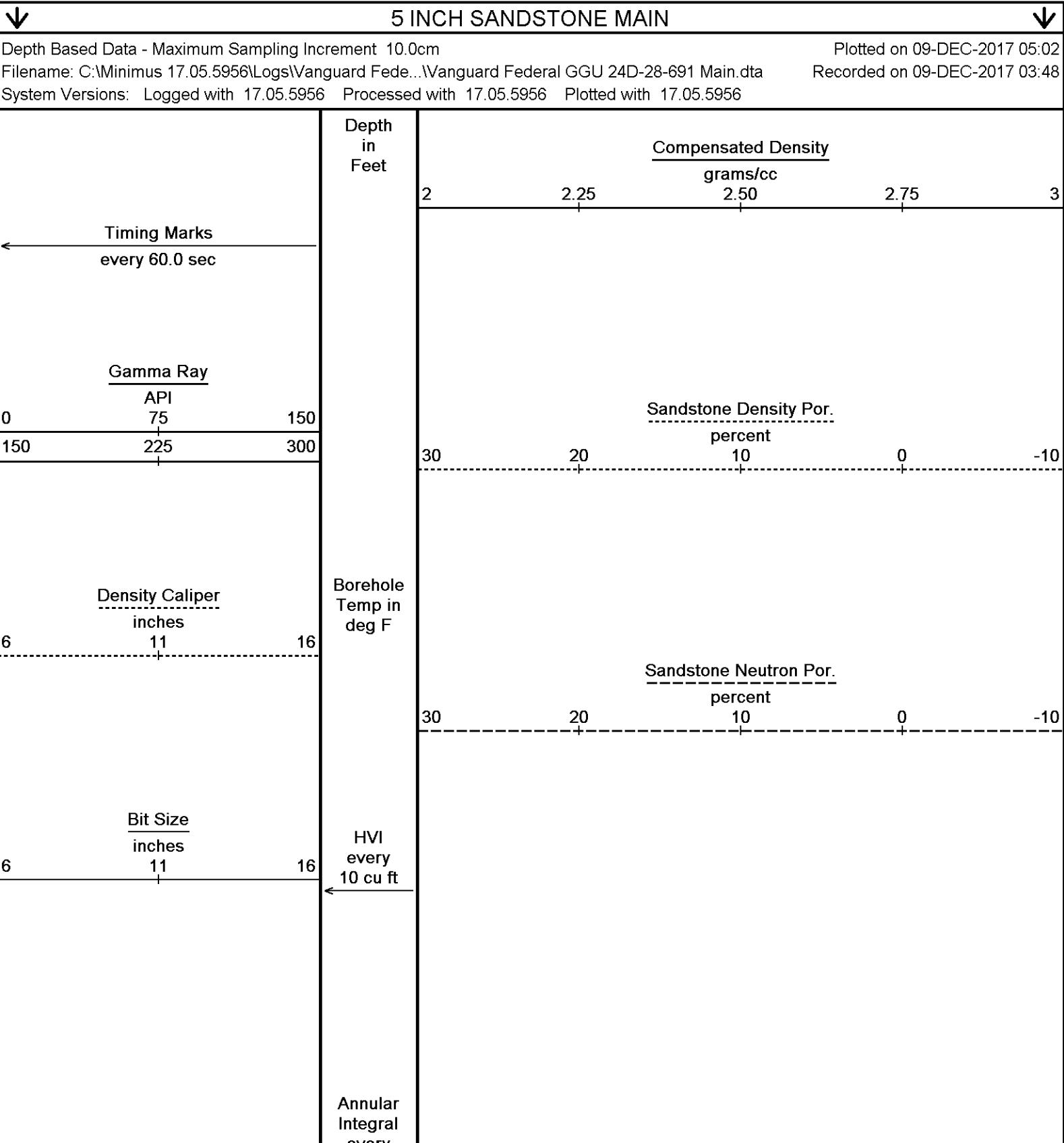
COMPANY	VANGUARD OPERATING, LLC.		
WELL	FEDERAL GGU #24D-28-691		
FIELD	MAMM CREEK		
PROVINCE/COUNTY	GARFIELD		
COUNTRY/STATE	U.S.A. / COLORADO		
LOCATION	1001' FSL & 536' FWL		
SEC 28	TWP 6S	RGE 91W	Other Services
Latitude	MAI		
Longitude			
API Number	05-045-23531		
Permanent Datum GL, Elevation 6130 feet			
Log Measured From KB, 17.00 feet above Permanent Datum			
Drilling Measured From KB			
Date	09-DEC-2017		Elevations: KB 6147.00 DF 6147.00 GL 6130.00
Run Number	ONE		
Service Order	4558-199975761		
Depth Driller	840.00	feet	
Depth Logger	840.00	feet	
First Reading	819.00	feet	
Last Reading	97.00	feet	
Casing Driller	97.00	feet	
Casing Logger	97.00	feet	
Bit Size	12.250	inches	
Hole Fluid Type	WBM		
Density / Viscosity	9.50 lb/USg	45.00 CP	
PH / Fluid Loss	9.40	---	
Sample Source	FLOWLINE		
Rm @ Measured Temp	1.71 @ 75.0	ohm-m	
Rmf @ Measured Temp	1.37 @ 75.0	ohm-m	
Rmc @ Measured Temp	2.05 @ 75.0	ohm-m	
Source Rmf / Rmc	CALC	CALC	
Rm @ BHT	1.32 @ 97.0	ohm-m	
Time Since Circulation	3 HOURS		
Max Recorded Temp	97.00	deg F	
Equipment / Base	13244	LIB	
Recorded By	ADAM SILL		
Witnessed By	RICHARD McNEILL		

BOREHOLE RECORD				Last Edited: 09-DEC-2017 05:00
Bit Size inches	Depth From feet		Depth To feet	
12.250	97.00		840.00	
CASING RECORD				
Type	Size inches	Depth From feet	Shoe Depth feet	Weight pounds/ft
CONDUCT	16.000	0.00	97.00	0.00

REMARKS
- SOFTWARE ISSUE: WLS 17.05.5956.
- RUN ONE: SHA, MCG, MVC, MDN, MPD, SKJ, MAI RUN IN COMBINATION. - HARDWARE: DUAL BOWSPRING USED ON MDN. 0.5 INCH STANDOFF USED ON MAI.
- 2.71 G/CC LIMESTONE DENSITY MATRIX USED TO CALCULATE POROSITY.
- BOREHOLE RUGOSITY, TIGHT PULLS, AND WASHOUTS WILL AFFECT DATA QUALITY.
- ALL INTERVALS LOGGED AND SCALED PER CUSTOMER'S REQUEST.
- ENGINEER: A. SILL.
- OPERATOR: B.TOVAR, D. GILLISPIE.

In interpreting, communicating or providing information and/or making recommendations, either written or oral, as to logs or test or other data,

type or amount of material, or Work or other service to be furnished, or manner of performance, or in predicting results to be obtained, the Contractor will give the Company the benefit of the Contractor's best judgment based on its experience and will perform all such Work in a good and workmanlike manner. Any interpretation of test or other data, and any recommendation or reservoir description based upon such interpretations, are opinions based upon inferences from measurements and empirical relationships and assumptions, which inferences and assumptions are not infallible, and with respect to which professional engineers and analysts may differ. ACCORDINGLY ANY INTERPRETATION OR RECOMMENDATION RESULTING FROM THE SERVICES WILL BE AT THE SOLE RISK OF THE COMPANY, AND THE CONTRACTOR CANNOT AND DOES NOT WARRANT THE ACCURACY, CORRECTNESS OR COMPLETENESS OF ANY SUCH INTERPRETATION OR RECOMMENDATION, WHICH INTERPRETATIONS AND RECOMMENDATIONS SHOULD NOT, THEREFORE, UNDER ANY CIRCUMSTANCES BE RELIED UPON AS THE SOLE OR MAIN BASIS FOR ANY DRILLING, COMPLETION, WELL TREATMENT, PRODUCTION OR FINANCIAL DECISION, OR ANY PROCEDURE INVOLVING ANY RISK TO THE SAFETY OF ANY DRILLING ACTIVITY, DRILLING RIG OR ITS CREW OR ANY OTHER INDIVIDUAL. THE COMPANY HAS FULL RESPONSIBILITY FOR ALL DECISIONS CONCERNING THE SERVICES.



every  
10 cu ft

**DST Uphole Tension**  
pounds

5000 0

Replay  
Scale  
1:240

86

600 Casing<sub>300</sub>  
Shoe

100

91°

150

92°

200

500

PE  
---  
barns/electron

Density Correction  
grams/cc

0

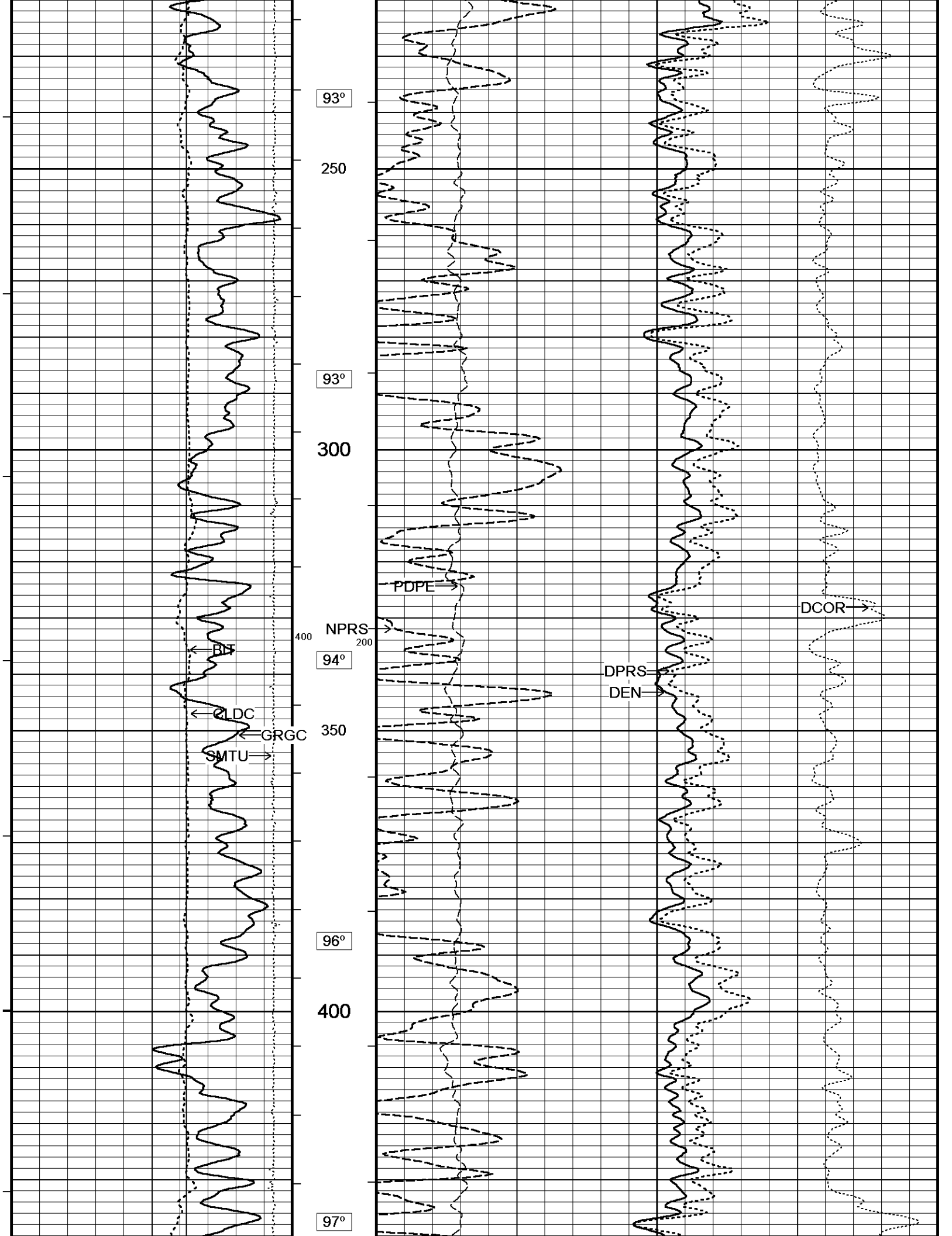
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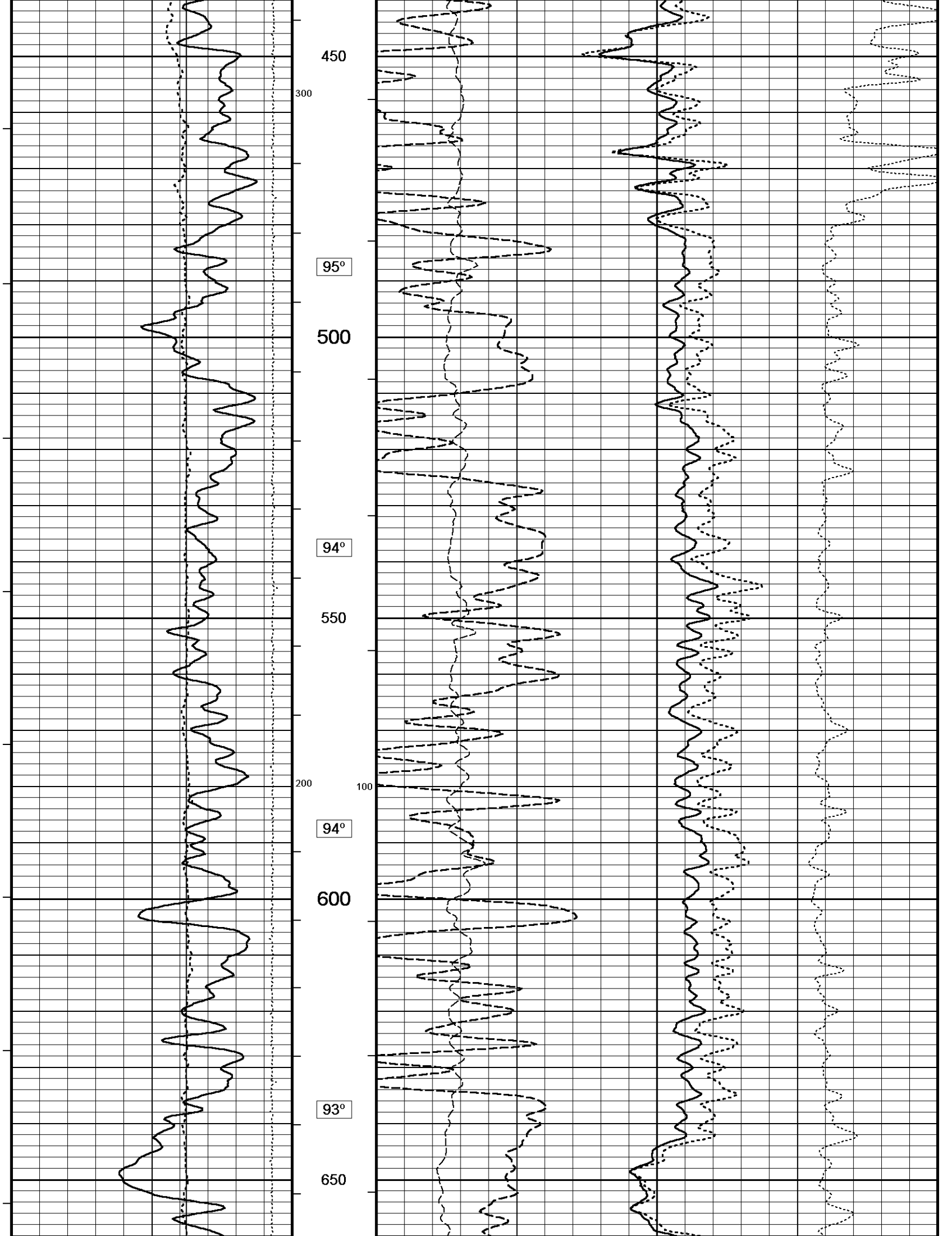
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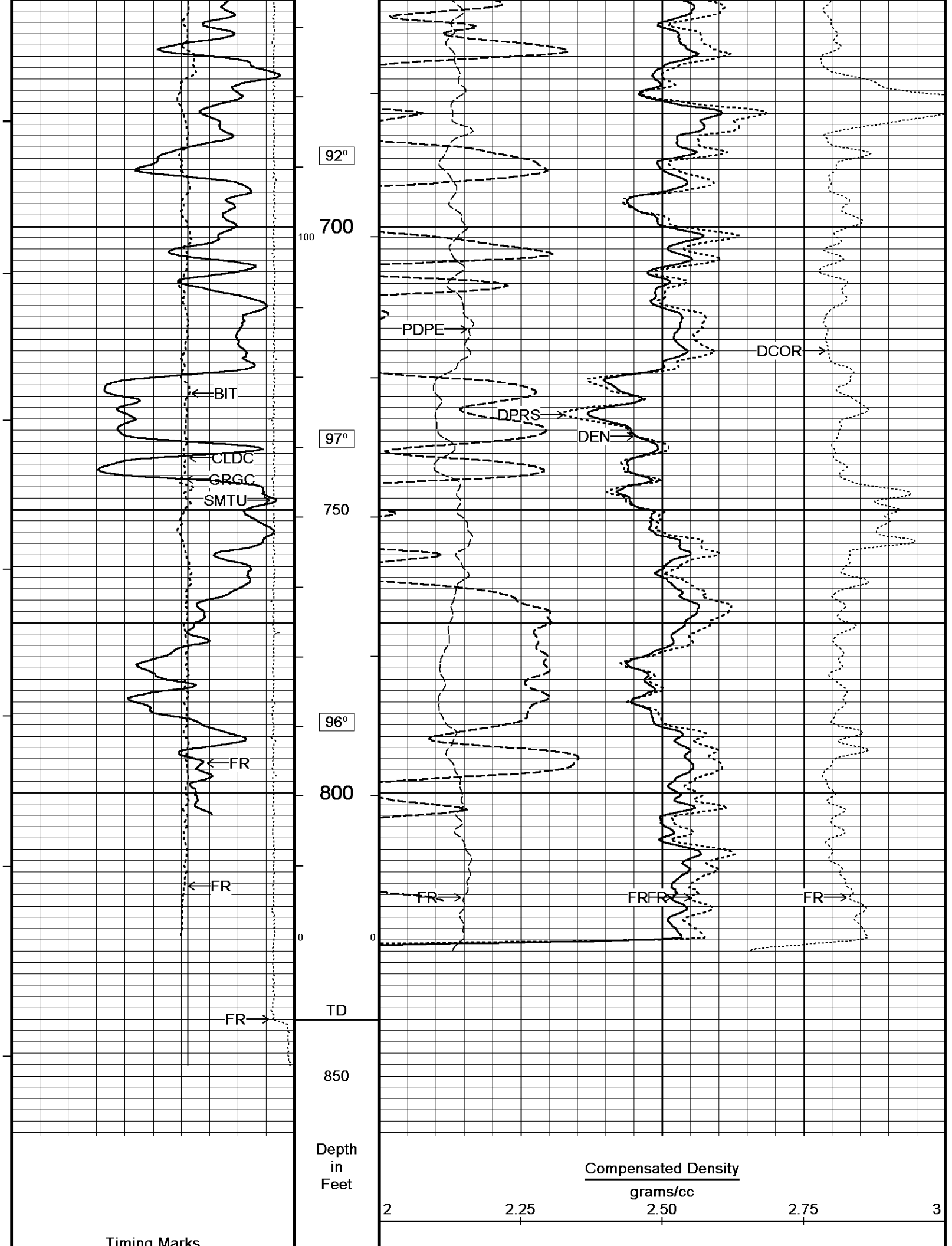
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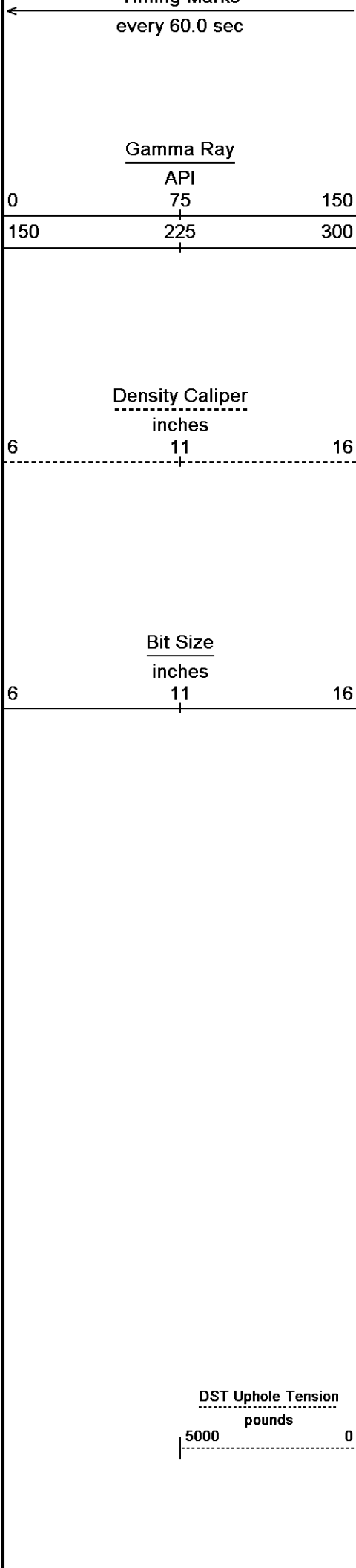
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0.25







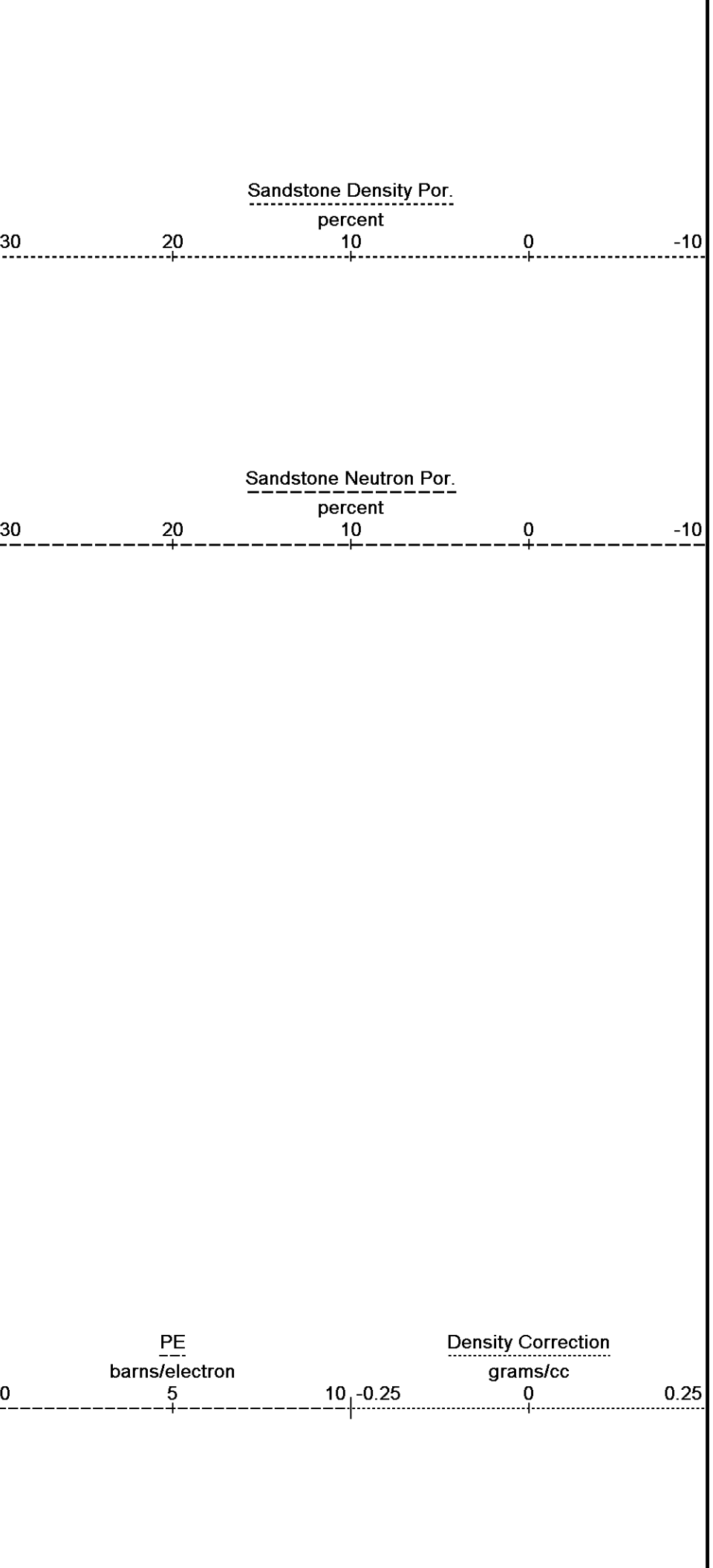


Borehole  
Temp in  
deg F

HVI  
every  
10 cu ft

Annular  
Integral  
every  
10 cu ft

Replay  
Scale  
1:240



↑

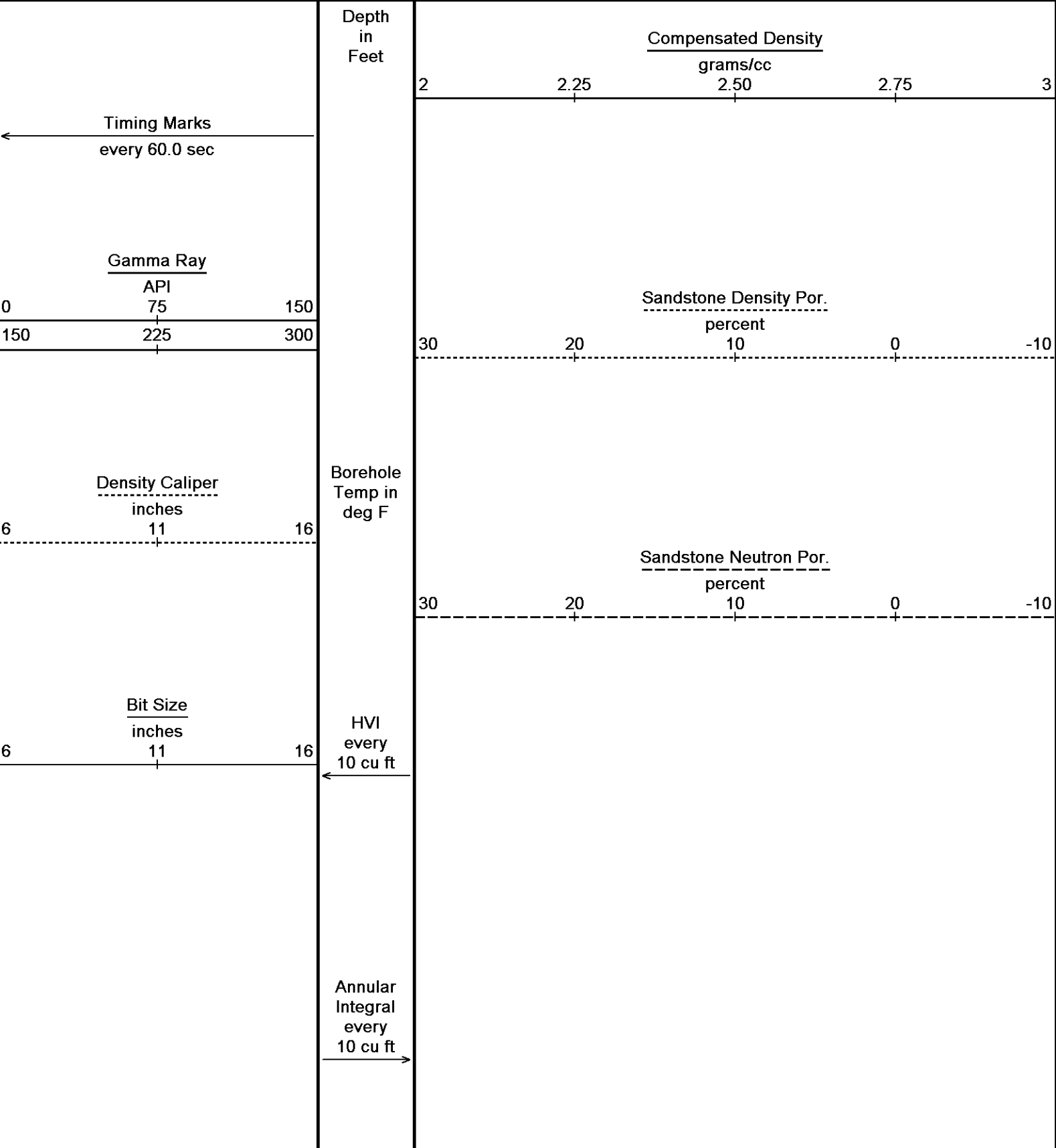
5 INCH SANDSTONE MAIN

↑

↓

REPEAT SECTION

↓





DST Uphole Tension  
pounds  
5000 0

Replay  
Scale  
1:240

638

650

95°

700

100

BIT

CLDC

SMTU

GRGC

750

96°

PE  
barns/electron

Density Correction  
grams/cc

0

5

10

-0.25

0

0.25

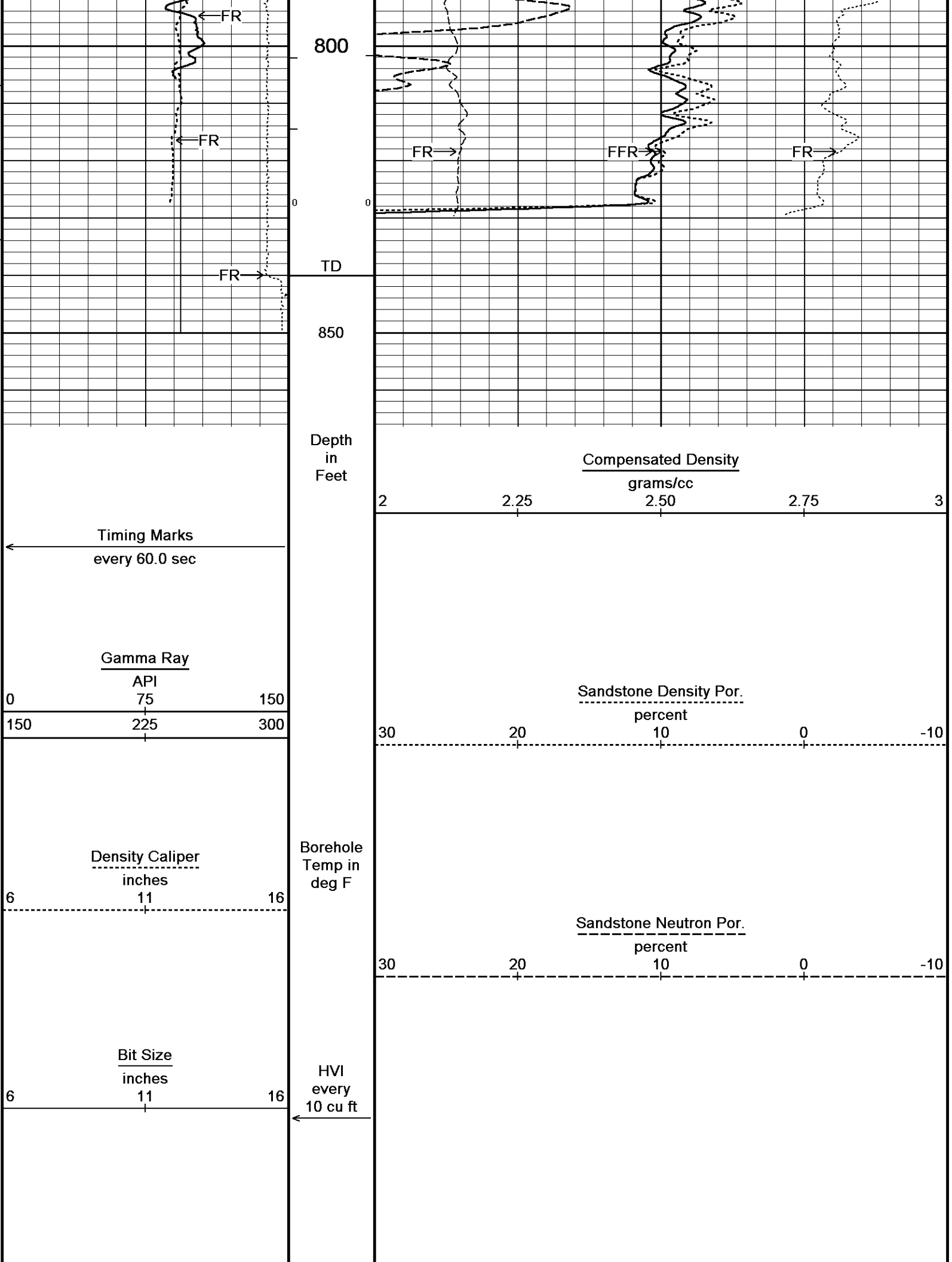
PDPE

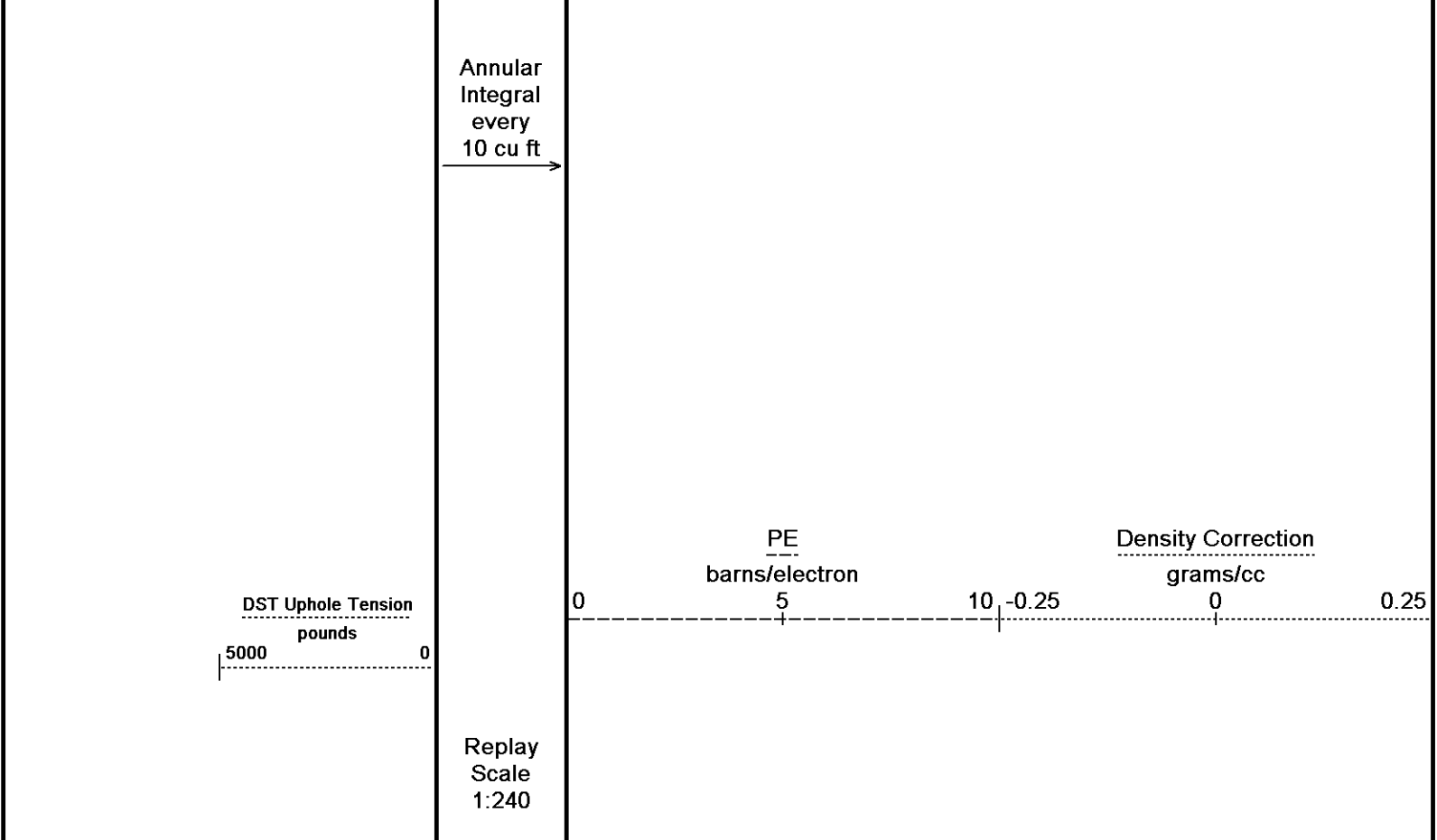
NPRS

DPRS

DEN

DCOR





Depth Based Data - Maximum Sampling Increment 10.0cmPlotted on 09-DEC-2017 05:02

Filename: C:\Minimus 17.05.5956\Logs\Vanguard Fe...\Vanguard Federal GGU 24D-28-691 Repeat.dtaRecorded on 09-DEC-2017 03:35

System Versions: Logged with 17.05.5956 Processed with 17.05.5956 Plotted with 17.05.5956

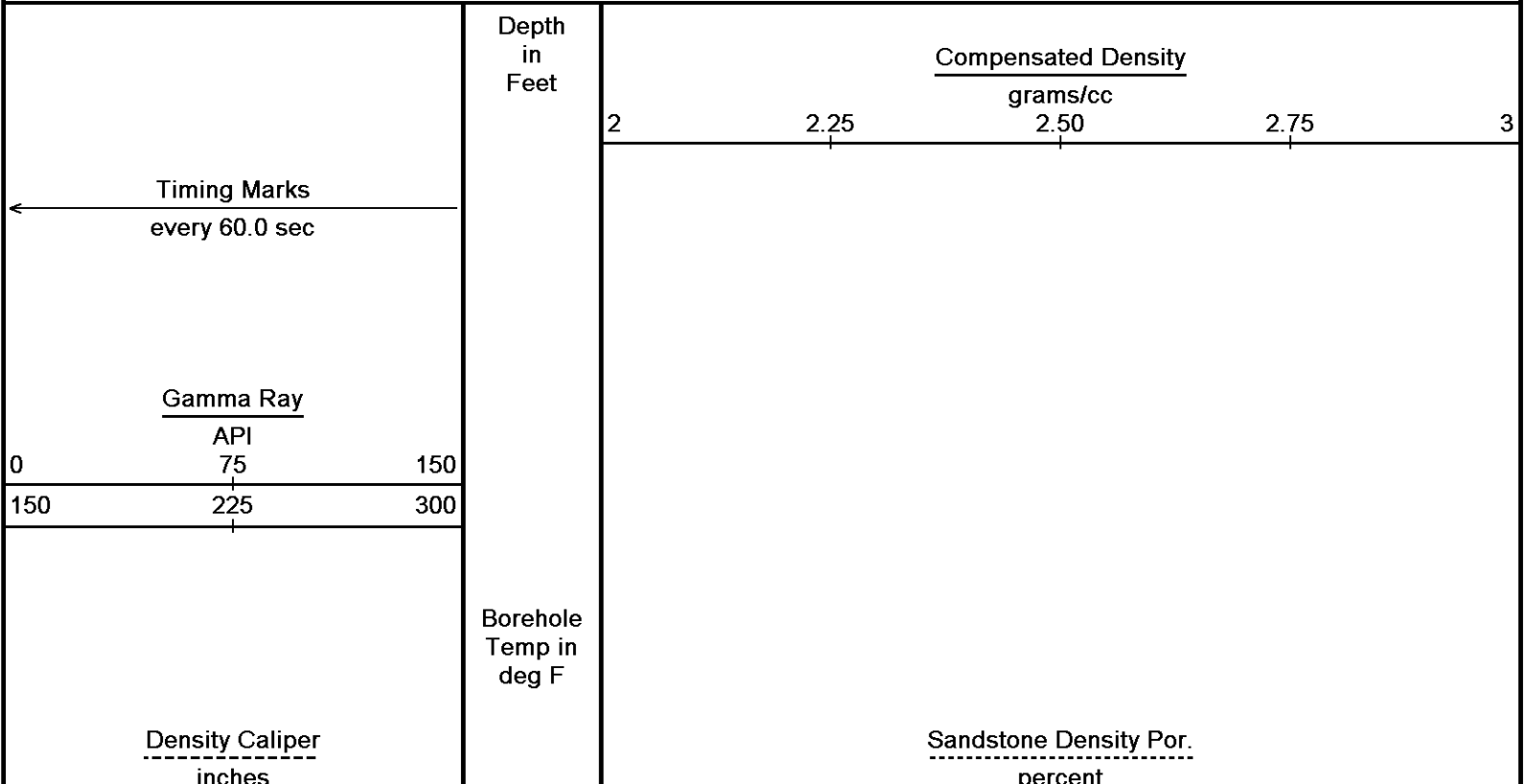
↑REPEAT SECTION↑

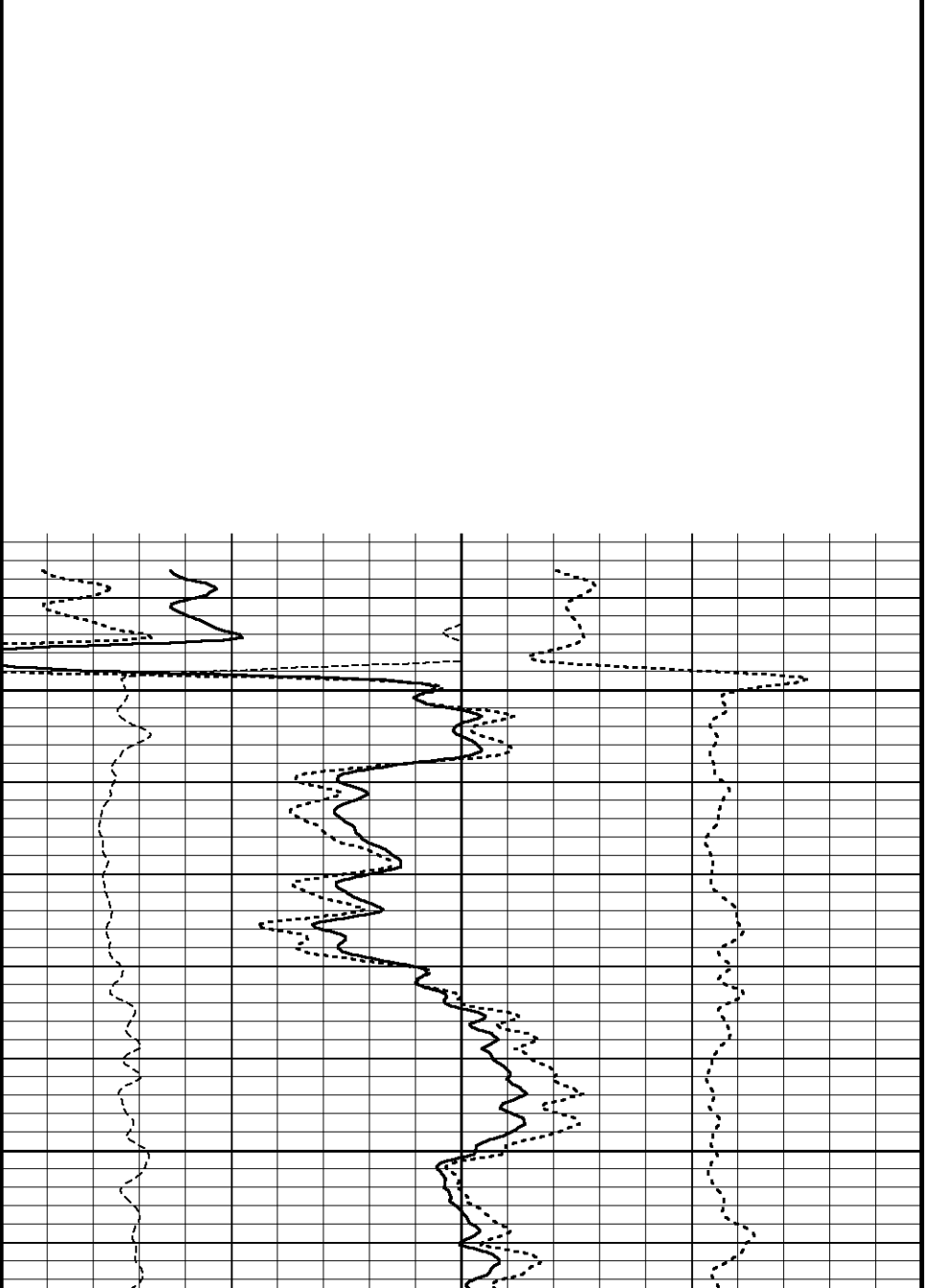
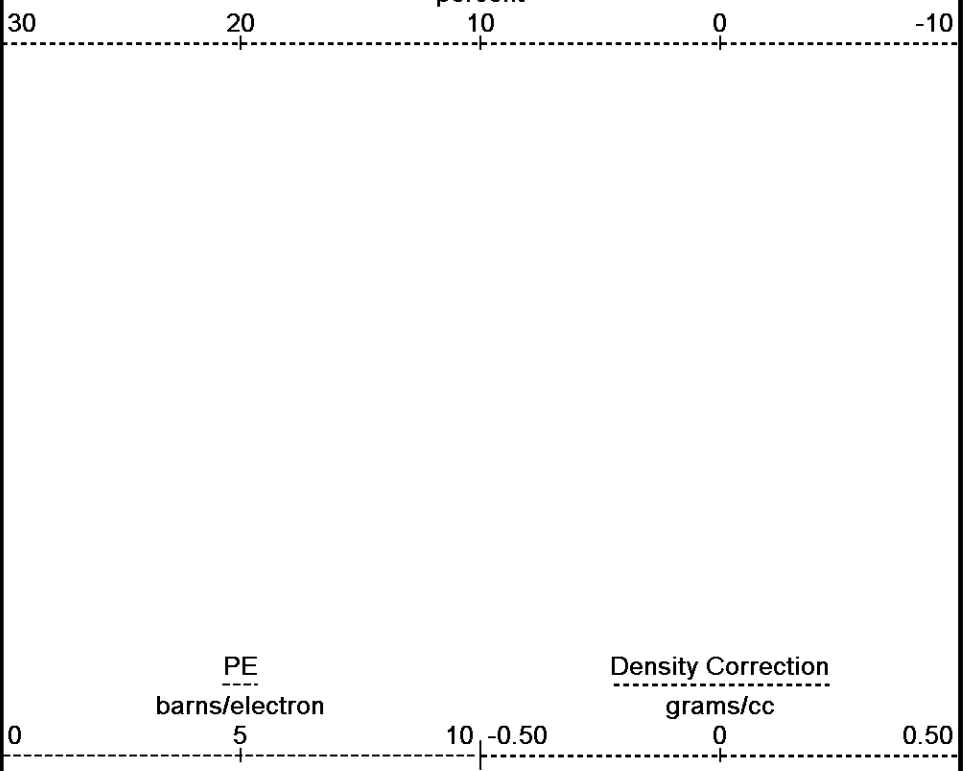
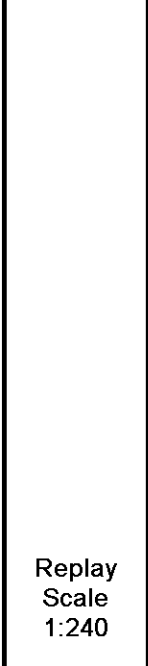
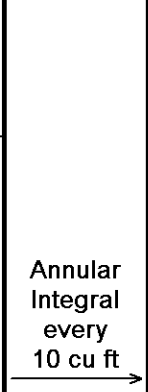
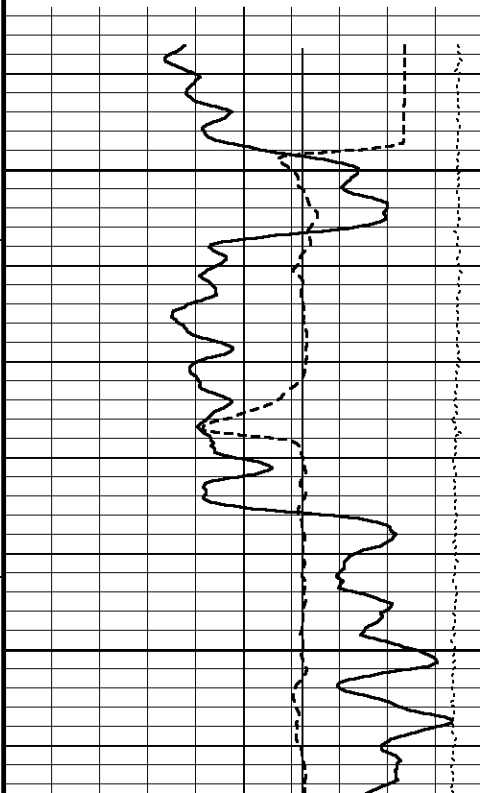
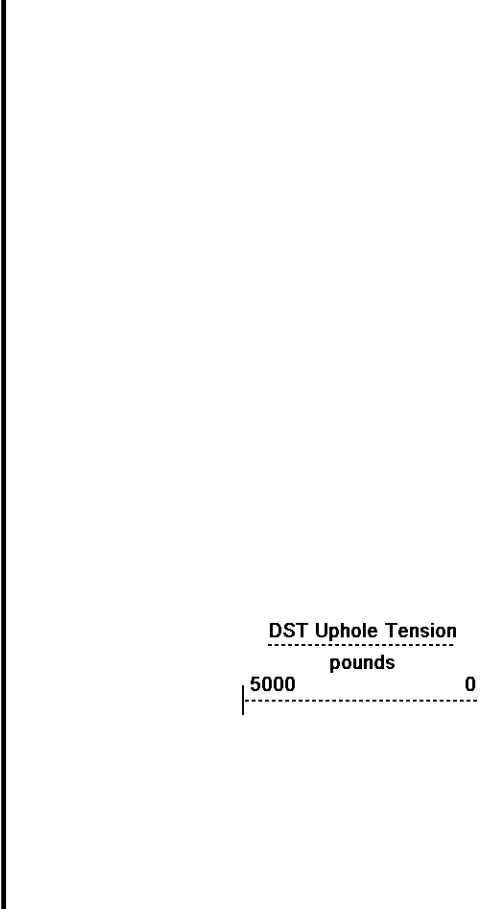
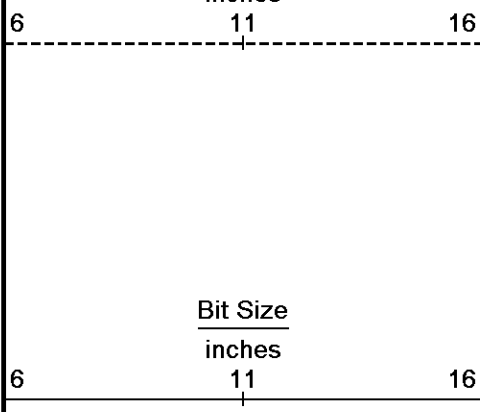
↓5 INCH BULK DENSITY MAIN↓

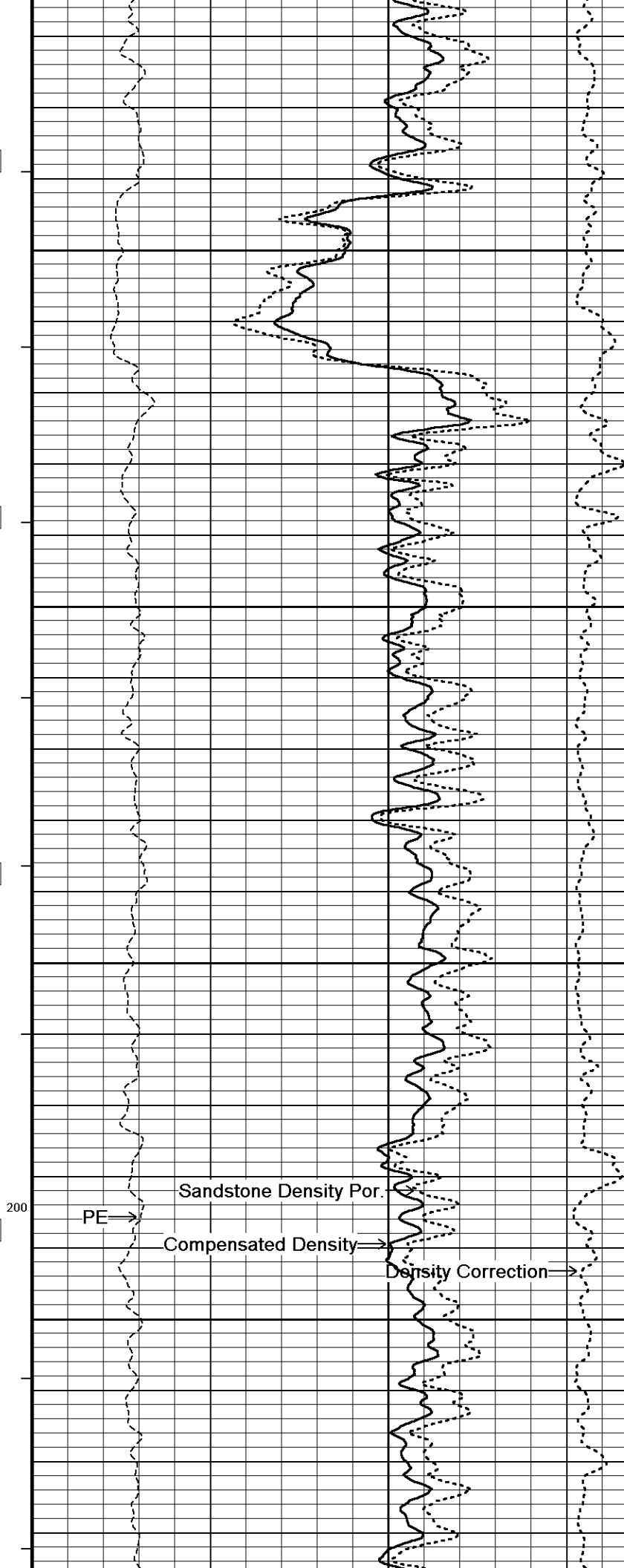
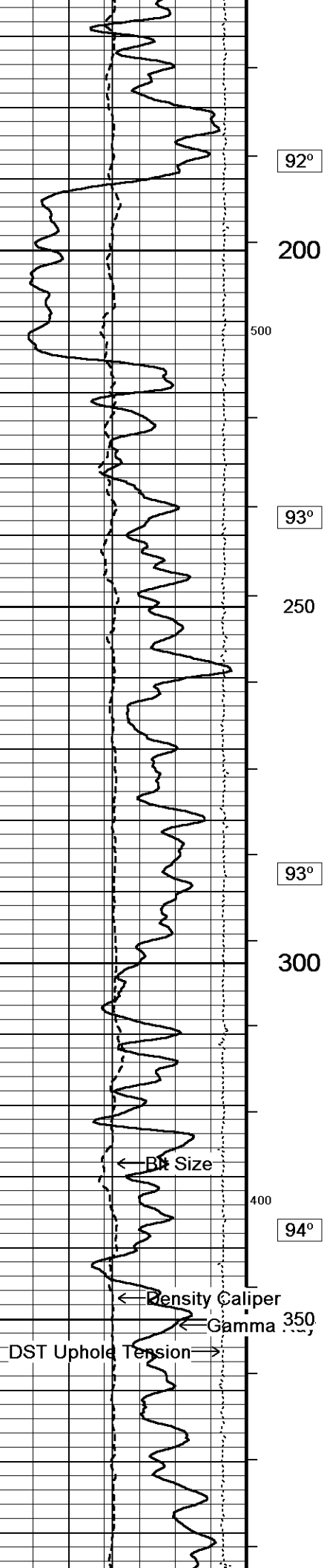
Depth Based Data - Maximum Sampling Increment 10.0cmPlotted on 09-DEC-2017 05:02

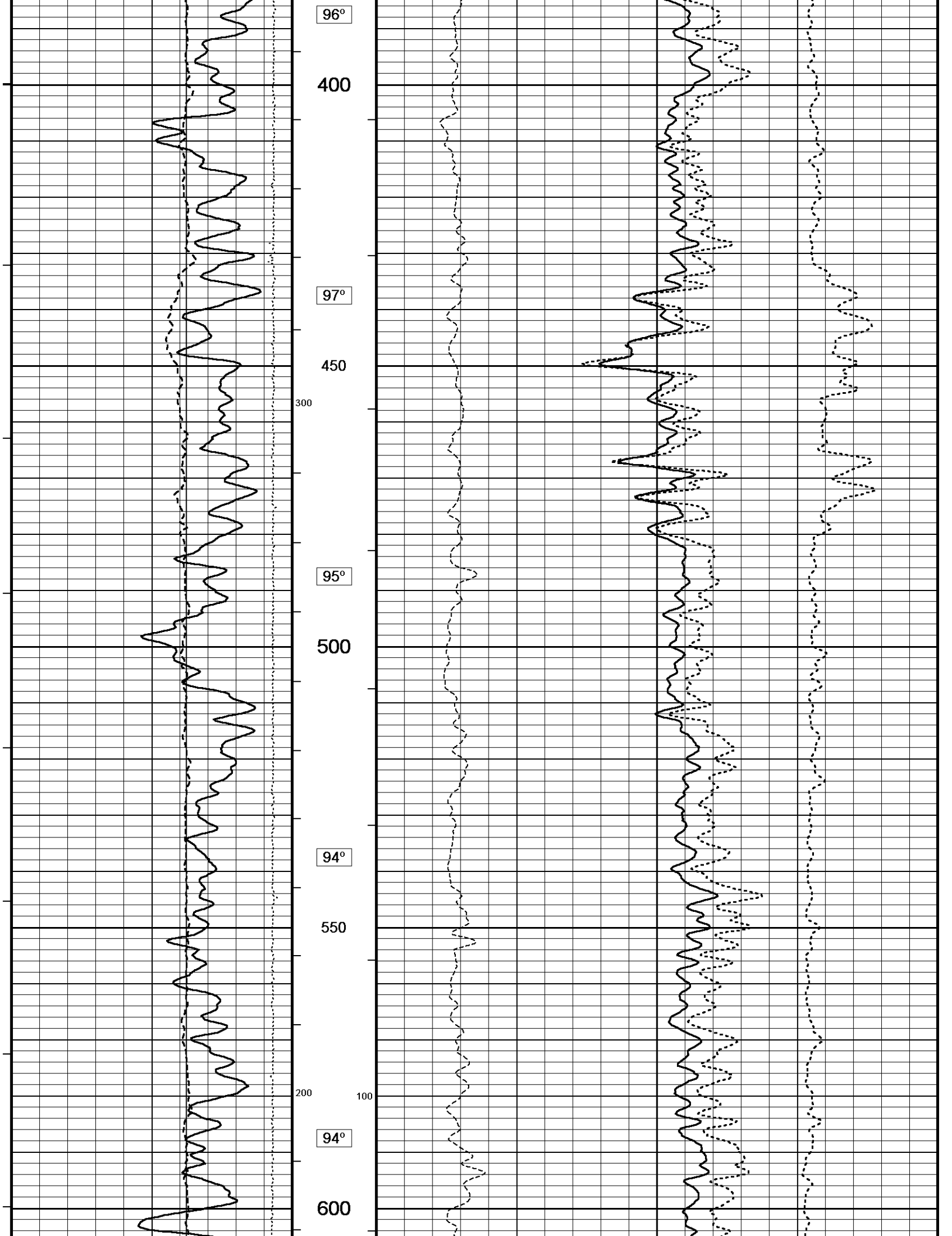
Filename: C:\Minimus 17.05.5956\Logs\Vanguard Fede...\Vanguard Federal GGU 24D-28-691 Main.dtaRecorded on 09-DEC-2017 03:48

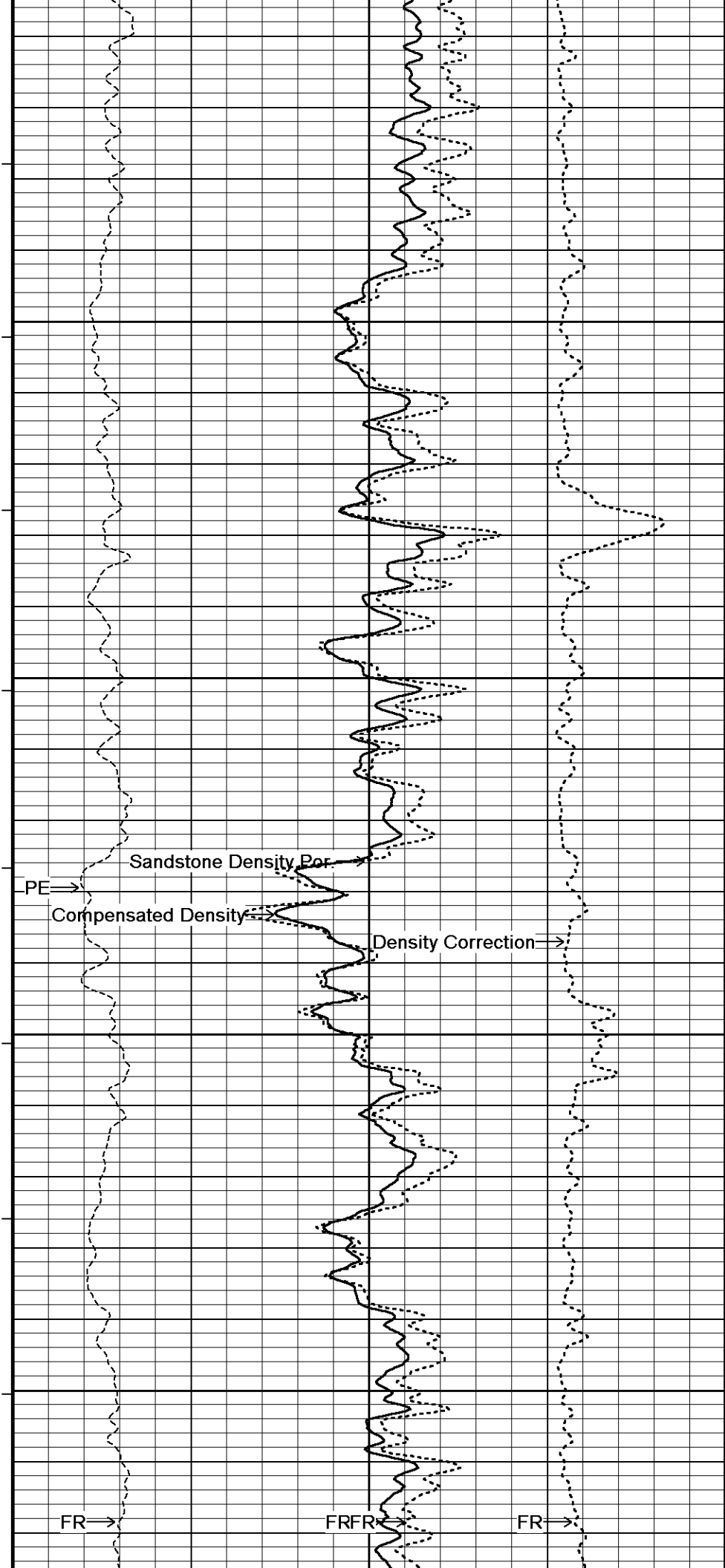
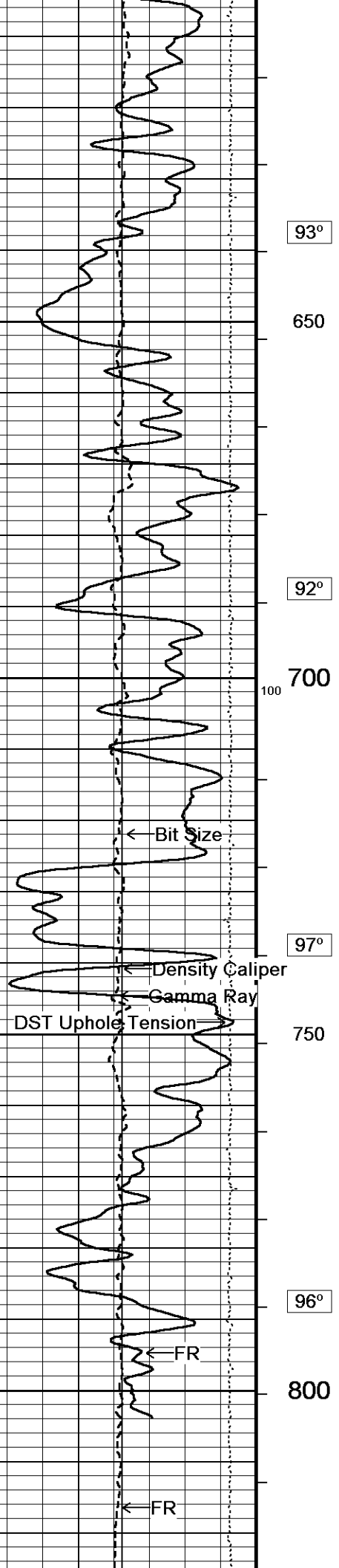
System Versions: Logged with 17.05.5956 Processed with 17.05.5956 Plotted with 17.05.5956

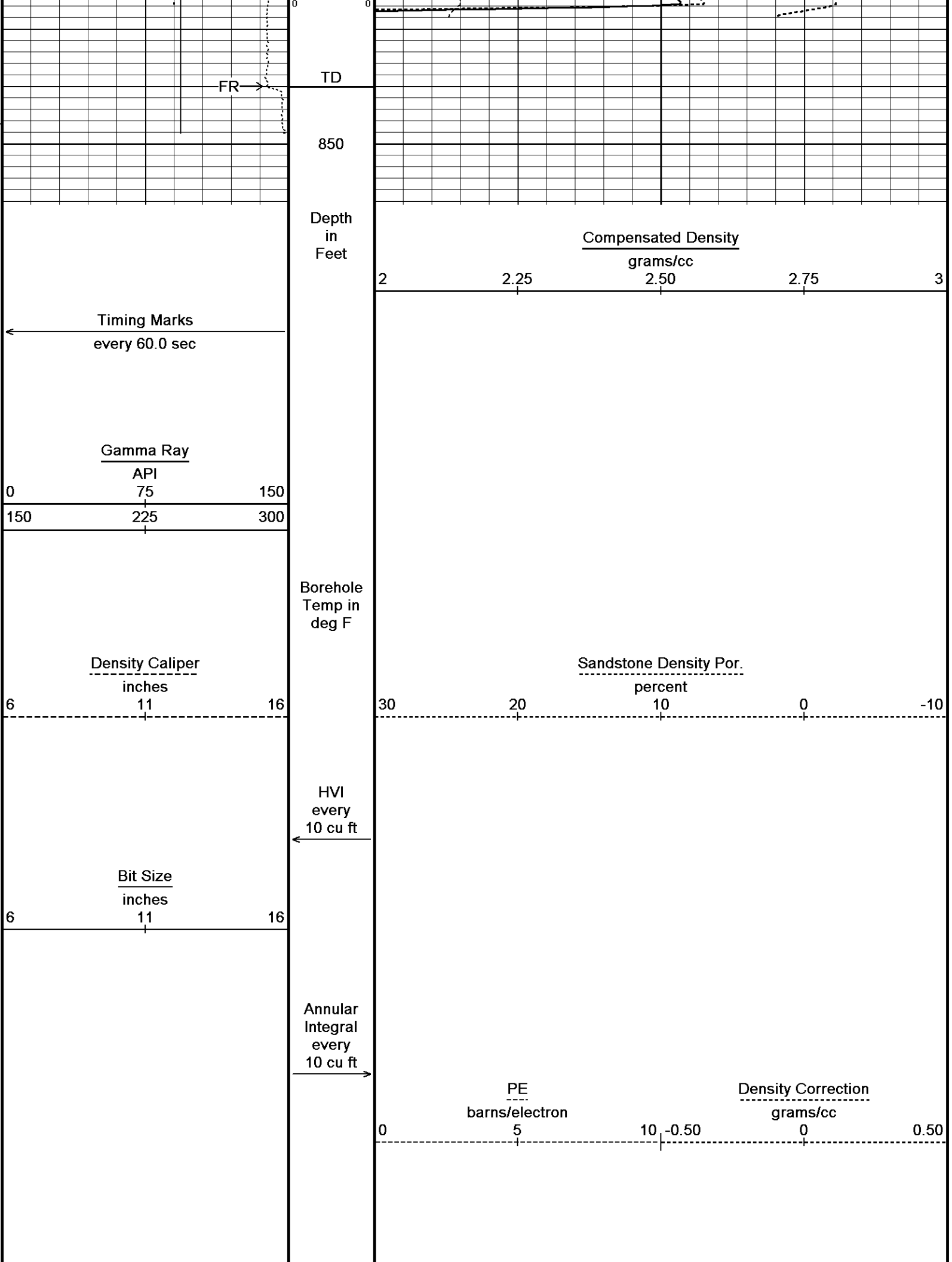




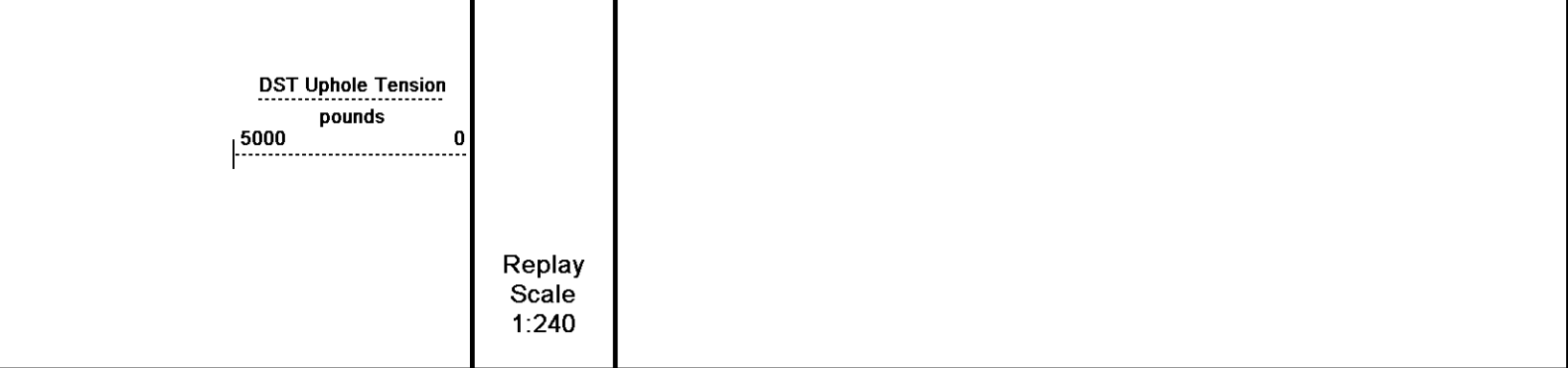










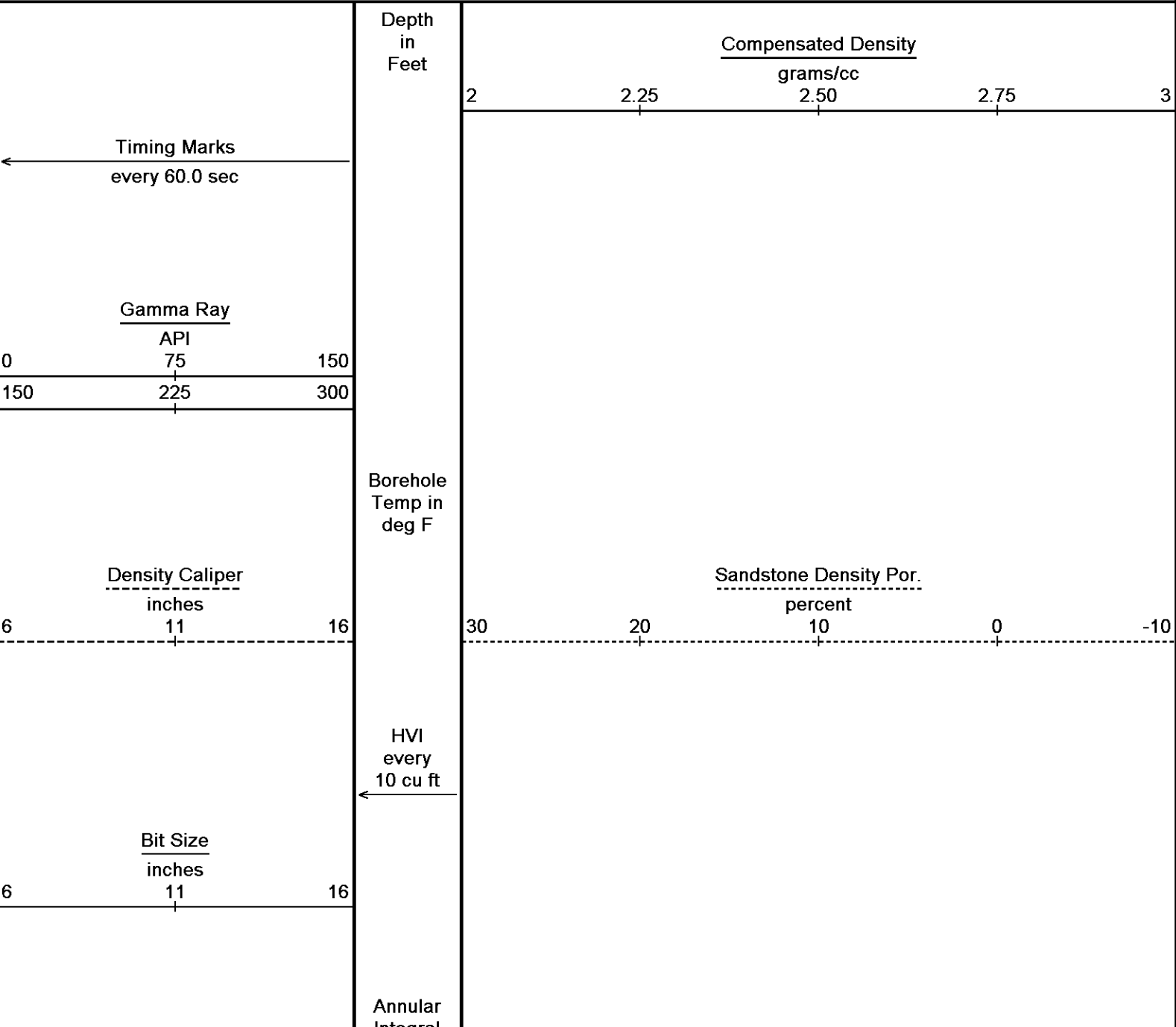


Depth Based Data - Maximum Sampling Increment 10.0cmPlotted on 09-DEC-2017 05:02

Filename: C:\Minimus 17.05.5956\Logs\Vanguard Fede...Vanguard Federal GGU 24D-28-691 Main.dtaRecorded on 09-DEC-2017 03:48

System Versions: Logged with 17.05.5956 Processed with 17.05.5956 Plotted with 17.05.5956

5 INCH BULK DENSITY MAIN



Integral  
every  
10 cu ft  
→

PE  
barns/electron  
0 5 10

Density Correction  
grams/cc  
-0.50 0 0.50

DST Uphole Tension  
pounds  
5000 0

Replay  
Scale  
1:240

638

650

95°

700

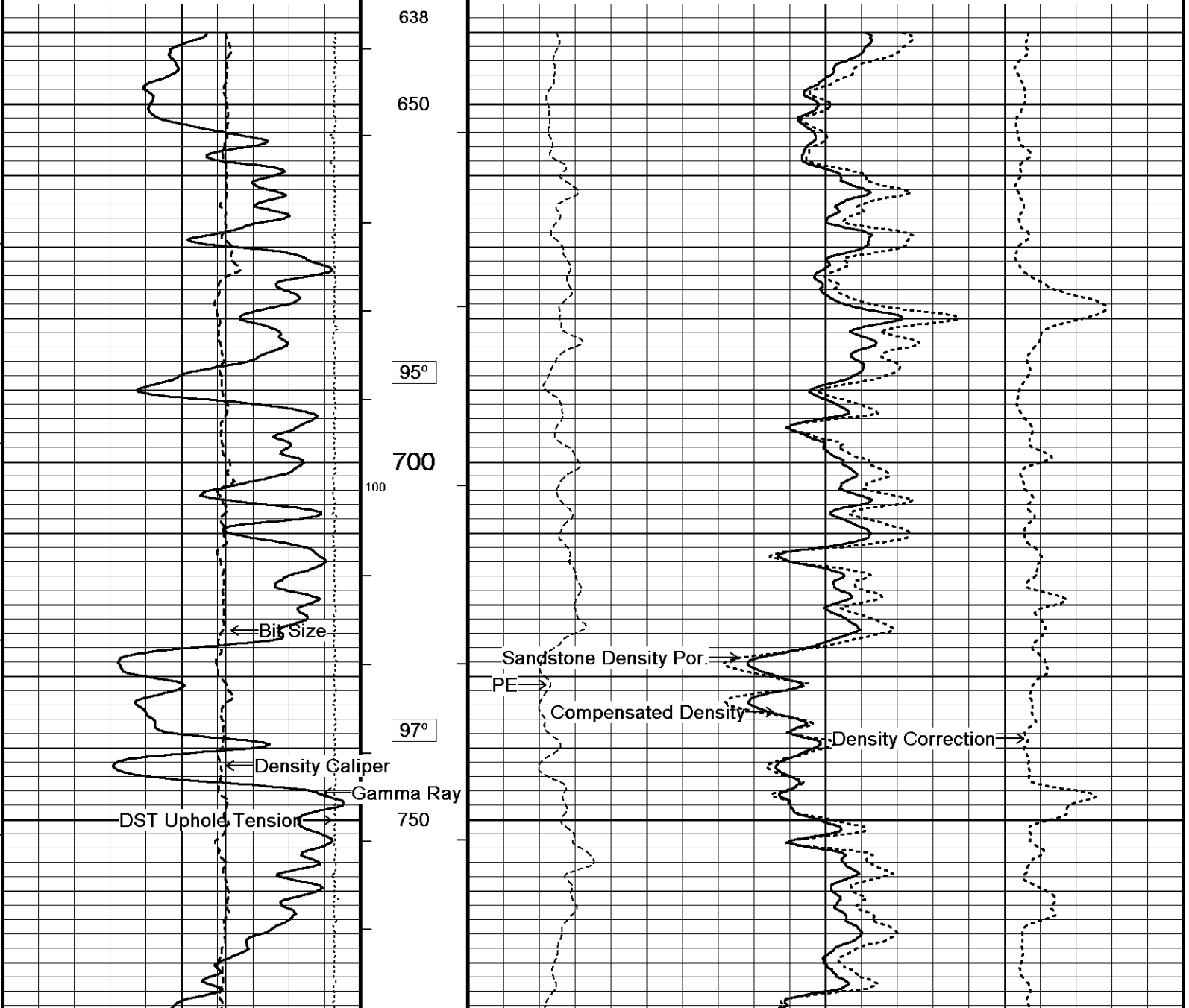
100

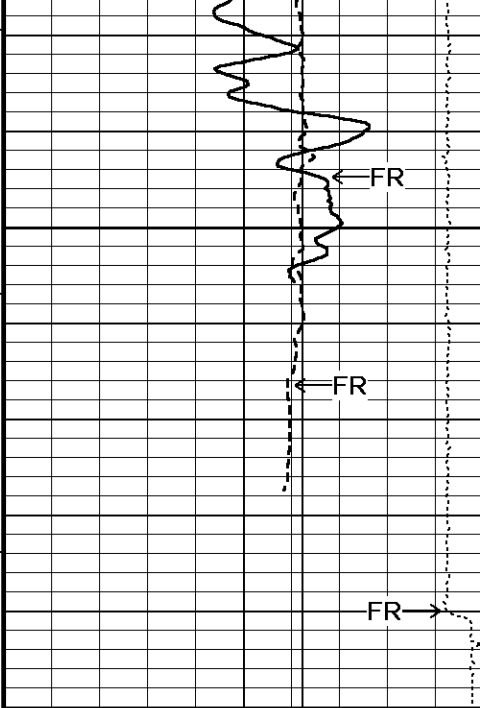
97°

750

← Bit Size  
← Density Caliper  
← DST Uphole Tension  
Gamma Ray

Sandstone Density Por. →  
PE →  
Compensated Density →  
Density Correction →





96°

800

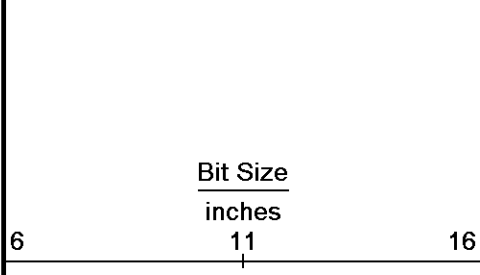
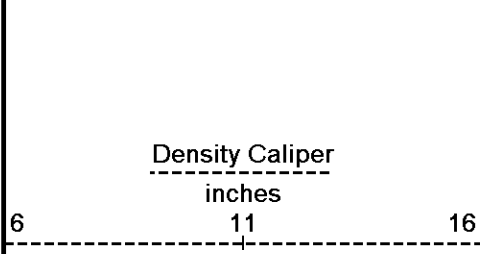
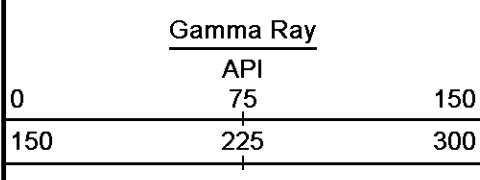
0

TD

850

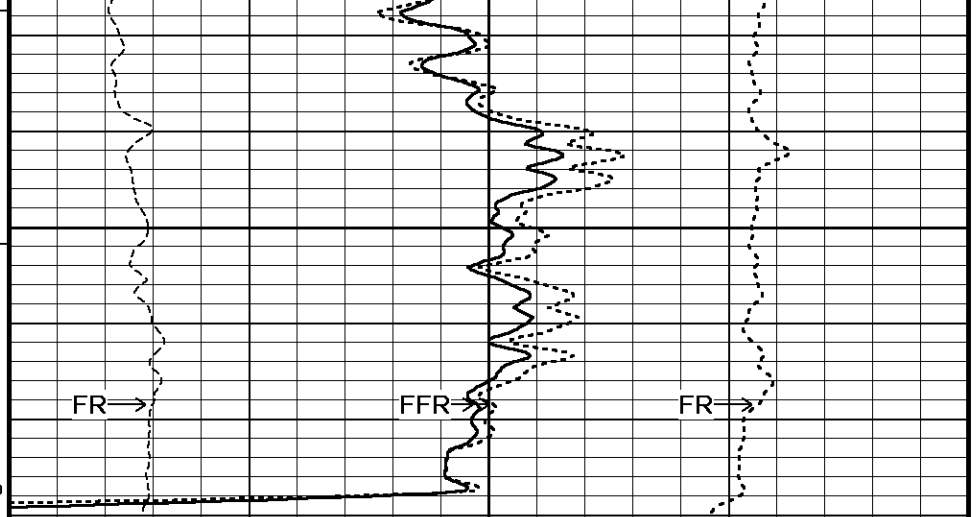
Depth  
in  
Feet

← Timing Marks  
every 60.0 sec



Borehole  
Temp in  
deg F

← HVI  
every  
10 cu ft



FR →

FFR →

FR →

0

2

2.25

grams/cc  
2.50

2.75

3

Compensated Density

30

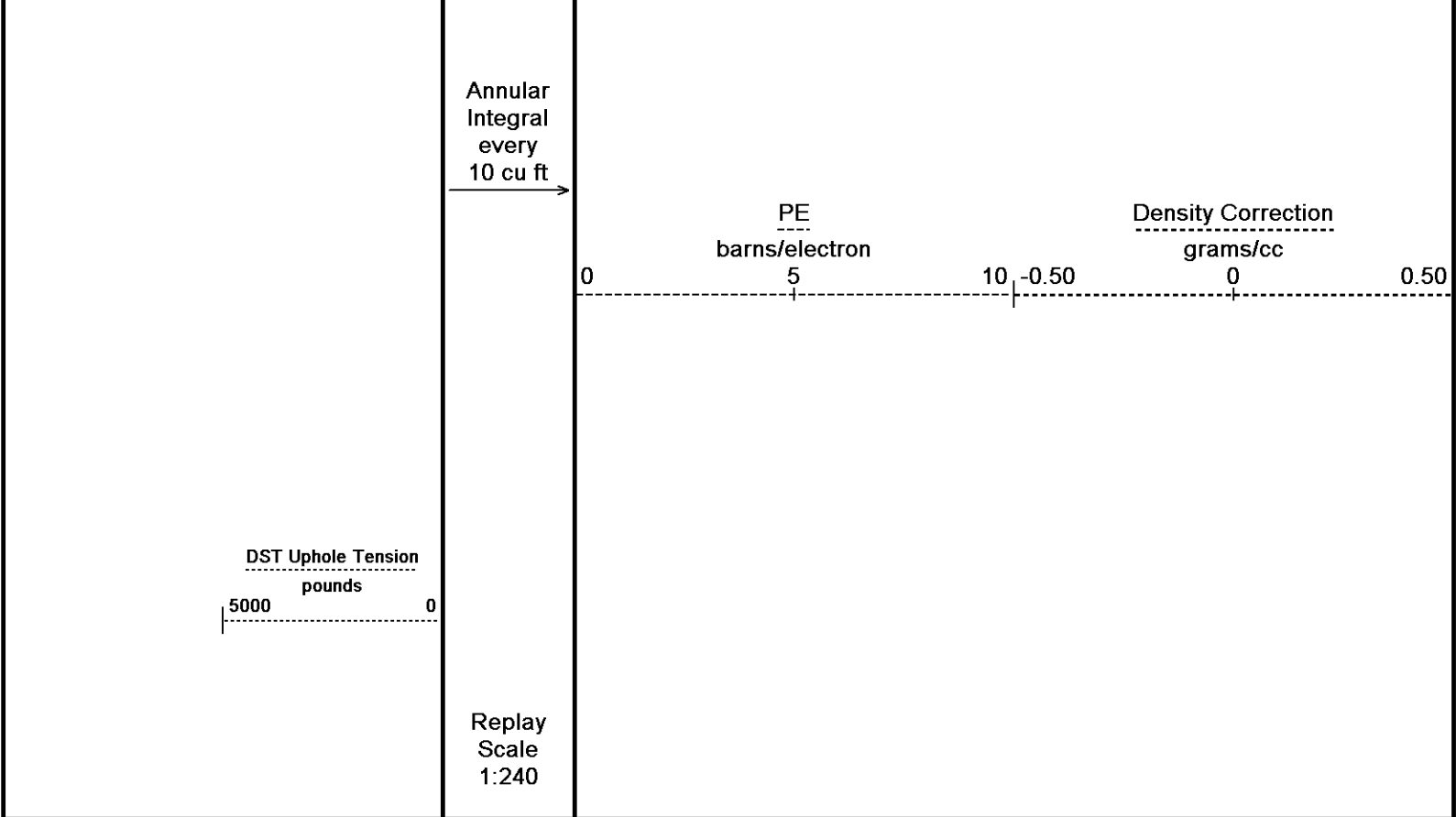
20

percent  
10

0

-10

Sandstone Density Por.



Depth Based Data - Maximum Sampling Increment 10.0cm  
 Plotted on 09-DEC-2017 05:02  
 Filename: C:\Minimus 17.05.5956\Logs\Vanguard Fe...\Vanguard Federal GGU 24D-28-691 Repeat.dta  
 Recorded on 09-DEC-2017 03:35  
 System Versions: Logged with 17.05.5956 Processed with 17.05.5956 Plotted with 17.05.5956

↑ REPEAT SECTION ↑

## BEFORE SURVEY CALIBRATION

C:\Minimus 17.05.5956\Logs\Vanguard Federal GGU 24D-28-691\Vanguard Federal GGU 24D-28-691 Main.dta

General Constants All 000			Last Edited on 09-DEC-2017,04:56
General Parameters			
Mud Resistivity	1.710	ohm-metres	
Mud Resistivity Temperature	75.000	degrees F	
Water Level	0.000	feet	
Borehole Fluid Processing	Wet Hole		
Hole/Annular Volume and Differential Caliper Parameters			
HVOL Method	Single Caliper		
HVOL Caliper 1	Density Caliper		
HVOL Caliper 2	N/A		
Annular Volume Diameter	8.625	inches	
Caliper for Differential Caliper	None		
Rwa Parameters			
Porosity used	Crossplot Porosity		
Resistivity used	Array Ind. Four Res Rt		
RWA Constant A	0.620		
RWA Constant M	2.150		
SW/APOR Tool Source	0.000		

Down-hole Tension Calibration SMS 0			Field Calibration on 30-NOV-2017 05:42
Reading No	Measured	Calibrated (lbs)	
1	14848.58	0.00	
2	15713.82	507.00	

Gamma Calibration MCG-C 84			Field Calibration on 07-DEC-2017,16:20
	Measured	Calibrated (API)	

Background	72	50
Calibrator (Gross)	730	506
Calibrator (Net)	658	456

Gamma Calibration Tolerances MCG-C 84		
Ratio	1.443	<div> <div>1.40</div> <div>1.475</div> <div>1.55</div> </div> Counts/API

Gamma Constants MCG-C 84		Last Edited on 09-DEC-2017,01:34	
Gamma Calibrator Number	MCGGRCC141		
GRC-M Calibrator Jig in Use?	NO		
Inactive Background Jig in Use?	NO		
Mud Density	1.14	gm/cc	
Caliper Source for Processing	Density Caliper		
Tool Position	Eccentred		
Potassium Equivalence	Chloride		
K Mud Concentration	0.00	%	

SP Calibration MCG-C 84		Field Calibration on 29-NOV-2017,13:21	
	Measured	Calibrated (mV)	
Reference 1	104.4	100.1	
Reference 2	-95.8	-100.1	

High Resolution Temperature Calibration MCG-C 84		Field Calibration on 29-NOV-2017,13:22	
	Measured	Calibrated(Deg F)	
Lower	50.00	50.00	
Upper	212.00	212.00	

High Resolution Temperature Constants MCG-C 84		Last Edited on 30-AUG-2017,13:52	
Pre-filter Length	11		

Caliper Calibration MVC-A.A 139		Base Calibration on 04-DEC-2017 22:00	
		Field Calibration on 04-DEC-2017 22:03	
Base Calibration			
Reading No	Measured	Calibrator Size (in)	
1	9272	4.01	
2	15786	5.96	
3	23078	7.98	
4	29574	9.86	
5	36950	11.93	
6	N/A	N/A	
Field Calibration			
	Measured Caliper (in)	Actual Caliper (in)	
	7.96	7.98	

Neutron Calibration MDN-A.B 114		Base Calibration on 29-NOV-2017,13:50	
		Field Check on 07-DEC-2017,16:20	
Base Calibration			
	Measured	Calibrated (cps)	
	Near Far	Near Far	
	3039 94	3714 110	
Ratio	32.458	33.764	
Field Calibrator at Base		Calibrated (cps)	
		2150 3142	
Ratio		0.684	
Field Check		Calibrated (cps)	
		2128 3104	
Ratio		0.686	

Neutron Calibration Tolerances MDN-A.B 114		
Ratio	32.458	<div> <div>-5%</div> <div>33</div> <div>+5%</div> </div>
Base Check	0.684	<div> <div>0.65</div> <div>0.7</div> <div>0.75</div> </div>
		<div> <div>0.664</div> <div>0.684</div> <div>0.704</div> </div>

## Neutron Constants MDN-A.B 114

Last Edited on 09-DEC-2017,01:34

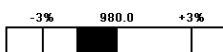
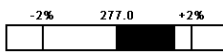
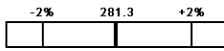
Neutron Source Id	P0204NN	
Neutron Jig Number	NJ5736	
Air Hole Processing	Modified Ratio	
Caliper Source for Processing	Density Caliper	
Stand-off	0.00	inches
Mud Density	1.00	gm/cc
Limestone Sigma	7.10	cu
Sandstone Sigma	4.26	cu
Dolomite Sigma	4.70	cu
Formation Pressure Source	None	
Formation Pressure	N/A	kpsi
Temperature Source	Constant Value	
Temperature	68.00	degrees F
Mud Salinity	0.00	kppm
Salinity Correction	Not Applied	
Formation Fluid Salinity Source	None	
Formation Fluid Salinity	N/A	kppm
Barite Mud Correction	Not Applied	

## FE Calibration MFE-B.J 352

Base Calibration on 29-NOV-2017,13:09  
Field Check on 09-DEC-2017,03:28

	Resistor 1 (ohm)	Resistor 2 (ohm)
	0.0	1000.0
Base Calibration		
	Measured	Calibrated (ohm-m)
Reference 1	0.0	0.0
Reference 2	963.8	126.8
Base Check		281.3
Field Check		281.1

## FE Calibration Tolerances MFE-B.J 352

Reference 2	963.8		ohm
Base Check	281.3		ohm-m
Field Check	281.1		ohm-m

## FE Constants MFE-B.J 352

Last Edited on 09-DEC-2017,03:28

Running Mode	No Sleeve	
MFE K Factor	0.1268	
Borehole Correction Constants		
Sonde Position	0.5	inches
Hole Size Source	Density Caliper	
Hole Size Constant Value	N/A	inches
Rm Source	Global Value: Temperature Corrected	
Temp. for Rm Corr.	MCG External Temperature	

## Induction Calibration MAI-A.A 111

Factory Loop Calibration 29-NOV-2017,13:05  
Field Check on 07-DEC-2017 16:07

## Factory Loop Calibration

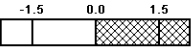

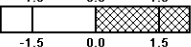

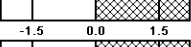
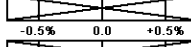

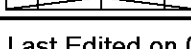
High Conductivity Reference Resistor	3.3	ohm
Low Conductivity Reference Resistor	333.3	ohm

Array	Measured Signal (unitless)		Reference Conductivity (mmho/m)		Calibration	
	Low	High	Low	High	Gain	Offset
1 (near)	17.6	473.6	9.3	966.2	0.000	0.0
2	6.4	385.9	7.6	821.4	0.000	0.0
3	3.2	264.0	5.2	566.0	0.000	0.0
4 (far)	2.1	135.5	2.6	279.2	0.000	0.0
Array Temperature		23.0		Deg F		

Tool Checks

Array	Factory Reference (mmho/m)		Before Survey (mmho/m)	
	Low	High	Low	High
1 (near)			8.8	3837.8
2			27.0	3496.9
3			26.7	2994.8
4 (far)			17.5	2040.2
Array Temperature		0.0	63.8	Deg F

#### Induction Check Tolerances MAI-A.A 111

Low Array 1	8.8		mmho/m	High Array 1	3837.8		mmho/m
Low Array 2	27.0		mmho/m	High Array 2	3496.9		mmho/m
Low Array 3	26.7		mmho/m	High Array 3	2994.8		mmho/m
Low Array 4	17.5		mmho/m	High Array 4	2040.2		mmho/m

#### Induction Constants MAI-A.A 111

Last Edited on 09-DEC-2017,03:28

Induction Model		RtAP-WBM	
Borehole Correction Constants			
Tool Centred		No	
Hole Size Source		Density Caliper	
Hole Size Constant Value		N/A	inches
Stand-off Type		Fins	
Stand-off		0.50	inches
Number of Fins on Stand-off		8.0000	
Stand-off Fin Angle		45.00	degrees
Stand-off Fin Width		0.5000	inches
Rm Source	Global Value: Constant Temperature		
Temp. for Rm Corr.		N/A	
Borehole Correction Method		Legacy	
Squasher Start		0.0020	mhos/metre
Squasher Offset		N/A	mhos/metre
Borehole Normalisation			
DRM1	0.0000	DRC1	0.0000
DRM2	0.0000	DRC2	0.0000
MRM1	0.0000	MRC1	0.0000
MRM2	0.0000	MRC2	0.0000
SRM1	0.0000	SRC1	0.0000
SRM2	0.0000	SRC2	0.0000
Calibration Site Corrections			
Channel 1		0.00	mmhos/metre
Channel 2		0.00	mmhos/metre
Channel 3		0.00	mmhos/metre
Channel 4		0.00	mmhos/metre
Symmetrised Receiver Gains			
Receiver 1		1.00	
Receiver 2		1.00	
Receiver 3		1.00	
Receiver 4		1.00	
Apparent Porosity and Water Saturation Constants			
Archie Constant (A)		1.00	
Cementation Exponent (M)		2.00	
Saturation Exponent (N)		2.00	
Saturation of Water for Apor		100.00	percent
Resistivity of Water for Apor and Sw		0.05	ohm-m
Resistivity of Mud Filtrate for Sw		0.00	ohm-m
Source for Rt		0.00	
Source for Rxo		0.00	

#### High Resolution Temperature Calibration MAI-A.A 111

Field Calibration on 29-NOV-2017,13:09

Measured      Calibrated(Deg F)

Lower	50.00	50.00
Upper	212.00	212.00

High Resolution Temperature Constants MAI-A.A 111	Last Edited on 26-JUN-2014,15:06
Pre-filter Length	11

Caliper Calibration MPD-C.A 216	Base Calibration on 09-DEC-2017,01:25	Field Calibration on 09-DEC-2017,01:25
Base Calibration		
Reading No	Measured	Calibrator Size (in)
1	16112	3.99
2	24947	5.98
3	33536	7.97
4	41696	9.86
5	51088	11.92
6	N/A	N/A
Field Calibration		
	Measured Caliper (in)	Actual Caliper (in)
	7.94	7.97

Caliper Calibration Tolerances MPD-C.A 216
Long Arm Field Cal. 7.94  in

Photo Density Calibration MPD-C.A 216	Base Calibration on 29-NOV-2017,13:10	Field Check on 07-DEC-2017 16:20
Density Calibration		
Base Calibration	Measured	Calibrated (sdu)
	Near Far	Near Far
Background	1025 1218	
Reference 1	51146 24580	59556 30836
Reference 2	20383 2310	24941 2541
Field Check at Base		
	1024.7 1217.9	
Field Check		
	1020.5 1208.3	
PE Calibration		
Base Calibration	Measured	Calibrated
	WS WH Ratio	Ratio
Background	187 916	
Reference 1	21227 50978 0.420	0.371
Reference 2	5863 20269 0.293	0.272
Field Check at Base		
	187.1 916.4	
Field Check		
	187.3 913.1	

Photo Density Calibration Tolerances MPD-C.A 216									
Near Density Ratio	2.59	<div><div>-5%</div><div>2.52</div><div>+5%</div></div>			Far Density Ratio	21.38	<div><div>-5%</div><div>21.00</div><div>+5%</div></div>		
PE Calibration	0.118	<div><div>0.089</div><div>0.110</div><div>0.131</div></div>							
Near Den. Field Check	1020.5	<div><div>-3%</div><div>1024.7</div><div>+3%</div></div>			Far Den. Field Check	1208.3	<div><div>-3%</div><div>1217.9</div><div>+3%</div></div>		
PE WS Field Check	187.3	<div><div>-6%</div><div>187.1</div><div>+6%</div></div>			PE WH Field Check	913.1	<div><div>-6%</div><div>916.4</div><div>+6%</div></div>		

Density Constants MPD-C.A 216	Last Edited on 09-DEC-2017,01:34
Density Source Id	P50557B
Nylon Calibrator Number	DNCE695
Aluminium Calibrator Number	DACD698
Density Shoe Profile	8 inch
Caliper Source for Processing	Density Caliper
PE Correction to Density	Not Applied



Mud Density	1.14	gm/cc
Mud Density Type		
Mud Filtrate Density	1.00	gm/cc
Dry Hole Mud Filtrate Density	1.00	gm/cc
DNCT	0.00	gm/cc
CRCT	0.00	gm/cc
Density Z/A Correction	Hybrid	
Precision Enhanced Density Processing	Not Applied	

Matrix Density (gm/cc)	Depth (ft)
2.71	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00

## DOWNHOLE EQUIPMENT

C:\Minimus 17.05.5956\Logs\Vanguard Federal GGU 24D-28-691\Vanguard Federal GGU 24D-28-691 Main.dta

Cablehead, 11 pin  
CBH-C 0 LG: 2.40 ft WT: 24.3 lb OD: 2.244 in

Compact Swivel Head Adaptor  
SHA-F 33 LG: 2.74 ft WT: 26.5 lb OD: 2.244 in

Compact Comms Gamma  
MCG-C 84 LG: 8.70 ft WT: 63.9 lb OD: 2.244 in

Compact Vee Arm Caliper  
MVC-A.A 139 LG: 8.06 ft WT: 61.7 lb OD: 2.244 in

Compact Neutron  
MDN-A.B 114 LG: 5.04 ft WT: 50.7 lb OD: 2.244 in

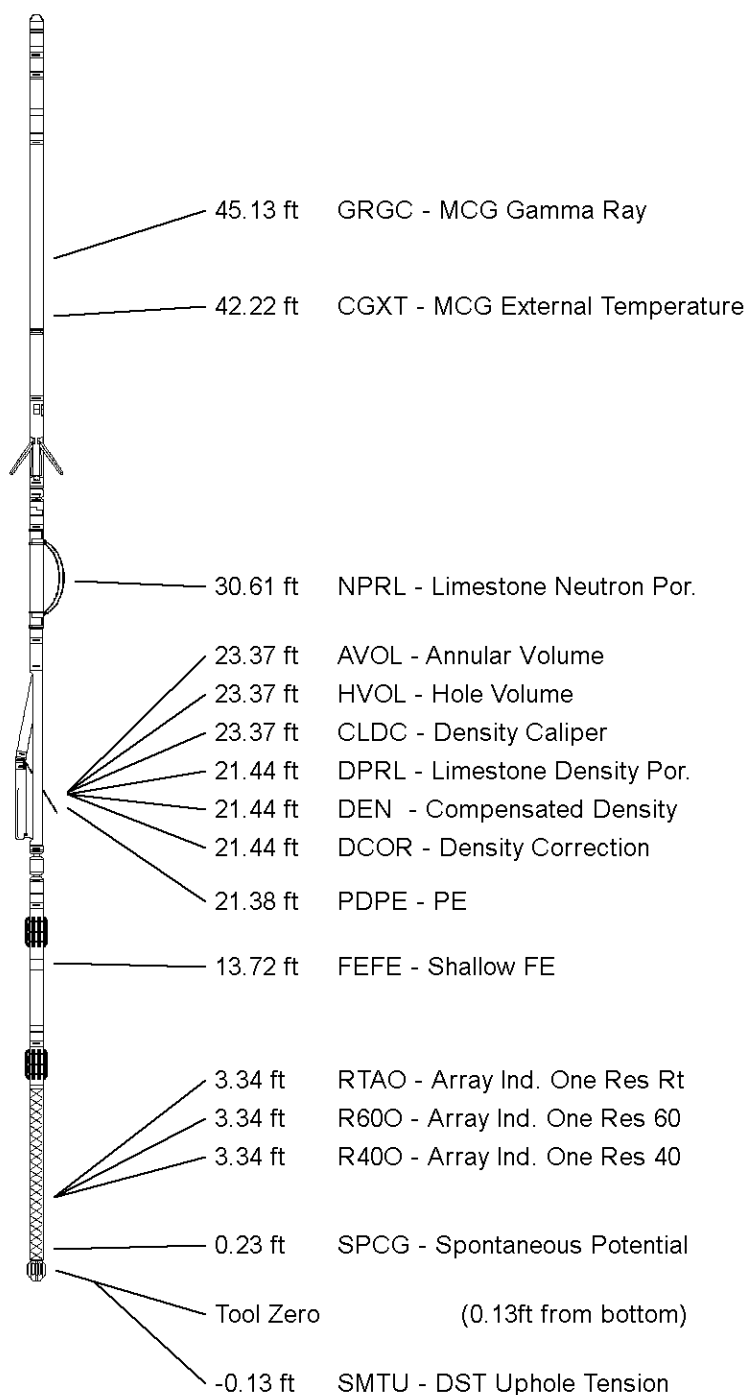
Compact Density/Caliper  
MPD-C.A 216 LG: 9.59 ft WT: 90.4 lb OD: 2.449 in

Compact Knuckle Joint  
SKJ-E.A 409 LG: 2.17 ft WT: 24.3 lb OD: 2.244 in

Compact Focussed Electric  
MFE-B.J 352 LG: 6.05 ft WT: 48.5 lb OD: 2.244 in

Compact Induction  
MAI-A.A 111 LG: 10.81 ft WT: 48.5 lb OD: 2.244 in

Total Length: 55.55 ft Weight: 438.7 lb



COMPANY	VANGUARD OPERATING, LLC.
WELL	FEDERAL GGU #24D-28-691
FIELD	MAMM CREEK
PROVINCE/COUNTY	GARFIELD
COUNTRY/STATE	U.S.A. / COLORADO

Elevation Kelly Bushing	6147	feet	First Reading	819.00	feet
Elevation Drill Floor	6147	feet	Depth Driller	840.00	feet
Elevation Ground Level	6130	feet	Depth Logger	840.00	feet



**Weatherford®**

COMPACT PHOTO DENSITY  
COMPENSATED NEUTRON