# COMPENSATED DENSITY COMPENSATED NEUTRON LOG

Weatherford

| | |
|---|---|
| COMPANY | EAST CHEYENNE GAS STORAGE LLC |
| WELL | ECGS No 6-21 WPD004-2 |
| FIELD | WEST PEETZ |
| PROVINCE/COUNTY | LOGAN |
| COUNTRY/STATE | U.S.A / COLORADO |
| LOCATION | SHL: 1440' FSL & 2297' FWL |

| | | | |
|---|---|---|---|
| SEC 6 | TWP 11N | RGE 52W | Other Services |
| Latitude | | | MFE/MAI |
| Longitude | | | |
| API Number | 0507509426-0000 | | |

| | | | |
|---|---|---|---|
| Permanent Datum GL, Elevation 4557 feet | | Elevations: | feet |
| Log Measured From KB | | KB | 4567.00 |
| Drilling Measured From KB | | DF | 4566.00 |
| | | GL | 4557.00 |

| | | | | | |
|---|---|---|---|---|---|
| Date | 18-OCT-2014 | | | | |
| Run Number | 1 | | | | |
| Service Order | 2577-100789597 | | | | |
| Depth Driller | 5440.00 | feet | | | |
| Depth Logger | 5440.00 | feet | | | |
| First Reading | 5388.00 | feet | | | |
| Last Reading | 1213.00 | feet | | | |
| Casing Driller | 1220.00 | feet | | | |
| Casing Logger | 1213.00 | feet | | | |
| Bit Size | 8.750 | inches | | | |
| Hole Fluid Type | WBM | | | | |
| Density / Viscosity | 9.60 | lb/USg | 70.00 | SEC/QT | |
| PH / Fluid Loss | 8.00 | | | | |
| Sample Source | FLOWLINE | | | | |
| Rm @ Measured Temp | 2.21 @ 65.7 | ohm-m | | | |
| Rmf @ Measured Temp | 1.76 @ 65.7 | ohm-m | | | |
| Rmc @ Measured Temp | 2.65 @ 65.7 | ohm-m | | | |
| Source Rmf / Rmc | FLOWLINE | | | | |
| Rm @ BHT | 0.89 @168.0 | ohm-m | | | |
| Time Since Circulation | 5 HOURS | | | | |
| Max Recorded Temp | 168.00 | deg F | | | |
| Equipment / Base | 13173 | CASPER | | | |
| Recorded By | M.RICHINS | | | | |
| Witnessed By | R.LYNDE | | | | |

## BOREHOLE RECORD

Last Edited: 17-OCT-2014 20:59

| Bit Size inches | Depth From feet | Depth To feet |
|---|---|---|
| 8.750 | 1219.00 | 5260.00 |

## CASING RECORD

| Type | Size inches | Depth From feet | Shoe Depth feet | Weight pounds/ft |
|---|---|---|---|---|
| Surface | 9.625 | 0.00 | 1219.00 | 36.00 |

## REMARKS

SOFTWARE VERSION: 14.01.3220

MCG, MDN, MPD, MFE, MIE, AND MAI RAN IN COMBINATION.

HARDWARE: MAI: 0.5" STAND OFF, SEE TOOL STRING.

TIGHT PULLS, BOREHOLE SIZE AND RUGOSITY WILL AFFECT REPEATABILITY AND DATA QUALITY.

ALL INTERVALS LOGGED AND SCALED PER CUSTOMER'S REQUEST.

IMAGE TOOL PACKED UP WITH MUD AND WELL DEBRIS. REPEAT PASS PRESENTED INSTEAD OF MAIN. IMAGE PULLED 300 FEET OFF BOTTOM.

POROSITY TOOLS PULLED TO 3900 FEET PER CUSTOMER REQUEST.

RESISTIVITY PULLED TO SURFACE CASING, AND GAMMA PULLED TO SURFACE.

TOTAL HOLE VOLUME FROM TD (5440 FEET) TO SURFACE CASING = 1840 CUBIC FEET

TOTAL HOLE VOLUME FROM TD (6145 FEET) TO SURFACE CASING = 1013 CUBIC FEET.

ANNULAR HOLE VOLUME WITH 7' CASING FROM TD TO SURFACE CASING = 720

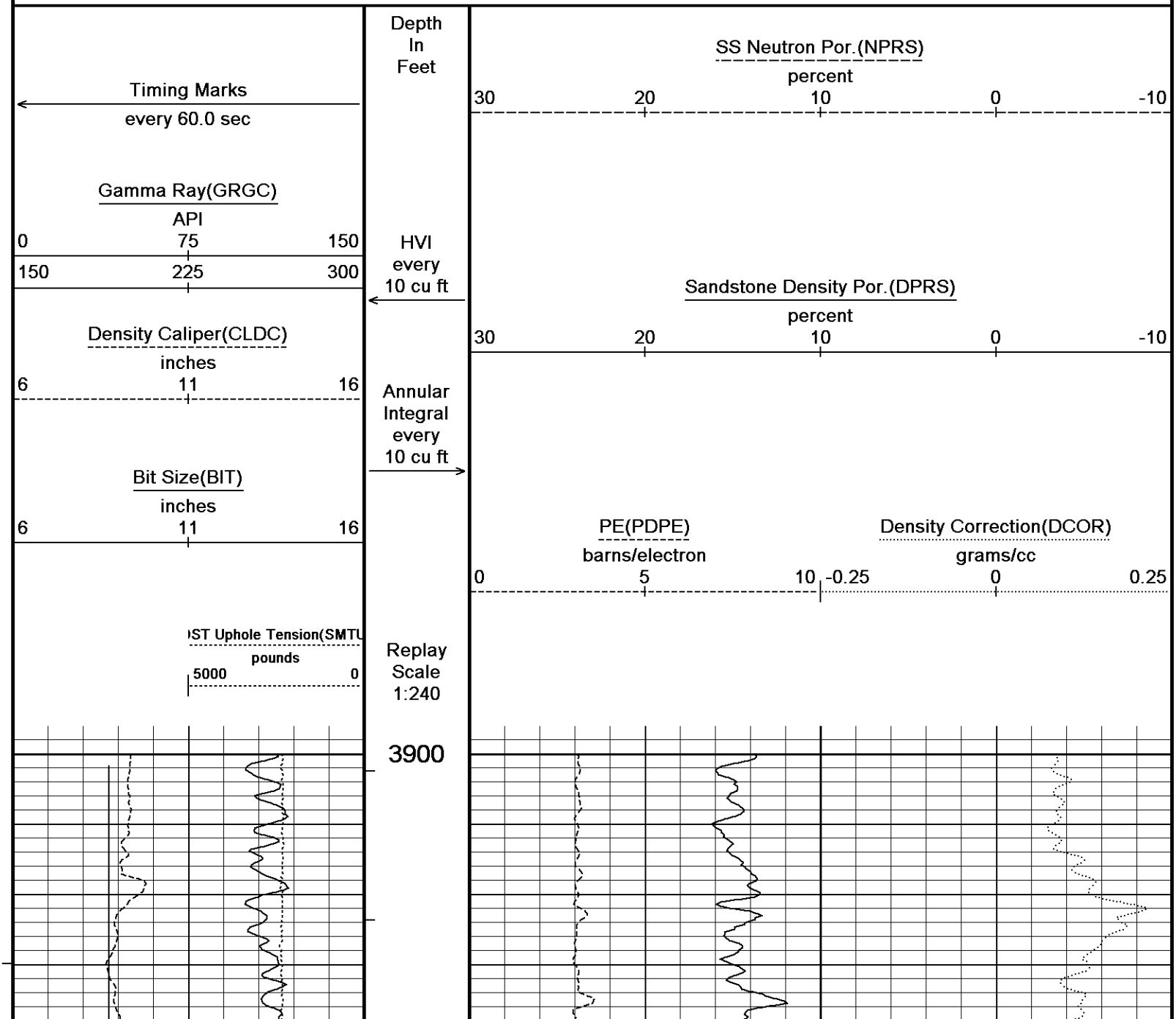
In interpreting, communicating or providing information and/or making recommendations, either written or oral, as to logs or test or other data, type or amount of material, or Work or other service to be furnished, or manner of performance, or in predicting results to be obtained, the Contractor will 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.

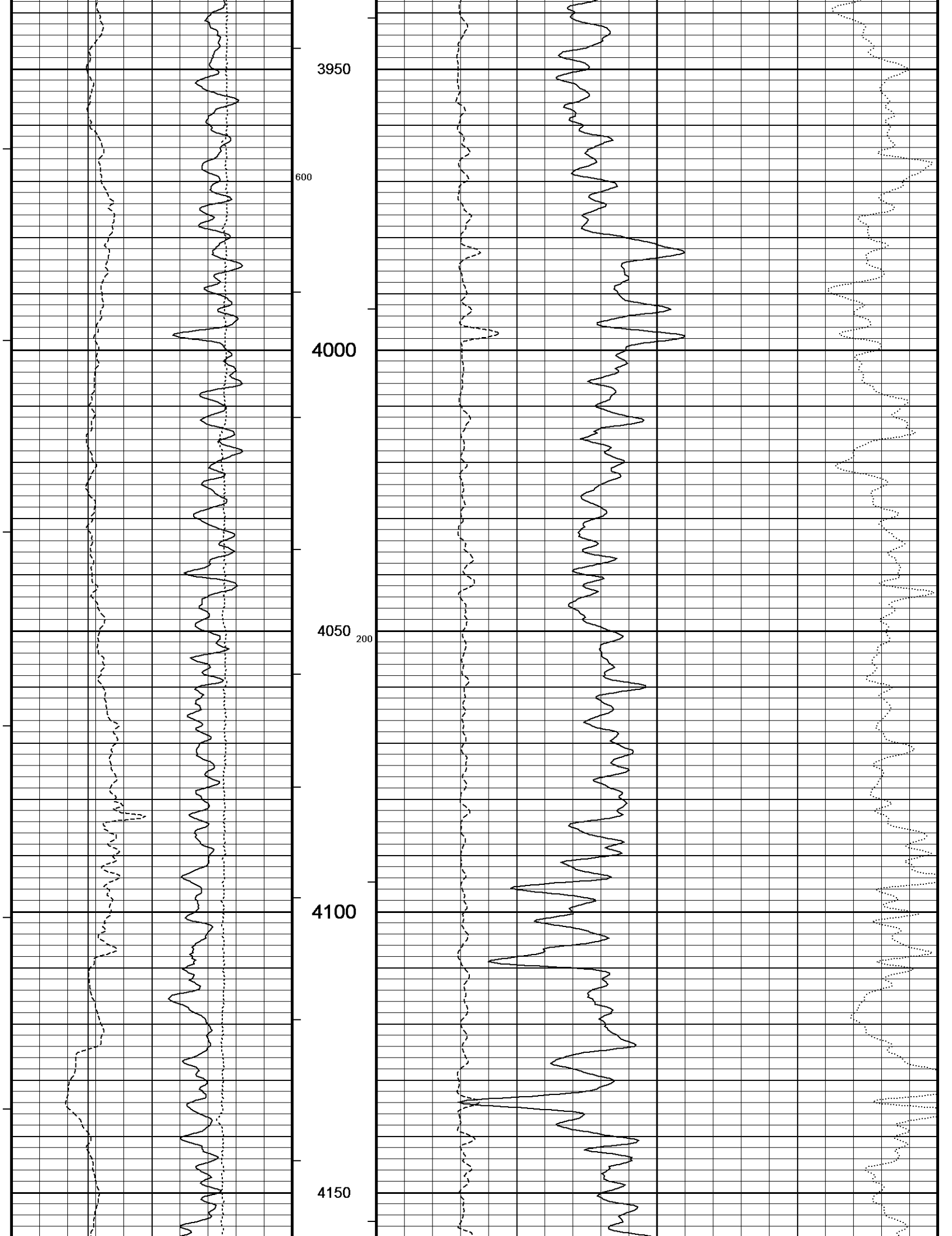
## 5 INCH MAIN LOG DSC

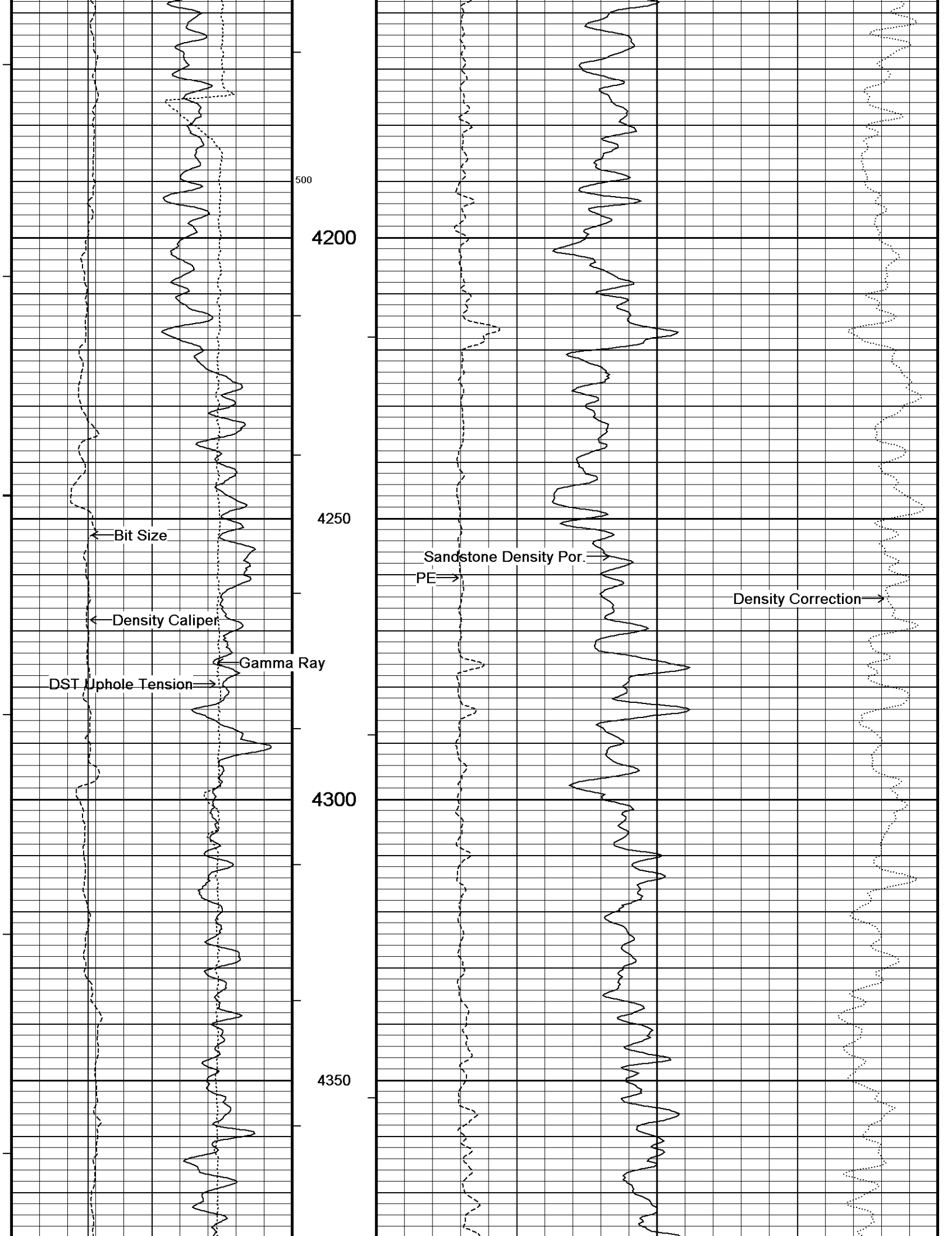
Depth Based Data - Maximum Sampling Increment 10.0cm — Plotted on 18-OCT-2014 15:15

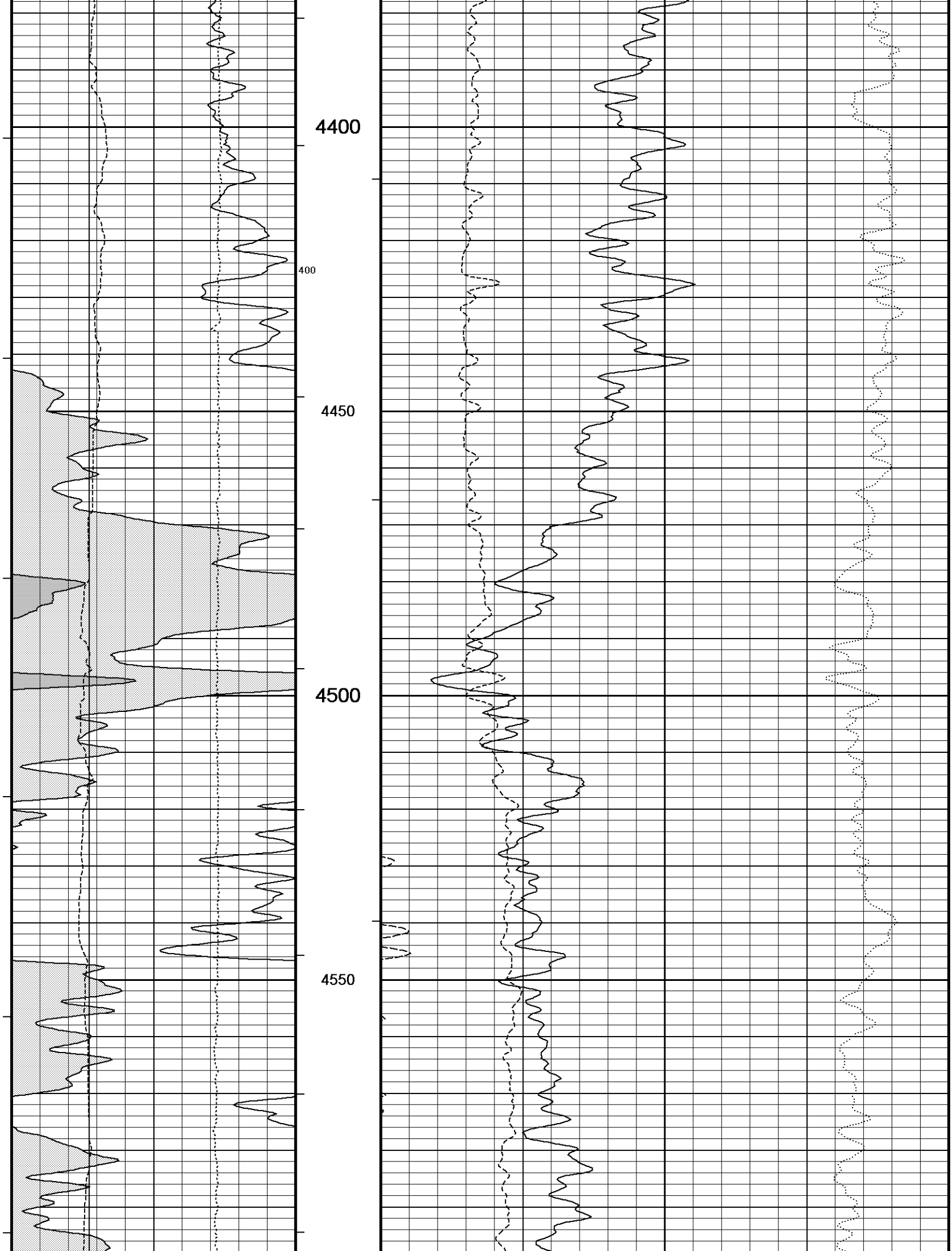
Filename: C:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Main2.dta — Recorded on 18-OCT-2014 08:21

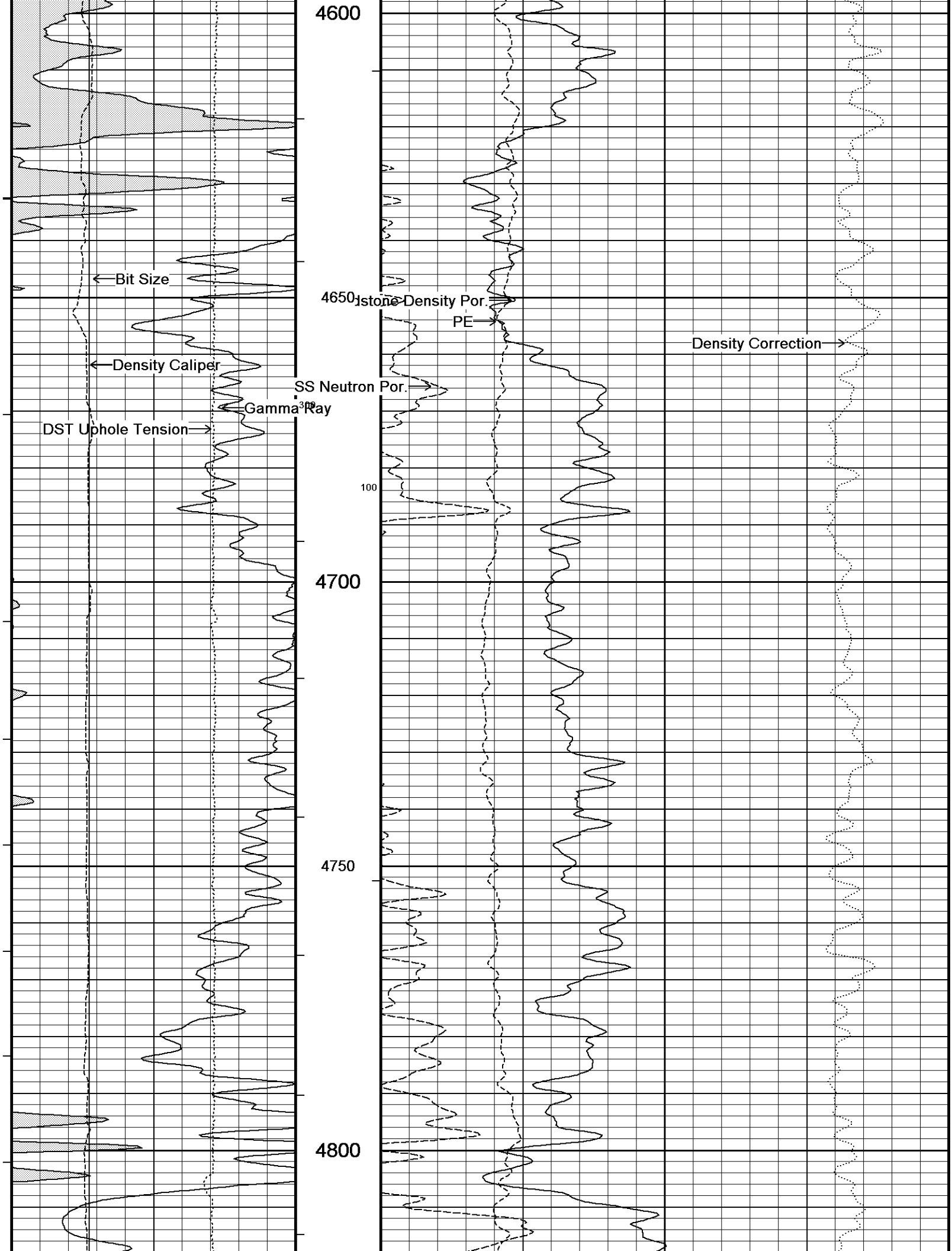
System Versions: Logged with 14.01.3220 Processed with 14.01.3220 Plotted with 13.08.1505

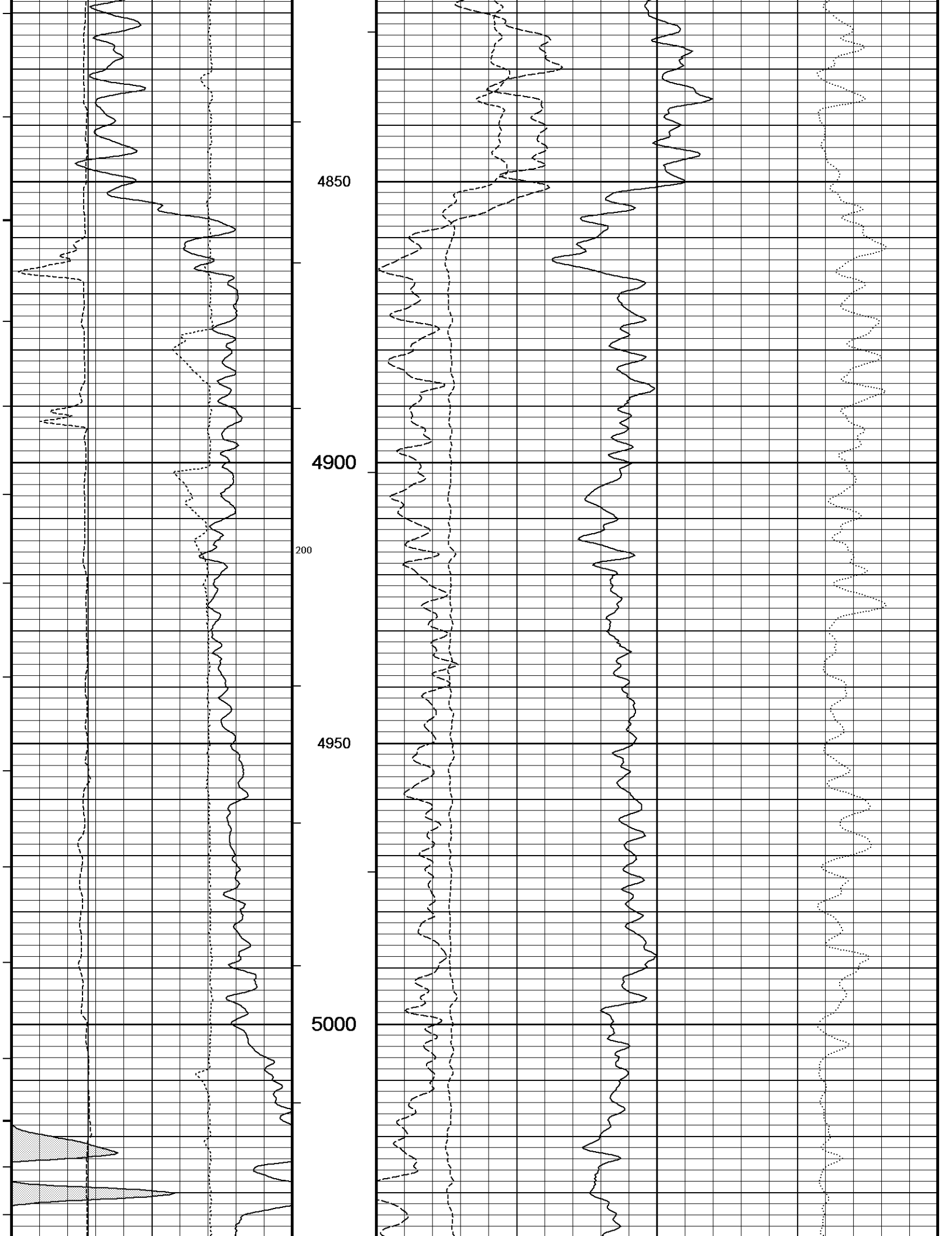


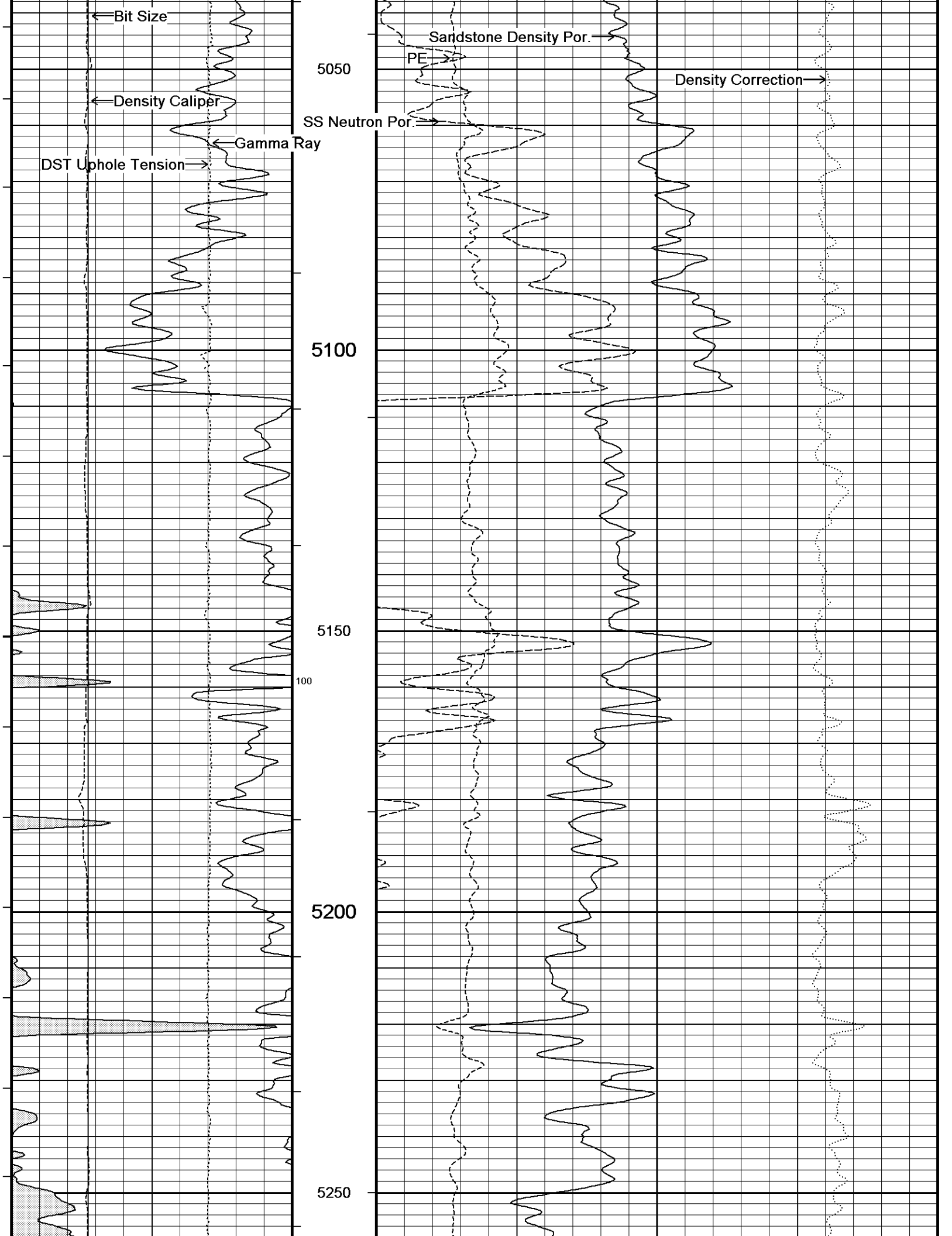

3950
600
4000
4050
200
4100
4150

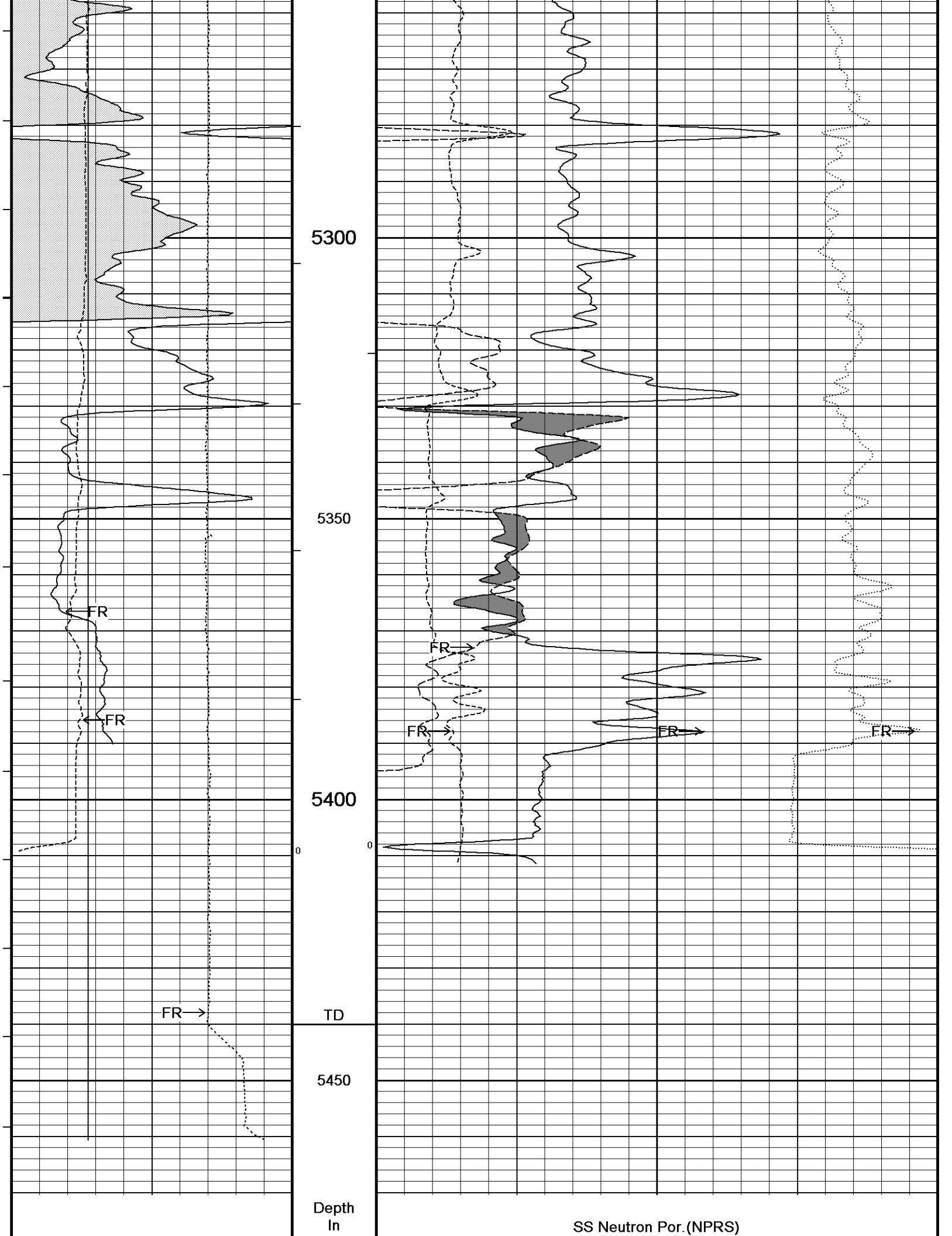

500
4200
4250
4300
4350
Bit Size
Density Caliper
Gamma Ray
DST Uphole Tension
Sandstone Density Por.
PE
Density Correction

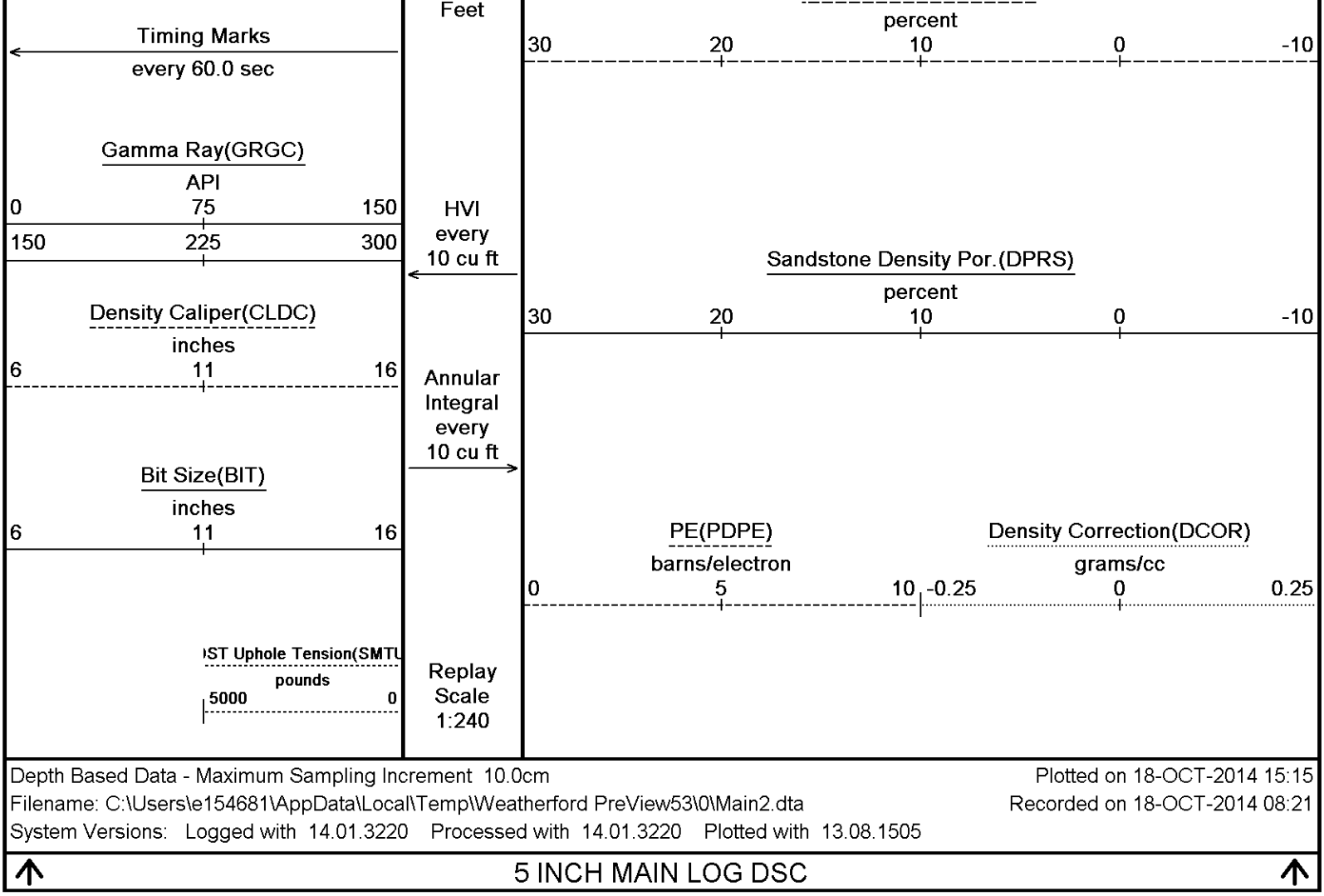

4400
400
4450
4500
4550


4600
Bit Size
4650
Istone Density Por.
PE
Density Caliper
SS Neutron Por.
Gamma Ray
300
DST Uphole Tension
100
4700
4750
4800
Density Correction


4850
4900
200
4950
5000

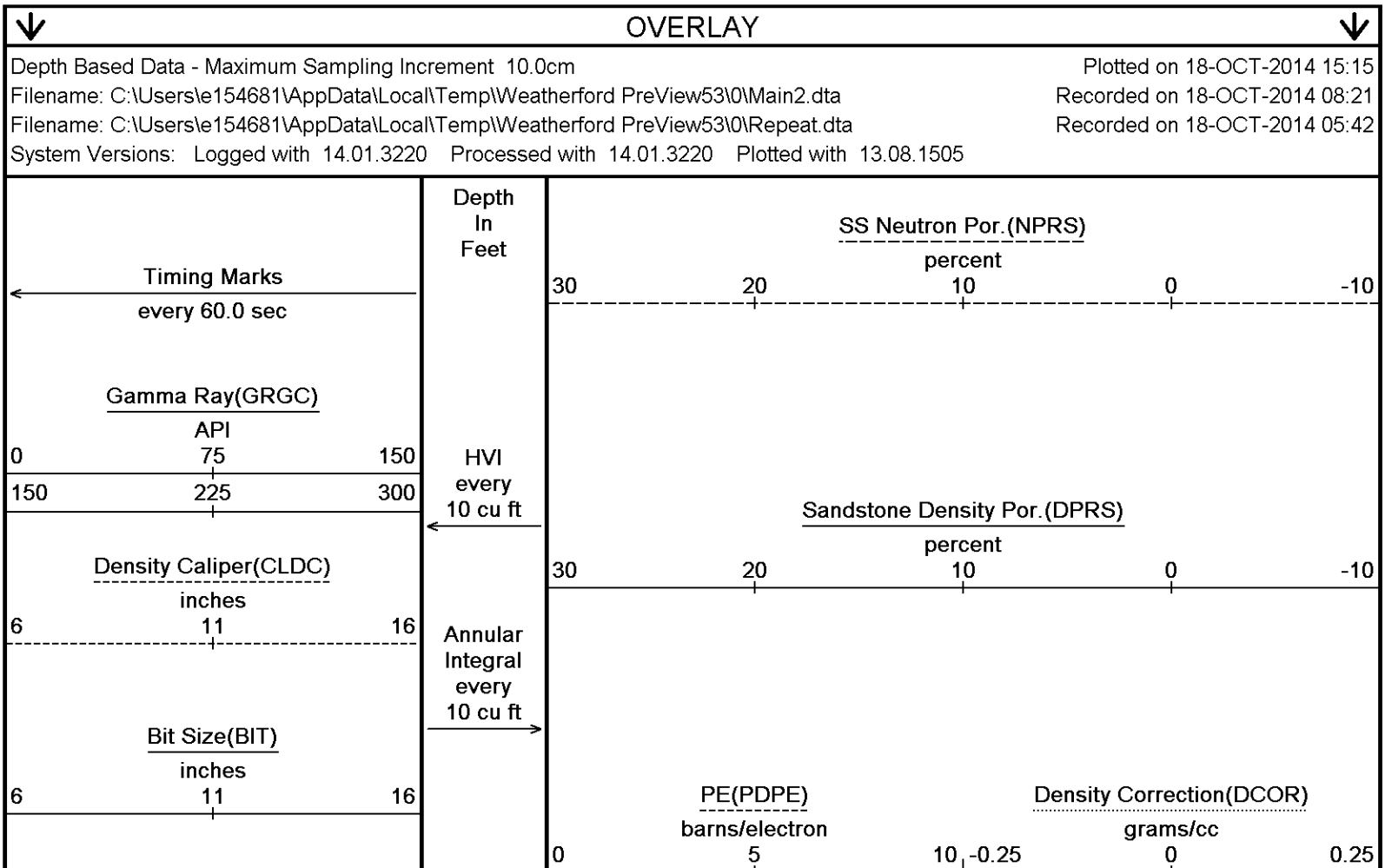

Bit Size
Density Caliper
Gamma Ray
DST Uphole Tension
Sandstone Density Por.
PE
SS Neutron Por.
Density Correction
5050
5100
5150
5200
5250
100

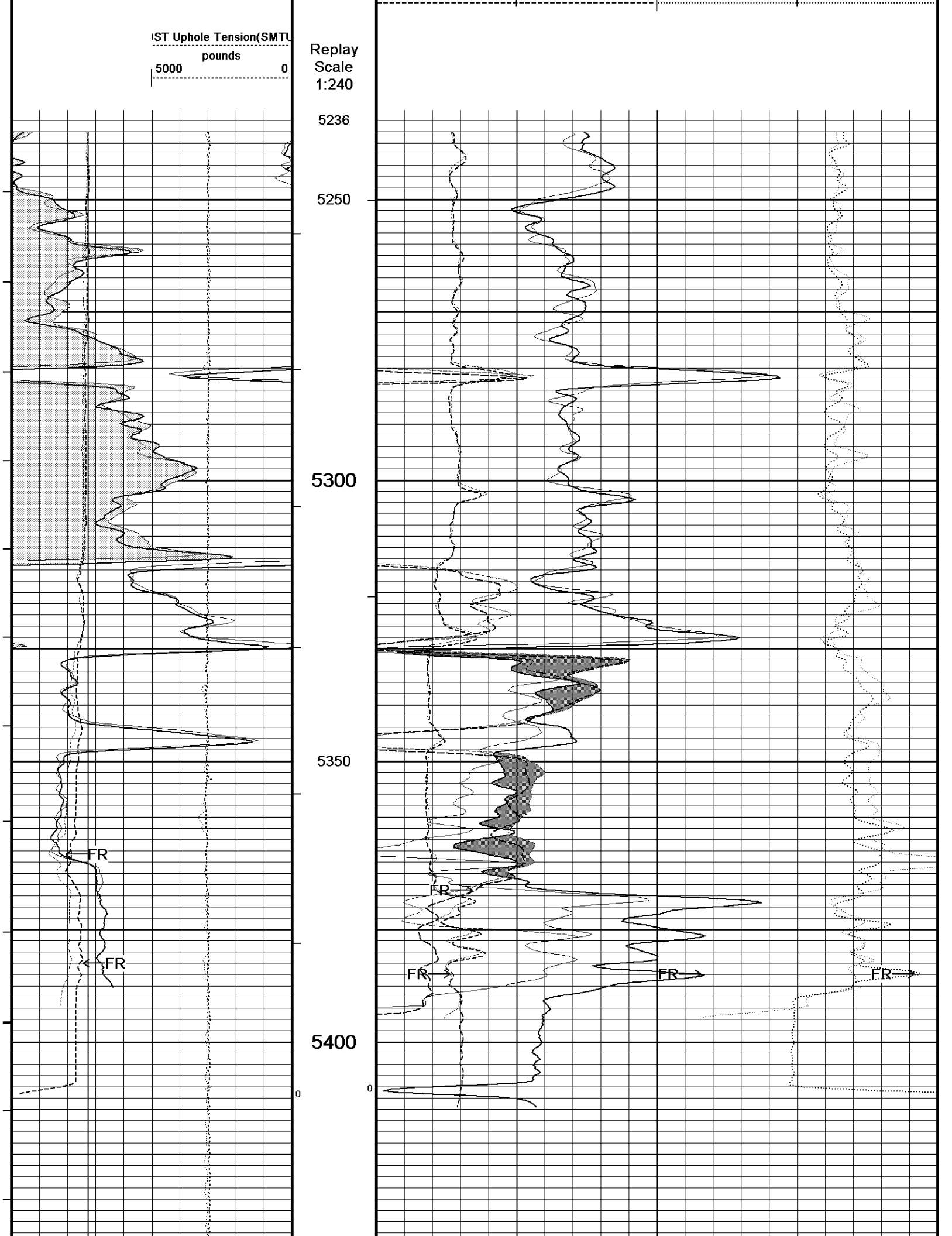

5300
5350
5400
TD
5450
FR
FR
FR
FR
FR
FR
FR
0
0
Depth
In
SS Neutron Por.(NPRS)

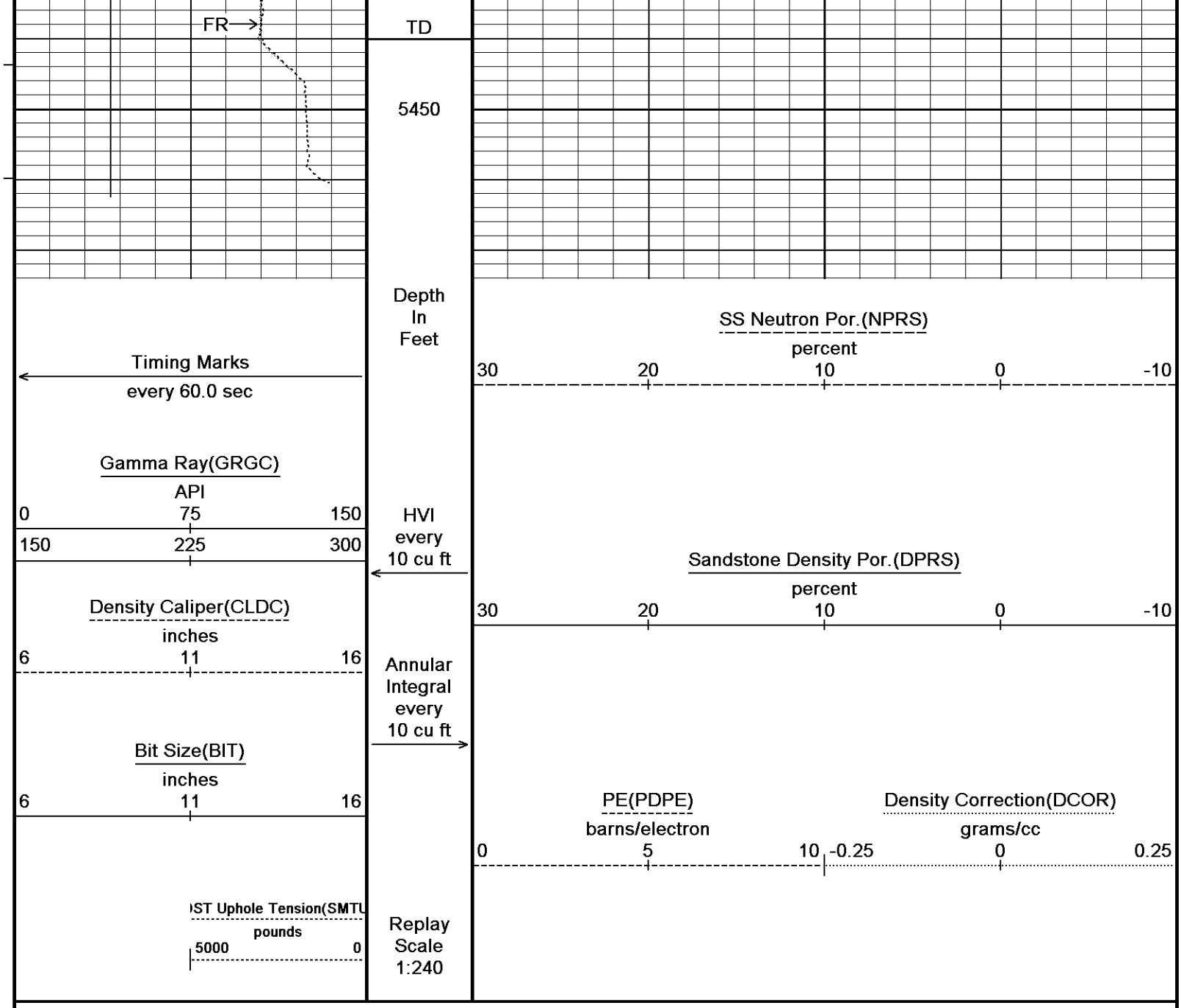



5 INCH MAIN LOG DSC

OVERLAY




ST Uphole Tension(SMTU
pounds
5000
0
Replay
Scale
1:240
5236
5250
5300
5350
5400
0
0
FR
FR
FR
FR
FR
FR

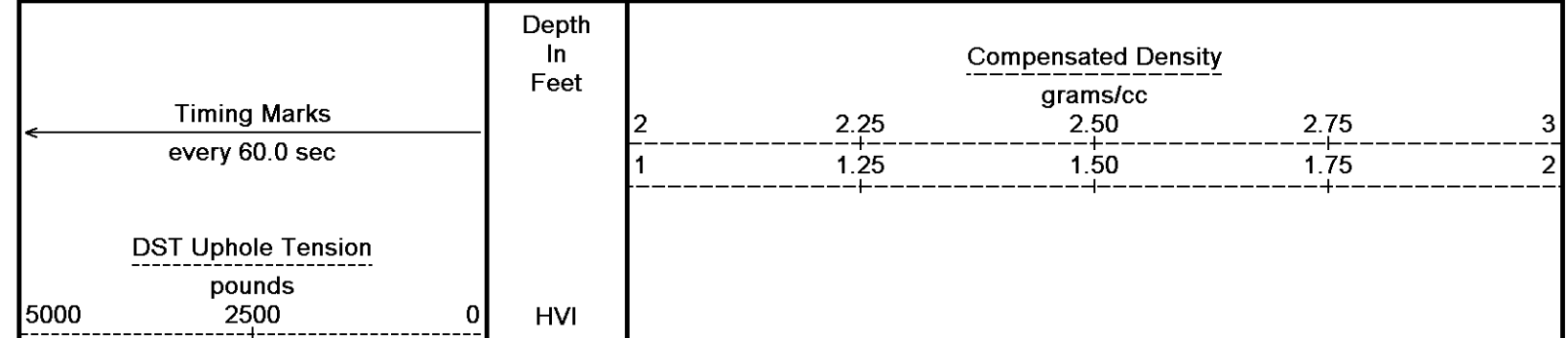


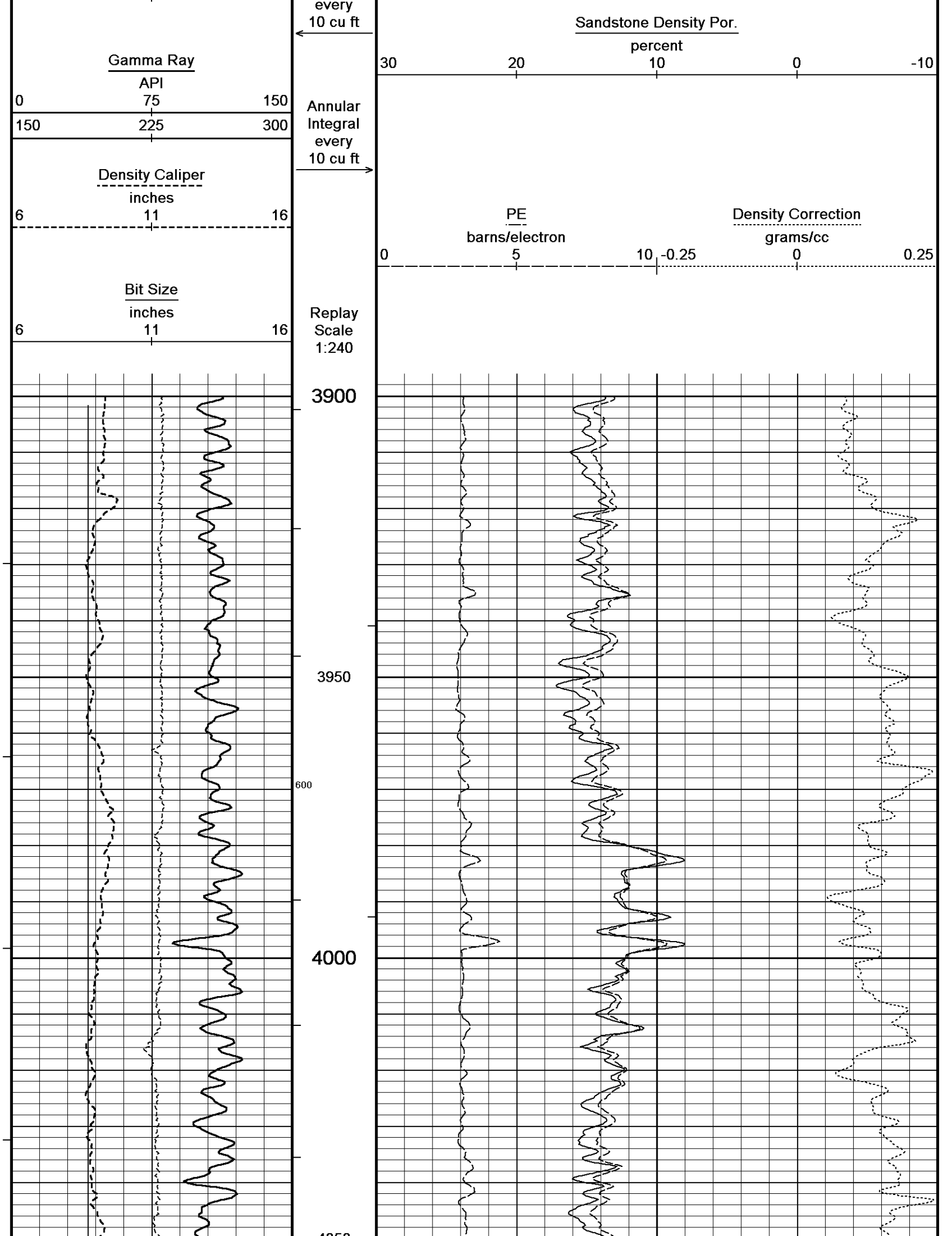

Depth Based Data - Maximum Sampling Increment 10.0cm — Plotted on 18-OCT-2014 15:15
Filename: C:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Main2.dta — Recorded on 18-OCT-2014 08:21
Filename: C:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Repeat.dta — Recorded on 18-OCT-2014 05:42
System Versions: Logged with 14.01.3220 Processed with 14.01.3220 Plotted with 13.08.1505

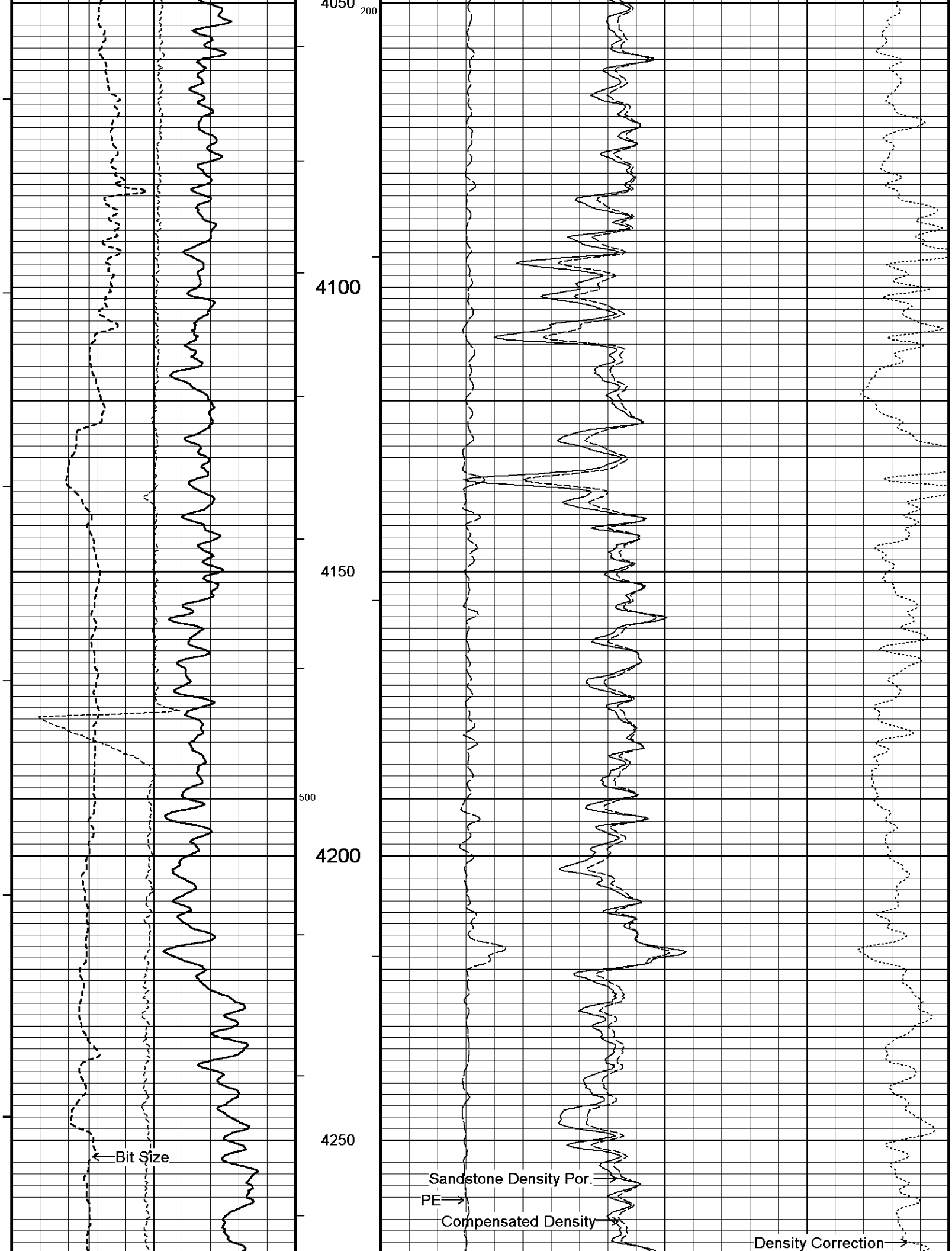
OVERLAY

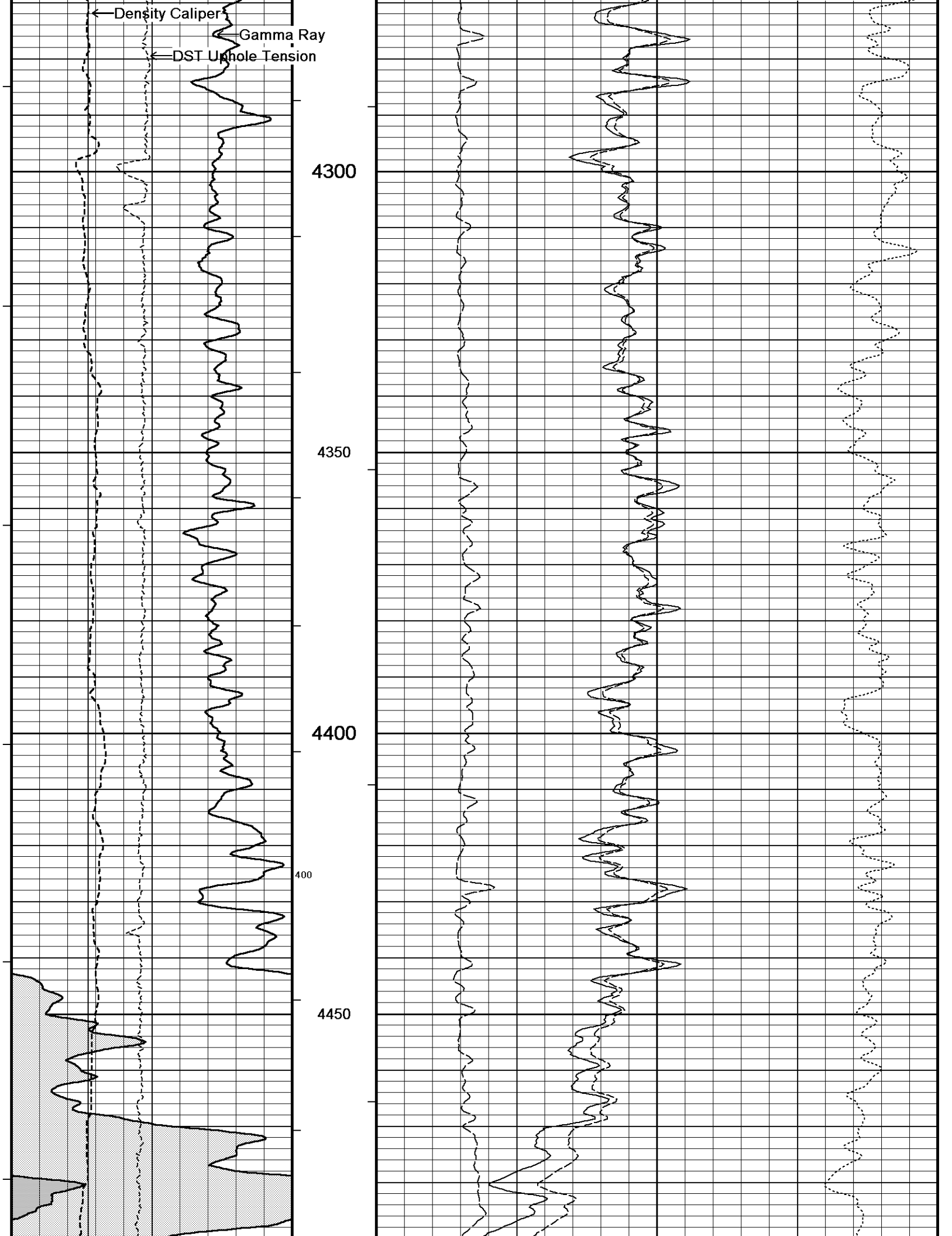
## 5 INCH MAIN LOG DSC

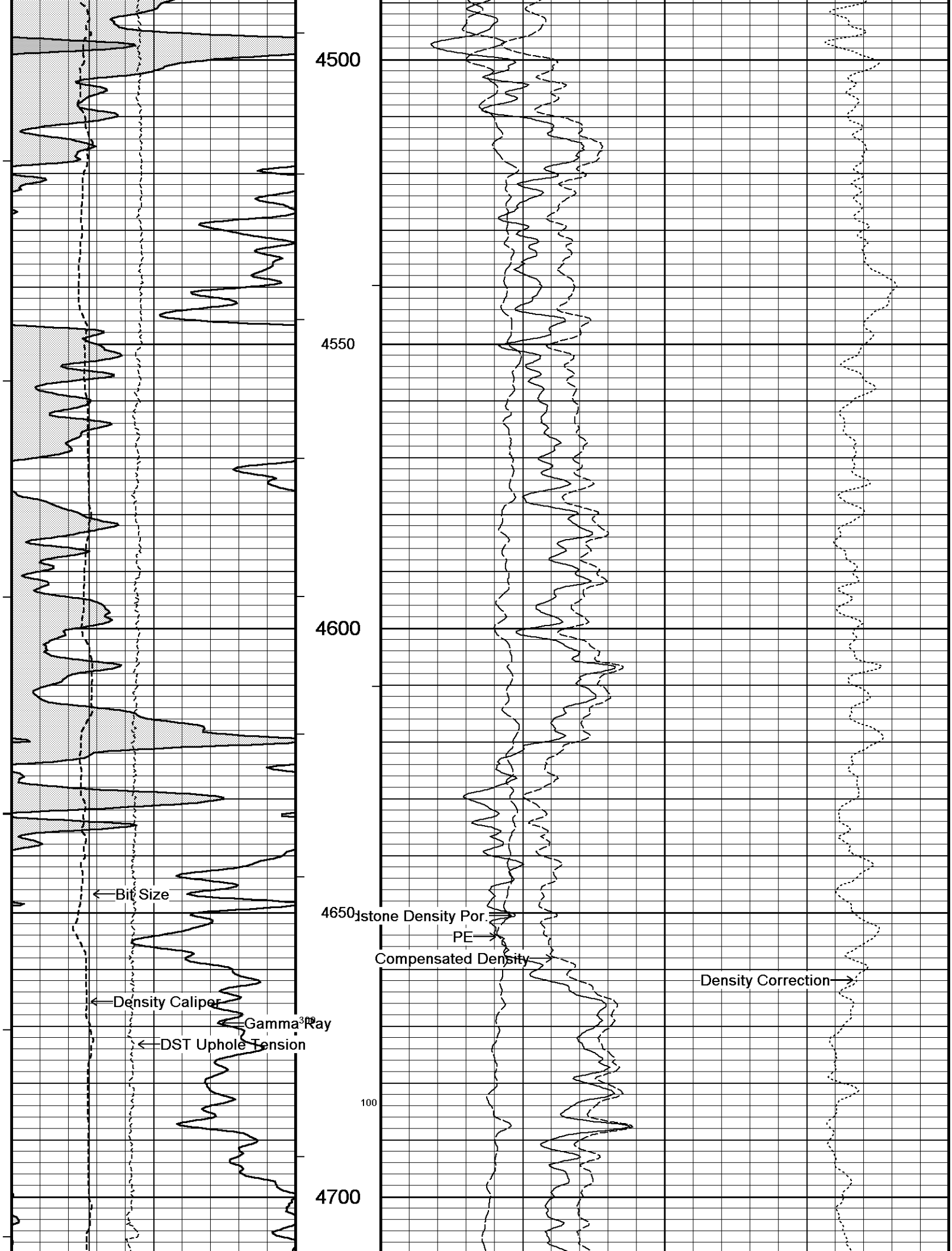
Depth Based Data - Maximum Sampling Increment 10.0cm — Plotted on 18-OCT-2014 15:15
Filename: C:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Main2.dta — Recorded on 18-OCT-2014 08:21
System Versions: Logged with 14.01.3220 Processed with 14.01.3220 Plotted with 13.08.1505

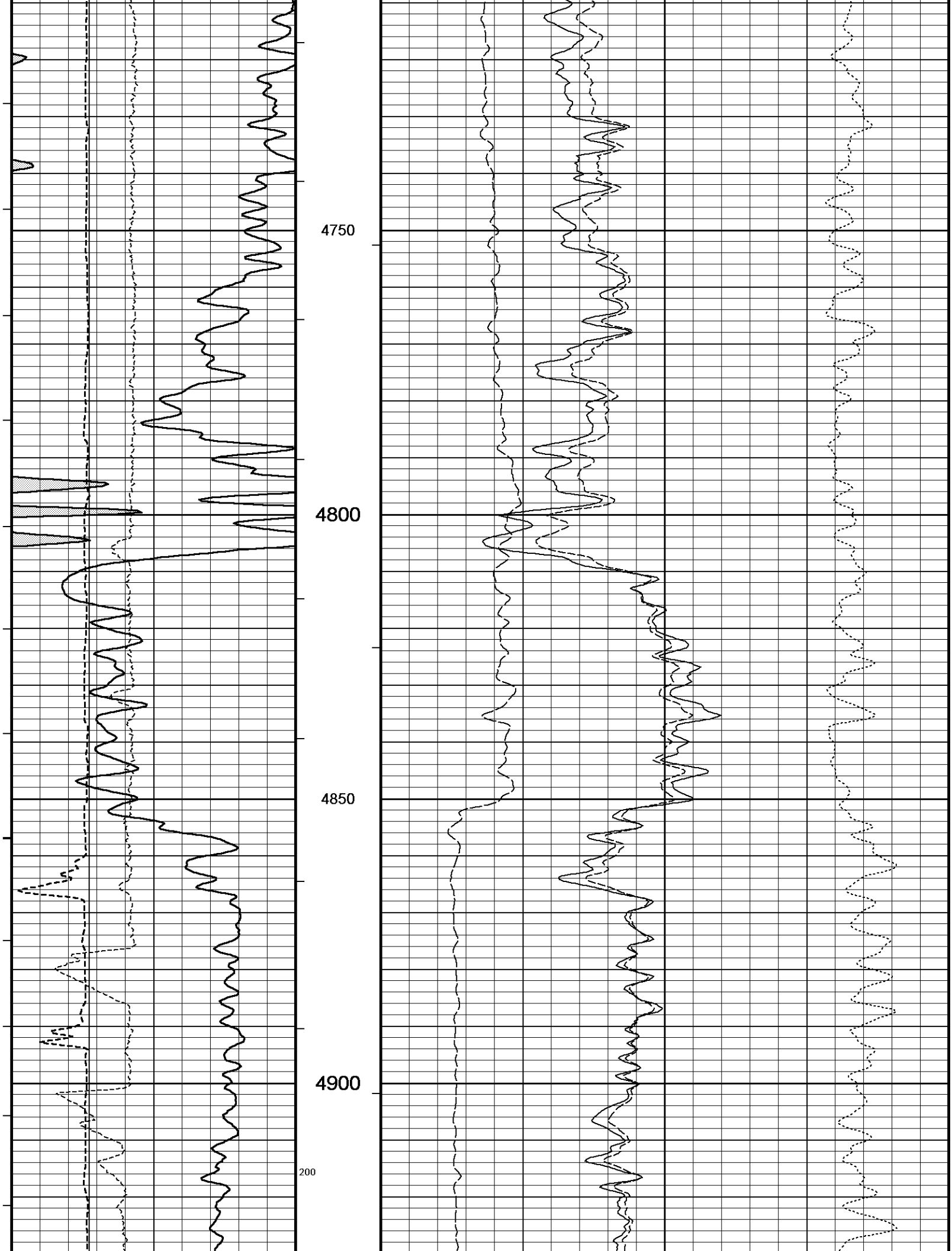


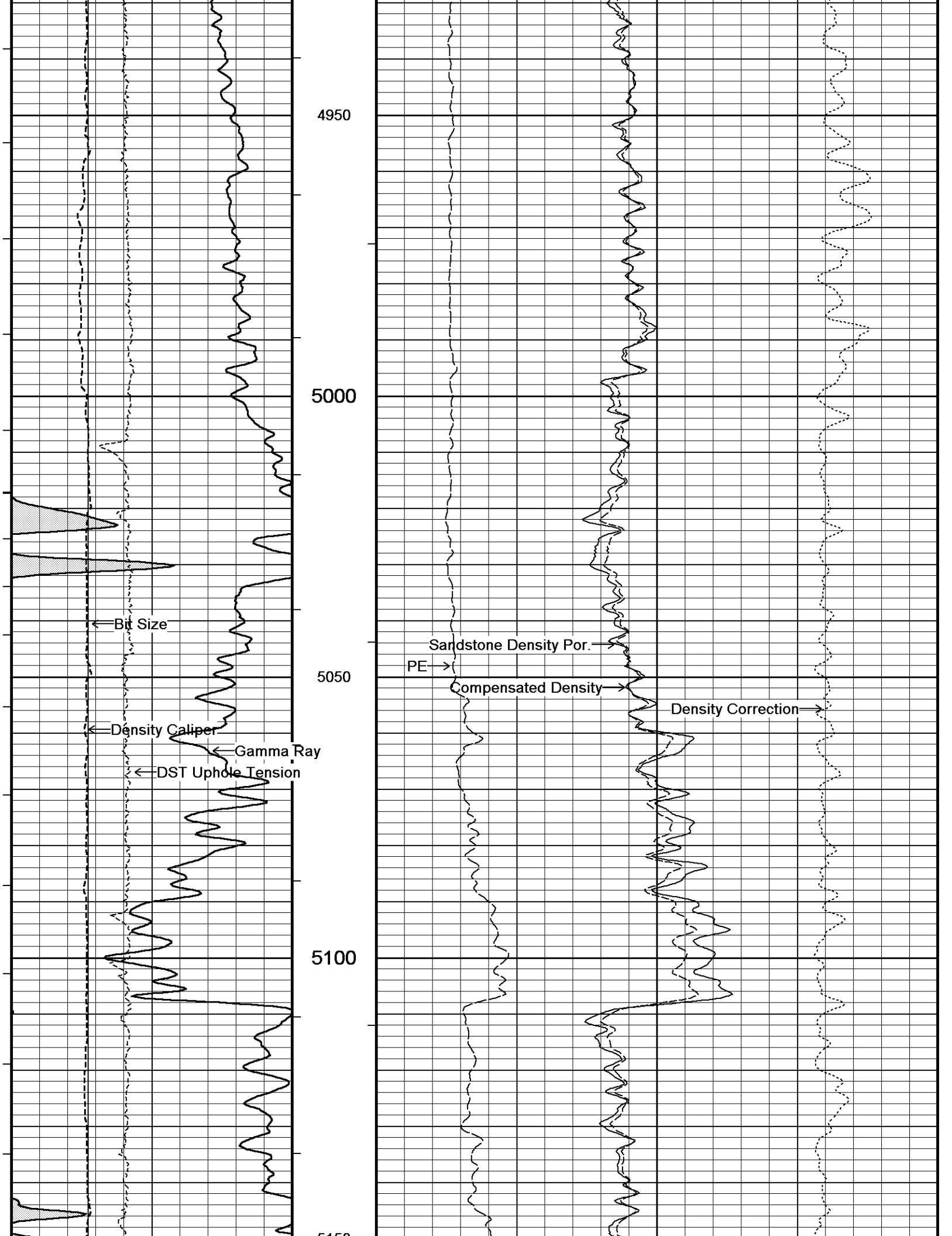

every
10 cu ft
Gamma Ray
API
0
75
150
150
225
300
Annular
Integral
every
10 cu ft
Density Caliper
inches
6
11
16
Bit Size
inches
6
11
16
Replay
Scale
1:240
Sandstone Density Por.
percent
30
20
10
0
-10
PE
barns/electron
0
5
10
Density Correction
grams/cc
-0.25
0
0.25
3900
3950
600
4000

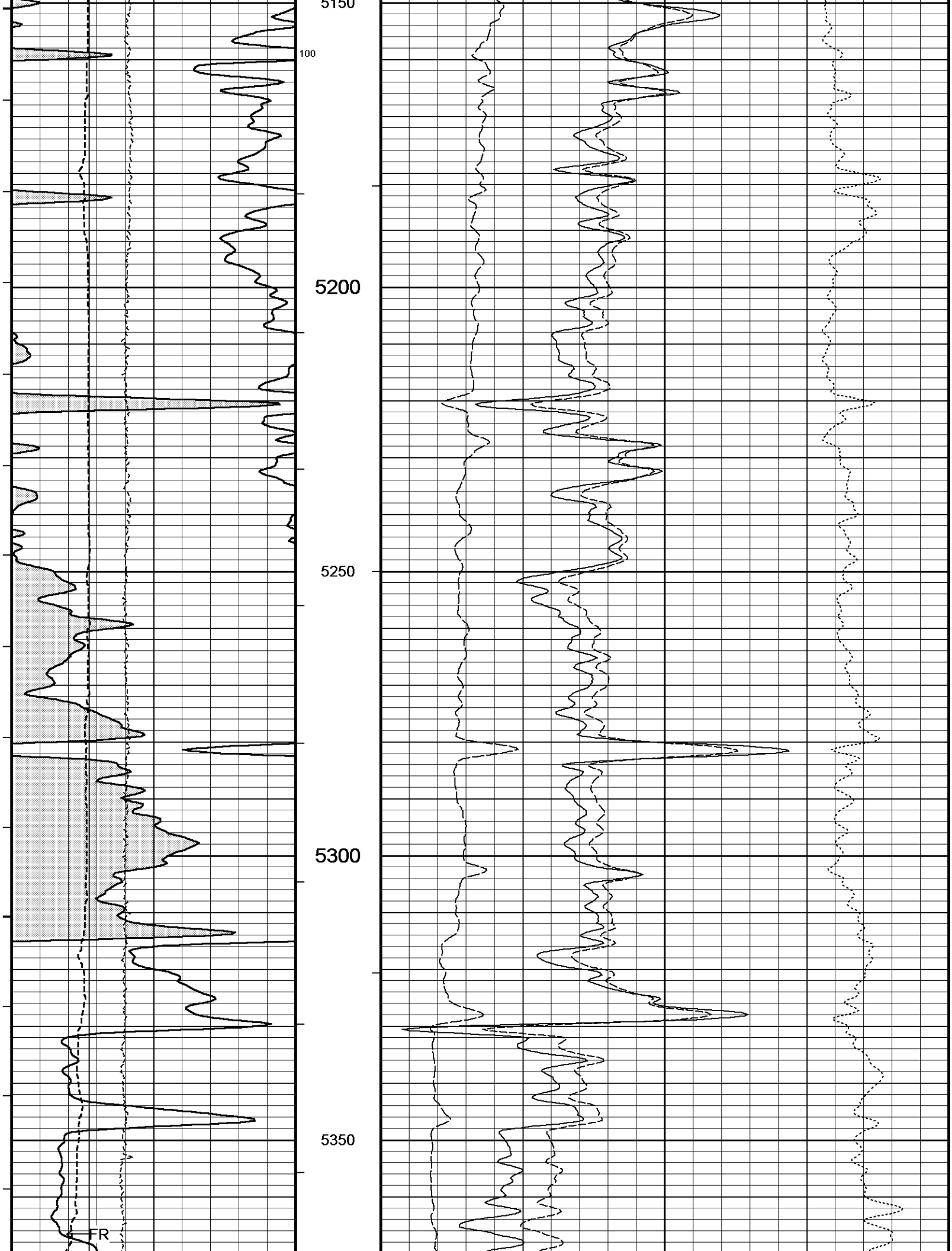

4050
200
4100
4150
500
4200
4250
Bit Size
Sandstone Density Por.
PE
Compensated Density
Density Correction

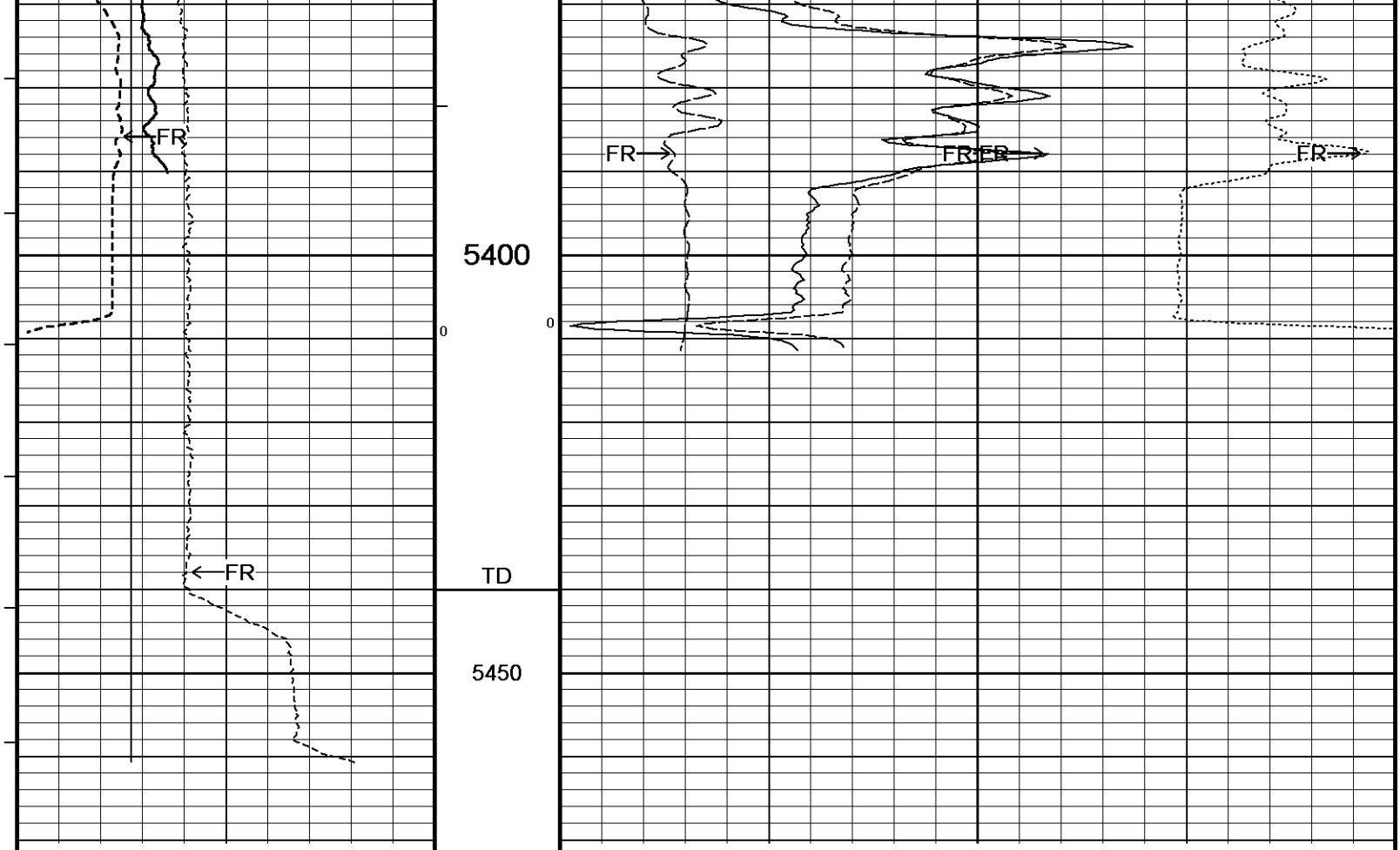

Density Caliper
Gamma Ray
DST Uphole Tension
4300
4350
4400
400
4450


4500
4550
4600
4650
4700
Bit Size
Density Caliper
Gamma Ray
DST Uphole Tension
Istone Density Por.
PE
Compensated Density
Density Correction
100


4750
4800
4850
4900
200


4950
5000
5050
5100
Bit Size
Density Caliper
Gamma Ray
DST Uphole Tension
Sandstone Density Por.
PE
Compensated Density
Density Correction


5150
100
5200
5250
5300
5350
FR




Depth In Feet

Timing Marks
every 60.0 sec

DST Uphole Tension
pounds
5000 2500 0

HVI every 10 cu ft

Gamma Ray
API
0 75 150
150 225 300

Annular Integral every 10 cu ft

Density Caliper
inches
6 11 16

Bit Size
inches
6 11 16

Replay Scale 1:240

Compensated Density
grams/cc
2 2.25 2.50 2.75 3
1 1.25 1.50 1.75 2

Sandstone Density Por.
percent
30 20 10 0 -10

PE
barns/electron
0 5 10

Density Correction
grams/cc
-0.25 0 0.25

Depth Based Data - Maximum Sampling Increment 10.0cm
Plotted on 18-OCT-2014 15:15
Filename: C:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Main2.dta
Recorded on 18-OCT-2014 08:21
System Versions: Logged with 14.01.3220 Processed with 14.01.3220 Plotted with 13.08.1505

5 INCH MAIN LOG DSC

# BEFORE SURVEY CALIBRATION

C:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Main2.dta

## General Constants All 000

Last Edited on 18-OCT-2014,09:49

| | | |
|---|---|---|
| **General Parameters** | | |
| Mud Resistivity | 2.210 | ohm-metres |
| Mud Resistivity Temperature | 65.700 | 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 | 7.000 | inches |
| Caliper for Differential Caliper | Density Caliper | |
| **Rwa Parameters** | | |
| Porosity used | Base Density Porosity | |
| Resistivity used | Array Ind. One Res Rt | |
| RWA Constant A | 0.610 | |
| RWA Constant M | 2.150 | |
| SW/APOR Tool Source | 0.000 | |

## Gamma Calibration MCG-E.A 514

Field Calibration on 17-OCT-2014 21:37

| | Measured | Calibrated (API) |
|---|---|---|
| Background | 158 | 108 |
| Calibrator (Gross) | 1491 | 1020 |
| Calibrator (Net) | 1333 | 912 |

## Gamma Constants MCG-E.A 514

Last Edited on 18-OCT-2014,09:49

| | | |
|---|---|---|
| Gamma Calibrator Number | GRC 72 | |
| Mud Density | 1.15 | gm/cc |
| Caliper Source for Processing | Density Caliper | |
| Tool Position | Eccentred | |
| Concentration of KCl | | kppm |
| K Mud Type | Chloride | |
| K Mud Concentration | 0.09 | % |

## Imager Pad Check MIE-A.J 244

Field Check on 14-OCT-2014 16:09

| | | | |
|---|---|---|---|
| Pad 1 | 20/20 Buttons Verified | Pad 5 | 20/20 Buttons Verified |
| Pad 2 | 24/24 Buttons Verified | Pad 6 | 24/24 Buttons Verified |
| Pad 3 | 20/20 Buttons Verified | Pad 7 | 20/20 Buttons Verified |
| Pad 4 | 24/24 Buttons Verified | Pad 8 | 24/24 Buttons Verified |

## Compact Micro Imager Constants MIE-A.J 244

Last Edited on 07-JUN-2012 08:23

| | | |
|---|---|---|
| Sonde Configuration | Imager Mode | |
| Arm-Pad Kit | Normal Pads (12.25 in) | |
| Arm-Pad Kit Serial Number | | |
| Centre Pad 1 Rotational Offset | 0.00 | degrees |
| Image/Borehole Ovality Reference | Azimuth of Pad 1 | |
| Non Active Buttons | Omit | |
| Search Angle | 0.00 | degrees |
| Correlation Interval | 3.28 | feet |
| Correlation Step | 1.64 | feet |
| Current Offset | 0.0000 | mAmp |
| Squasher Start | 11111111.0000 | mAmp |
| Image Processing | 11111111 | |

## Navigation Constants MIE-A.J 244

Last Edited on 11-JUL-2012 12:21

| | | | |
|---|---|---|---|
| Magnetic Declination | 0.00 | degrees | East |

## Magnetometer Parameters MIE-A.J 244

Date Of Last Magnetometer Calibration 22-AUG-2013,09:56

| | X Magnetometer | Y Magnetometer | Z Magnetometer |
|---|---|---|---|
| Slope | -1.000000 | -1.011965 | -0.991340 |
| Offset | 0.010303 | -0.015788 | 0.008269 |

## Magnetometer Constants MIE-A.J 244

Last Edited on

Magnetometer Calibrator Number 000

## Accelerometer Parameters MIE-A.J 244

Date Of Last Accelerometer Calibration 13-FEB-2013,14:31

| | X Accelerometer | Y Accelerometer | Z Accelerometer |
|---|---|---|---|
| Slope | -1.103572 | -1.107641 | -1.103778 |
| Offset | -0.006989 | 0.006286 | -0.003996 |

## Accelerometer Constants MIE-A.J 244

Last Edited on 14-OCT-2014,16:12

Accelerometer Calibrator Number 000

Accelerometer Temperature Characterisation

X Accelerometer

| | | | | |
|---|---|---|---|---|
| Serial Number | 1016 | | | |
| Calibration Date | 12-Apr-2011 | | | |
| | B0 | B1 | B2 | B3 |
| Bias(g) | 0.00000e+000 | 1.93698e-005 | -7.60293e-010 | 6.54727e-011 |
| | SF0 | SF1 | SF2 | SF3 |
| Scale Factor(mA/g) | 3.00000e+000 | 2.59257e-004 | 6.13375e-007 | -3.90888e-010 |

Y Accelerometer

| | | | | |
|---|---|---|---|---|
| Serial Number | 973 | | | |
| Calibration Date | 19-Jan-2011 | | | |
| | B0 | B1 | B2 | B3 |
| Bias(g) | 0.00000e+000 | 1.95276e-005 | -1.88058e-008 | 2.74122e-010 |
| | SF0 | SF1 | SF2 | SF3 |
| Scale Factor(mA/g) | 3.00000e+000 | 2.75268e-004 | 3.53140e-007 | 7.52116e-010 |

Z Accelerometer

| | | | | |
|---|---|---|---|---|
| Serial Number | 1032 | | | |
| Calibration Date | 18-Apr-2011 | | | |
| | B0 | B1 | B2 | B3 |
| Bias(g) | 0.00000e+000 | -1.14960e-005 | 3.94288e-009 | 8.97135e-011 |
| | SF0 | SF1 | SF2 | SF3 |
| Scale Factor(mA/g) | 3.00000e+000 | 2.88058e-004 | 2.44833e-007 | 8.38007e-010 |

## Caliper Calibration MIE-A.J 244

Base Calibration on 14-OCT-2014 16:03
Field Calibration on 14-OCT-2014 16:04

Base Calibration

| Reading No | Pads 1-5 Meas. | Pads 3-7 Meas. | Calibrator Size (in) |
|---|---|---|---|
| 1 | 24598 | 25678 | 5.96 |
| 2 | 34609 | 35979 | 7.97 |
| 3 | 44567 | 45592 | 9.84 |
| 4 | 55923 | 57146 | 11.91 |
| 5 | 0 | 0 | 0.00 |

| Reading No | Pad 2 Meas. | Pad 4 Meas. | Pad 6 Meas. | Pad 8 Meas. | Calibrator Size (in) |
|---|---|---|---|---|---|
| 1 | 24589 | 26958 | 24376 | 23838 | 5.96 |
| 2 | 33342 | 35325 | 33013 | 32430 | 7.97 |
| 3 | 41271 | 43620 | 41279 | 40227 | 9.84 |
| 4 | 51419 | 52989 | 50755 | 49959 | 11.91 |
| 5 | 0 | 0 | 0 | 0 | 0.00 |

Field Calibration

| Measured Pads 1-5 Caliper(in) | Measured Pads 3-7 Caliper(in) | Actual Caliper(in) |
|---|---|---|
| 8.00 | 7.94 | 7.97 |

| Measured Pad 2 Caliper(in) | Measured Pad 4 Caliper(in) | Measured Pad 6 Caliper(in) | Measured Pad 8 Caliper(in) | Actual Caliper(in) |
|---|---|---|---|---|
| 3.99 | 3.99 | 3.97 | 3.98 | 7.97 |

## Caliper Constants MIE-A.J 244

Last Edited on 07-JUN-2012 08:23

Caliper Difference for BRKT 0.120 inches

Caliper Difference for BKRT 0.120 inches

## Caliper Calibration MPD-D.A 460

Base Calibration on 14-OCT-2014 10:20
Field Calibration on 17-OCT-2014 21:07

Base Calibration

| Reading No | Measured | Calibrator Size (in) |
|---|---|---|
| 1 | 18461 | 3.98 |
| 2 | 26997 | 5.96 |
| 3 | 35483 | 7.97 |
| 4 | 43651 | 9.84 |
| 5 | 53133 | 11.91 |
| 6 | N/A | N/A |

Field Calibration

| Measured Caliper (in) | Actual Caliper (in) |
|---|---|
| 8.00 | 7.97 |

## Photo Density Calibration MPD-D.A 460

Base Calibration on 14-OCT-2014 14:09
Field Check on 17-OCT-2014 21:12

Density Calibration

| Base Calibration | Measured | | Calibrated (sdu) | |
|---|---|---|---|---|
| | Near | Far | Near | Far |
| Background | 1298 | 1497 | | |
| Reference 1 | 57019 | 26155 | 59827 | 30835 |
| Reference 2 | 22831 | 2654 | 24869 | 2514 |

Field Check at Base

| 1298.4 | 1497.0 |
|---|---|

Field Check

| 1300.4 | 1513.3 |
|---|---|

PE Calibration

| Base Calibration | Measured | | | Calibrated |
|---|---|---|---|---|
| | WS | WH | Ratio | Ratio |
| Background | 247 | 1158 | | |
| Reference 1 | 24103 | 56800 | 0.429 | 0.367 |
| Reference 2 | 6793 | 22680 | 0.304 | 0.269 |

Field Check at Base

| 247.0 | 1157.5 |
|---|---|

Field Check

| 248.8 | 1160.9 |
|---|---|

## Density Constants MPD-D.A 460

Last Edited on 18-OCT-2014,09:51

| | | |
|---|---|---|
| Density Source Id | P50562B | |
| Nylon Calibrator Number | 658 | |
| Aluminium Calibrator Number | 658 | |
| Density Shoe Profile | 8 inch | |
| Caliper Source for Processing | Density Caliper | |
| PE Correction to Density | Not Applied | |
| Mud Density | 1.15 | gm/cc |
| Mud Density Z/A Multiplier | 1.11 | |
| 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 | |

| Matrix Density (gm/cc) | Depth (ft) |
|---|---|
| 2.65 | 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:\Users\e154681\AppData\Local\Temp\Weatherford PreView53\0\Main2.dta

SHA-J.B Compact Swivel Head Adaptor
SHA-J.B 587 LG: 2.30 ft WT: 22.0 lb OD: 2.244 in

Compact Comms Gamma
MCG-E.A 514 LG: 8.70 ft WT: 63.9 lb OD: 2.244 in

Compact Neutron
MDN-B.A 296 LG: 5.04 ft WT: 50.7 lb OD: 2.244 in

MIS-D.B Compact Inline Bowspring sub
MIS-D.B 702 LG: 5.70 ft WT: 33.1 lb OD: 2.240 in

Compact Density/Caliper
MPD-D.A 460 LG: 9.59 ft WT: 90.4 lb OD: 2.449 in

SKJ-D.A Compact Knuckle Joint
SKJ-D.A 115 LG: 2.17 ft WT: 24.3 lb OD: 2.244 in

MIS-E.B Compact Inline Standoff sub
MIS-E.B 786 LG: 2.14 ft WT: 15.4 lb OD: 2.244 in

SKJ-D.A Compact Knuckle Joint
SKJ-D.A 88 LG: 2.17 ft WT: 24.3 lb OD: 2.244 in

Compact Focussed Electric
MFE-B.A 219 LG: 6.05 ft WT: 48.5 lb OD: 2.244 in

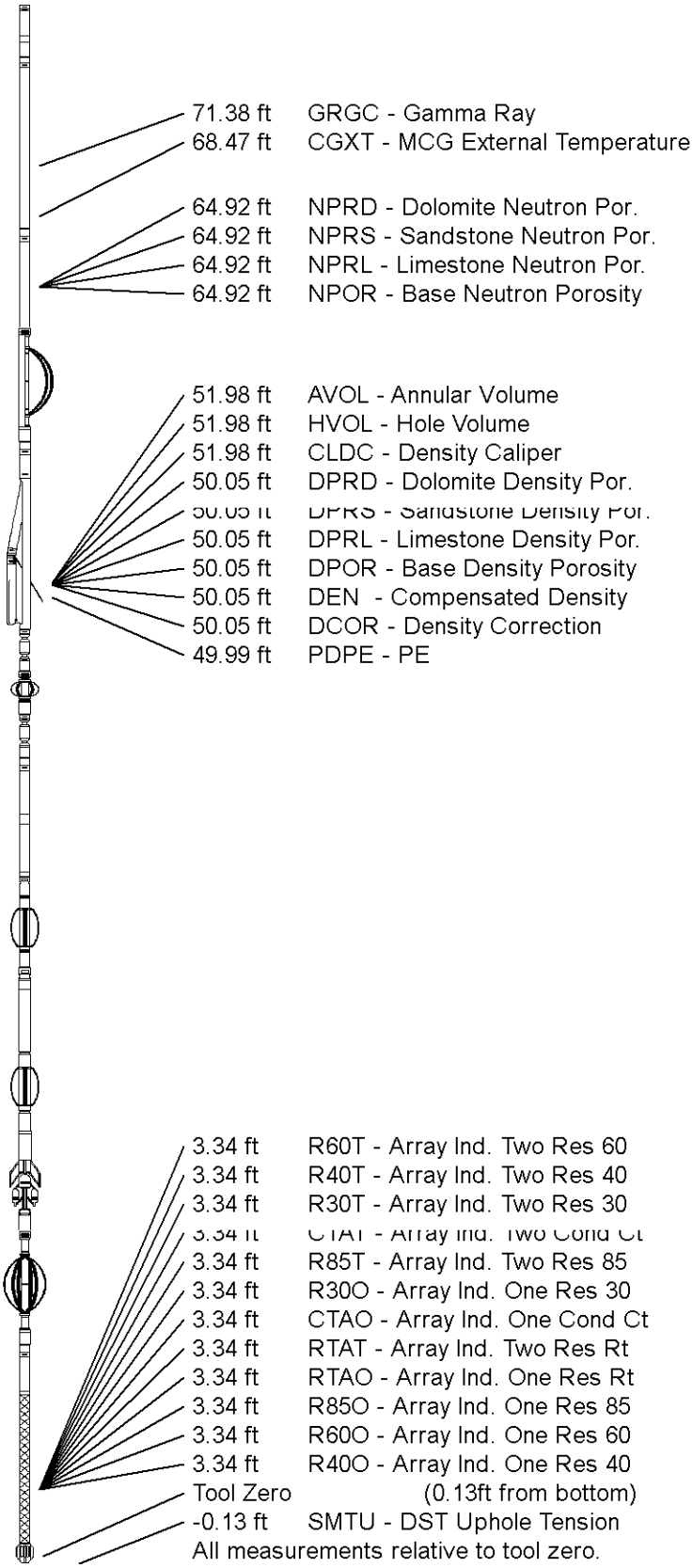
Compact MMI Memory Section
MIM-A.J 244 LG: 4.65 ft WT: 26.5 lb OD: 2.244 in

Compact MMI Electrode Section
MIE-A.J 244 LG: 13.96 ft WT: 99.2 lb OD: 4.094 in

MIS-D.B Compact Inline Bowspring sub
MIS-D.B 730 LG: 5.70 ft WT: 33.1 lb OD: 2.240 in

Compact Induction
MAI-B.A 269 LG: 10.81 ft WT: 48.5 lb OD: 2.240 in

Total Length: 78.96 ft Weight: 579.8 lb




| | |
|---|---|
| COMPANY | EAST CHEYENNE GAS STORAGE LLC |
| WELL | ECGS No 6-21 WPD004-2 |
| FIELD | WEST PEETZ |
| PROVINCE/COUNTY | LOGAN |

| COUNTRY/STATE | | | U.S.A / COLORADO | | |
|---|---|---|---|---|---|
| Elevation Kelly Bushing | 4567.00 | feet | First Reading | 5388.00 | feet |
| Elevation Drill Floor | 4566.00 | feet | Depth Driller | 5440.00 | feet |
| Elevation Ground Level | 4557.00 | feet | Depth Logger | 5440.00 | feet |

Weatherford®

# COMPENSATED DENSITY
# COMPENSATED NEUTRON
# LOG