

# COLUMBINE LOGGING

Scale: 5" / 100'  
Measured Depth Log

**Well Name** Reliance E23-66-1HC Horz

**Location** NESE 23 6N 65W 6 PM

**State** COLORADO

**County** WELD

**Country** UNITED STATES

**Rig Number** H&P 326

**API Number** 05-123-37605

**Field** WATTENBERG

**Region** DJ BASIN

**Drilling Completed** 3/23/2015

**Spud Date** 3/19/2015

**Surface Coordinates** NESE 23 6N 65W 6 PM

2148 FSL 280 FEL

Lat/Long: 40.4701/-104.62185

## Bottom Hole Coordinates

Planned Location

Sec: 23 Twp: 6N 65W

Footages: 2475 FNL 535 FWL

**Ground Elevation** 4695'

**K.B. Elevation** 4725'

**Logged Interval** 800' To 11484'

**Total Depth** 11484'

**Formation** CODELL

**Type of Drilling Fluid** LSND, WATER BASED MUD

## Operator

**Company** NOBLE ENERGY INC.

**Address** 1625 Broadway Suite 2200  
Denver, CO 80202

## Geologist

**Name** Holly Duncan

**Company** Noble Energy Inc

**Address** 1625 Broadway Suite 2200  
Denver, CO 80202

## Other

**Well Site Logging Company** Columbine Logging Inc.

**Well Site Geologist (Days)** Brad Wilson

**Well Site Geologist (Nights)** Andrew Martens

## Zone Color Coding

Oil  
Note  
Error

Condensate  
Core  
Water


































Gas  
Pressure  
Seal

## Rock Types












UNKNOWN	COAL	TR TR TR TR MARLSTONE	SHALY SANDSTONE
ANHYDRITE	CONGLOMERATE	METAMORPHIC	SHALY SILTSTONE
BENTONITE	DOLOMITE	NO SAMPLE	SILTY SHALE
BRECCIA	DOLOMITIC LIMESTONE	SALT	SILTSTONE
CHALK	GRANITE	SANDSTONE	TILL
CEMENT	GYPSSUM	SALT-PEPPER SAND	TUFF
CHERT	IGNEOUS	SHALE	WELDED TUFF
CLAY CHOKO SAND	SIDERITE or LIMONITE	SHALE COLORED	
CLAYSTONE	LIMESTONE	SHALE GRAY	

## Accessories

## Fossils

Fossils			
 GASTROPOD	 ARGILLITE GRAIN	 HEAVY MINERAL	
 INOCERAMUS	 B BENTONITE	 K KAOLIN	
 ALGAE	 O OOLITE	 BITUMENOUS SUBSTANCE	 M MARCASITE
 AMPHIPORA	 O OSTRACOD	 BRECCIA FRAGMENTS	 M MARLSTONE
 BELEMNITE	 P PELECYPOD	 C CALCAREOUS	 M MICACEOUS
 BIOCLASTIC	 P PELLET	 C CARBONACEOUS FLAKES	 M MINERAL CRYSTALS
 BRACHIOPOD	 P PISOLITE	 C CHITDK	 N NODULES
 BRYOZOA	 P PLANT REMAINS	 C CHITTL	 P PHOSPHATE PELLETS
 CEPHALOPOD	 S PLANT SPORES	 C COAL - THIN BEDS	 P PYRITE
 CORAL	 S SCAPHOPOD	 D DOLOMITIC	 S SALT CAST
 CRINOID	 S STROMATOPOROID	 F FELDSPAR	 S SANDY
 ECHINOID		 F FERRUGINOUS PELLET	 S SIDERITE
 FISH		 F FERRUGINOUS	 S SILICEOUS
 FORAMINIFERA	 A ANHYDRITIC	 G GLAUCONITE	 S SILTY
 F FOSSIL	 A ARGILLACEOUS	 G GYPSIFEROUS	 T TUFFACEOUS

**Springer**

-  ANHYDRITE STRINGER
-  BENTONITE STRINGER
-  COAL STRINGER
-  DOLOMITE STRINGER
-  GYPSUM STRINGER
-  LIMESTONE STRINGER
-  MARLSTONE (CALC) STRG
-  MARLSTONE (DOL) STRG
-  SANDSTONE STRINGER
-  SHALE STRINGER
-  SILTSTONE STRINGER

## Oil Show


**P** PINPOINT

# Engineering

- DEAD
- EVEN
- QUESTIONABLE
- BIT
- SPOTTED STAINING
- CONNECTION (UP)

## Porosity

# Porosity

	CONNECTION (DOWN)
	CONNECTION GAS
	CONNECTION GAS (LEAK)
	TRIP GAS
	TRIP GAS (LEFT)
	DOWN TIME GAS
	DOWN TIME GAS (LEAK)
	CORE - LOST
	CORE - RECOVERED

# Other Symbols

 DST INTERVAL       WIRELINE TESTED - LEFT    **E** EARTHY

 FAULT       WIRELINE TESTED - RT    **FX** FINELYXLN

 FORMATION TOP       DRILL STEM TEST      **GS** GRAINSTONE

 GAS SHOW       **MINDEPTH** MN DEPTH      **L** LITHOGRAPHIC


 OIL SHOW      **MX** MICROXLN


 **MINDEPTH** MN DEPTH UP      **MS** MUDSTONE

## Rounding

 **MINDEPTH** MN DEPTH (DOWN)      **A** ANGULAR      **PS** PACKSTONE

 NORMAL FAULT      **R** ROUNDED      **WS** WACKSTONE

 OVERTURNED STRATA      **B** SUBANG

 REVERSE FAULT      **rn** SUBRND

## Sorting


 CASING      **M** MODERATE

## Textures

 SIDEWALL CORE (LEFT)      **P** POOR

 SIDEWALL CORE (RIGHT) **BS** BOUNDSTONE      **W** WELL

 SLIDE      **C** CHALKY

 SURVEY      **CX** CRYPTOXLN

Slide/Rotate

ROP  
ROP  
GAMMA

COLUMBINE LOGGING RIGGED UP ON  
3/19/15 MANNED 2-PERSON  
ROP DATA IMPORTED FROM  
PASON EDR

Total Gas & Chromatograph

GAS  
C1  
C2  
C3  
C4

Mudlog Continued From "Reliance  
E23-66-1HC Vert.mplot"  
GAS DATA FROM BLOODHOUND  
CHROMATOGRAPH UNIT #312 JOB  
NUMBER 212 via IBALL GAS CHART  
DATA BASE  
"Reliance\_E23\_66\_1HC.mdb"

Depth Labels

6,160 6,170 6,180 6,190 6,200 6,210 6,220 6,230 6,240 6,250 6,260 6,270 6,280 6,290 6,300 6,310 6,320 6,330 6

% Lith

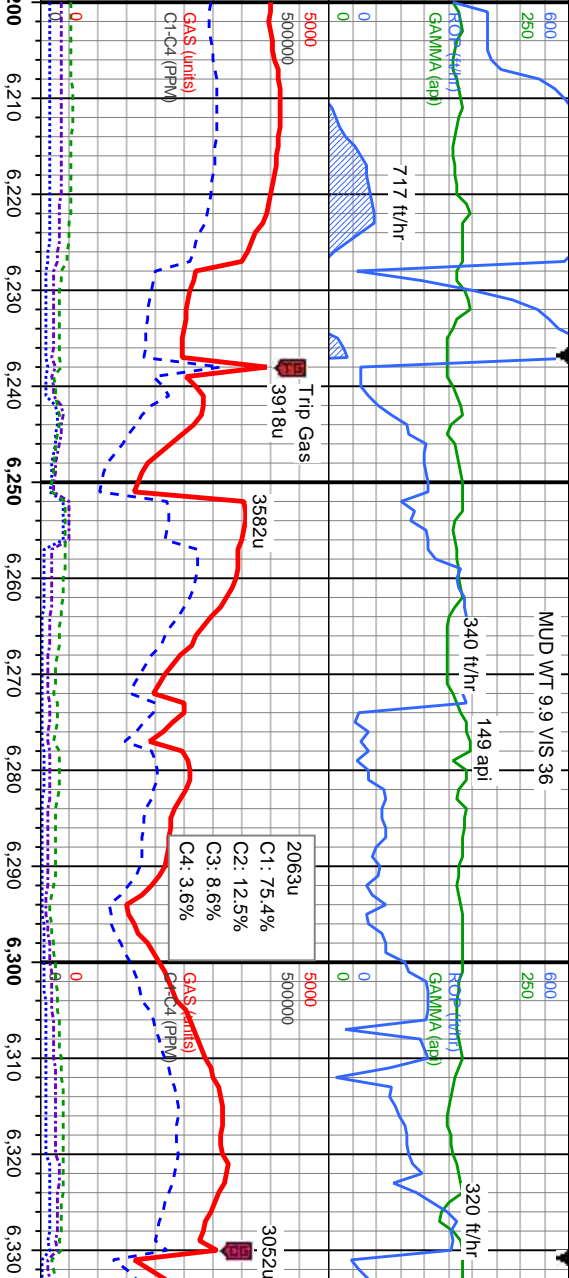
Survey and Gamma Data Provided by Ensign  
Directional Services

Well Bore  
TVD

Oil Show

E  
G  
M  
F  
T  
S

Images



TOOH for Tools @ 6237MD  
11:50 AM MDT 3/20/2015  
Resumed drilling @ 21:01 PM MDT 3/20/15

MD: 6,279'  
TVD: 6,233'  
Inclination: 9°  
Azimuth: 11°  
VS: -154°

70%SLTY SH: med - dk gy, sb blk, sb blk, sl  
sft- frm, slt tex, sl rthy lstr, pred aren, non calc  
30%SHY SS: llyg - occ wh, s&p, sft - brt occ  
frm, sb md-sb ang, f-v f gr, mod srl, arg cnt,  
mod calc, tr SS

70%SLTY SH: med - dk gy, sb blk, sb blk, sl  
sft- frm, slt tex, sl rthy lstr, pred aren, non calc  
30%SHY SS: llyg - occ wh, s&p, sft - brt occ  
frm, sb md-sb ang, f-v f gr, mod srl, arg cnt,  
mod calc, tr SS

60%SLTY SH: med - dk gy, sb blk, sb blk, sb  
sft- frm, slt tex, sl rthy lstr, pred aren, no  
40%SHY SS: llyg - occ wh, occly s&p, s  
occ frm, sb md-sb ang, f-v f gr, mod srl,  
cnt, mod calc, tr SS

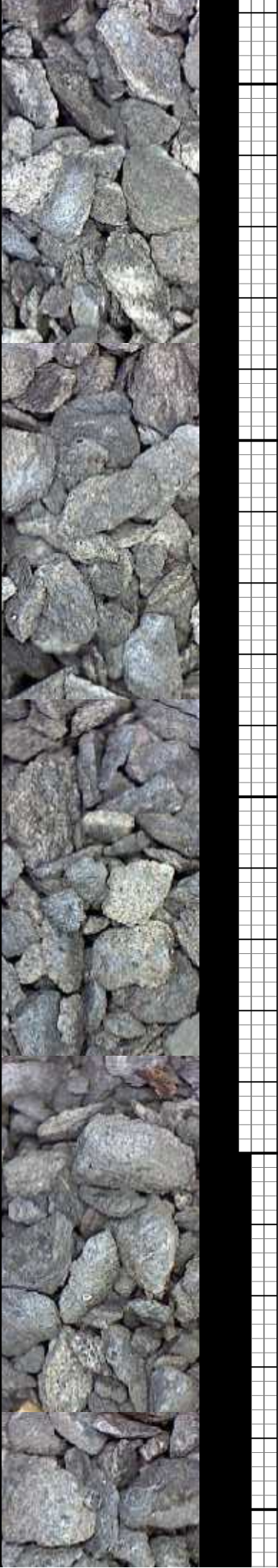
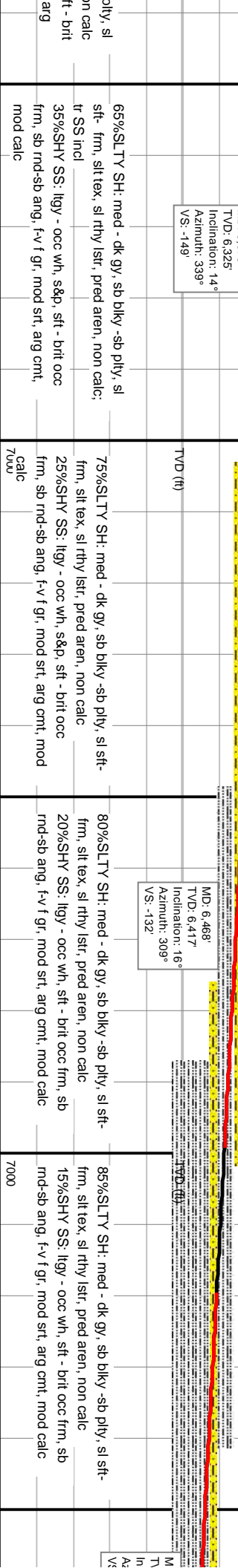
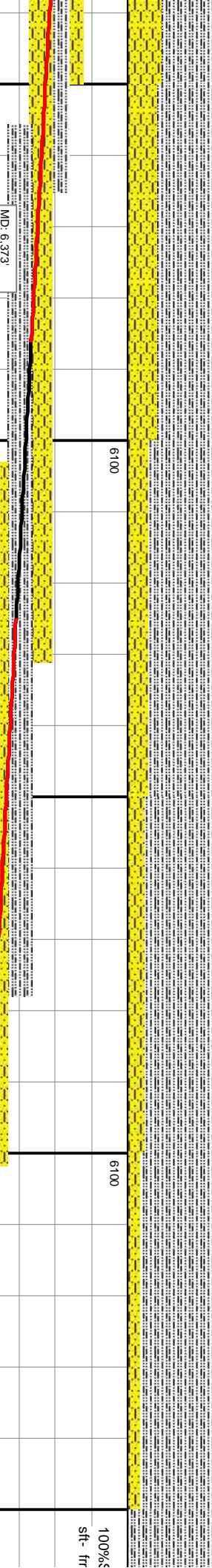
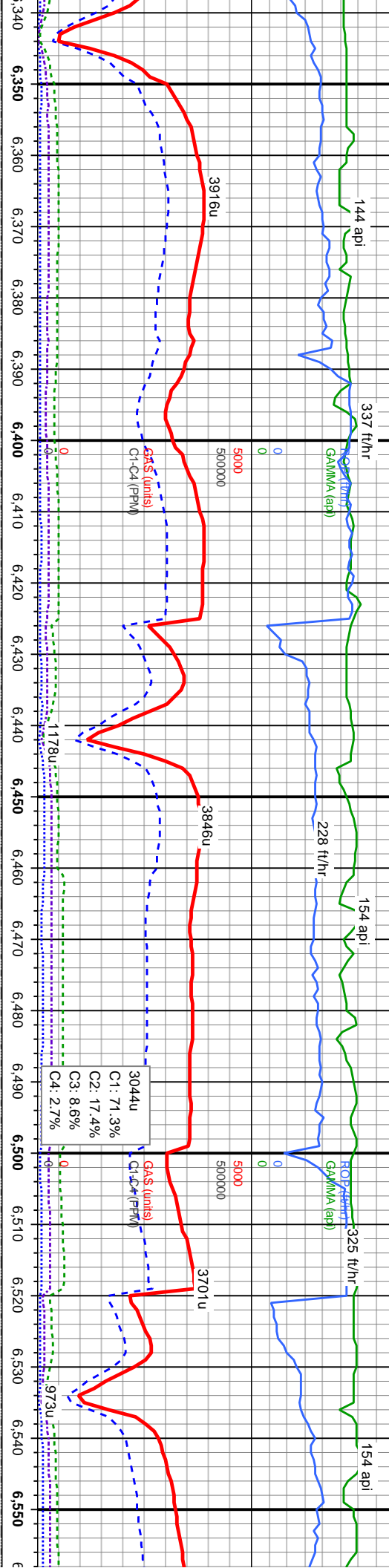
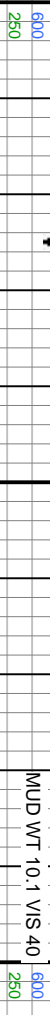
TVD (ft)

7000



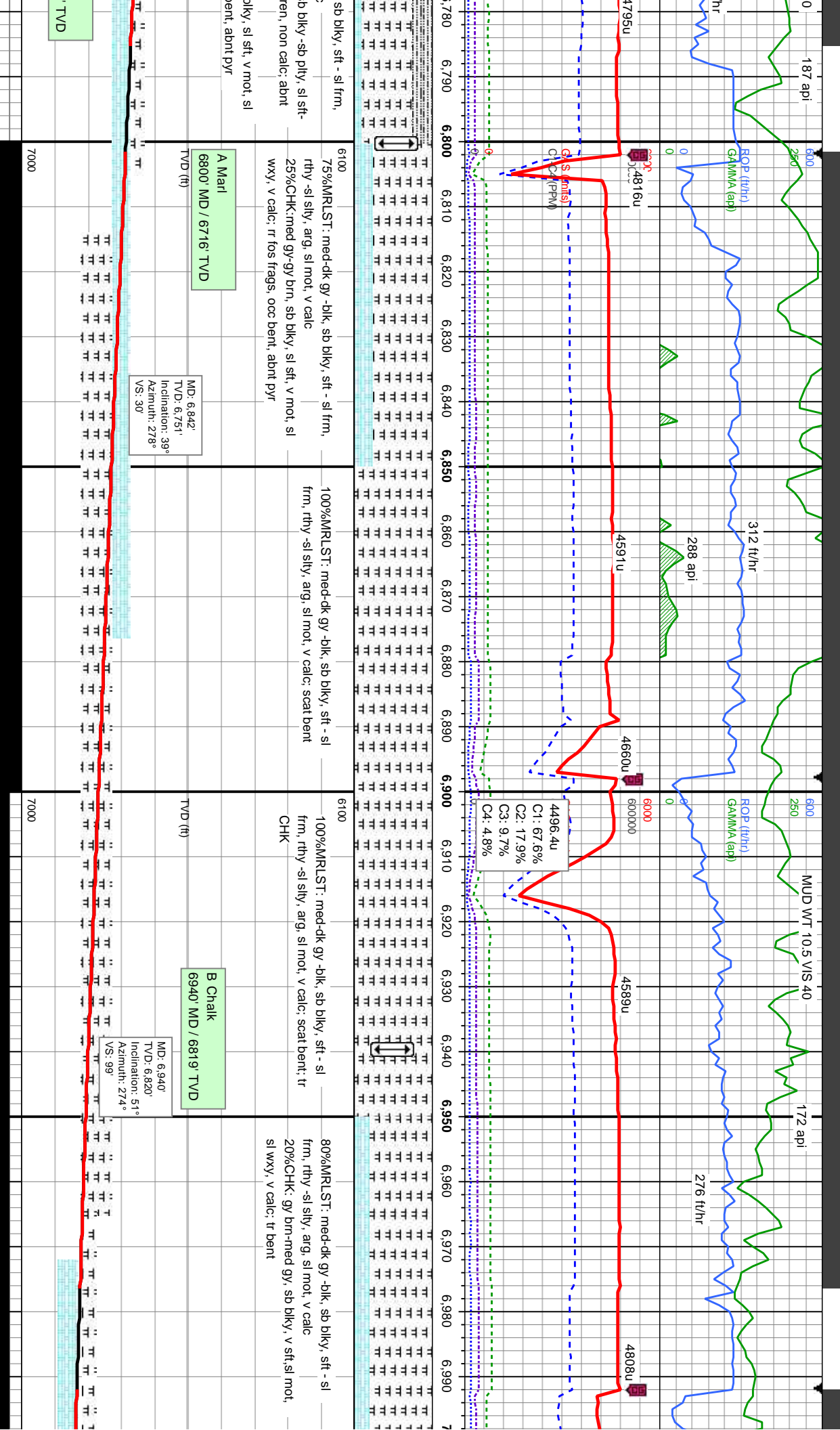


MUD WT 10.1 VIS 40

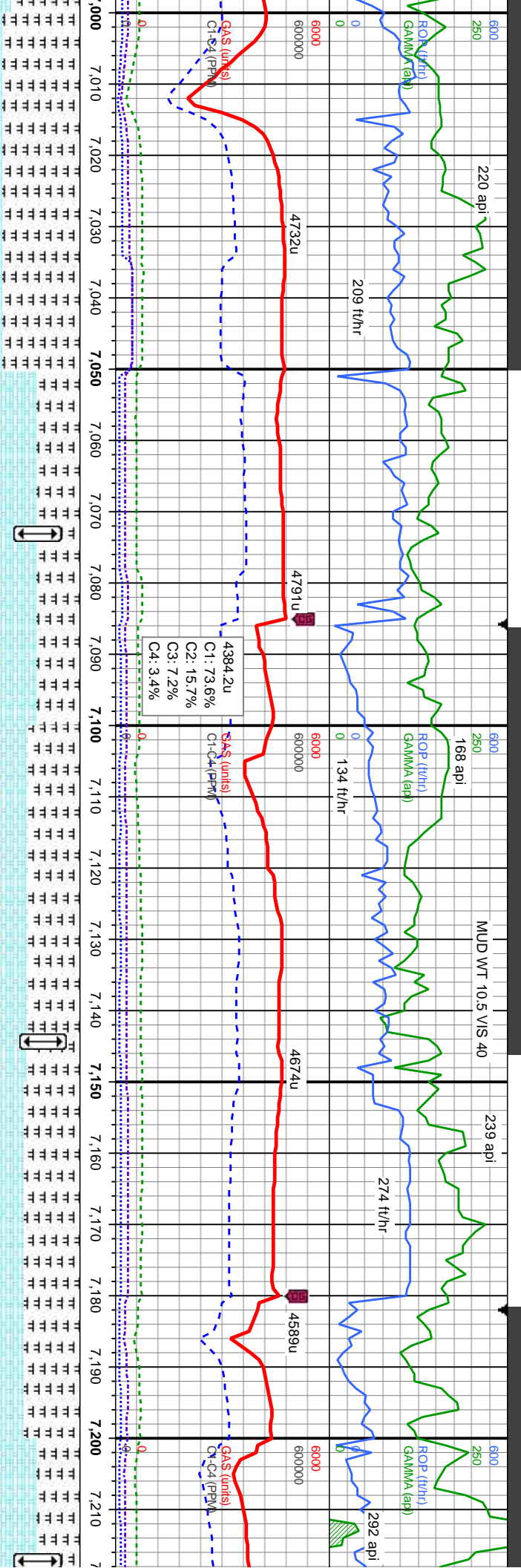








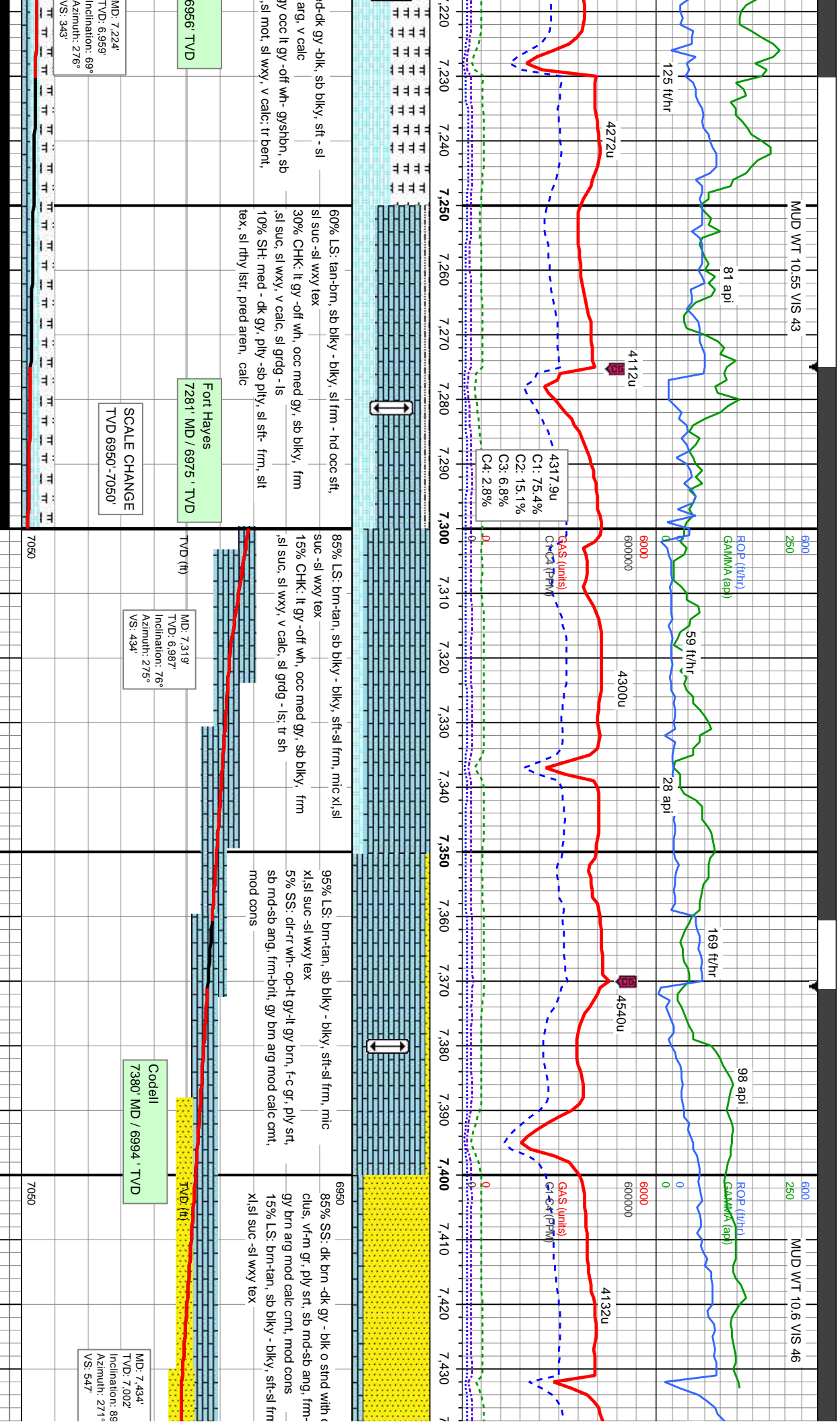




6100	90%MRSLT: med-dk gy -blk, sb blk, sft - sl frm, rthy -sl sily, arg, sl mot, v calc 10%CHK: gy brn-med gy, sb blk, v sft, sl mot, sl wxy, v calc; tr bent	6100	60%MRSLT: med-dk gy -blk, sb blk, sft - sl frm, rthy -sl sily, arg, v calc 50%CHK: lt-med gy occ off wh, sb blk, v sft-sl frm, sl mot, sl wxy, v calc; tr bent	6100	65%MRSLT: med-dk gy -blk, sb blk, sft - sl frm, rthy -sl sily, arg, v calc 35%CHK: med gy occ lt gy -off wh- gyshbn, sb blk, v sft-sl frm, sl mot, sl wxy, v calc; tr bent, tr foss	6100	65%MRSLT: med-dk gy -blk, sb blk, sft - sl frm, rthy -sl sily, arg, v calc 35%CHK: med gy blk, v sft-sl frm
B Marl Fauting		C Chalk 7073 MD / 6893 TVD		C Marl 7144 MD / 6926 TVD		D Chalk 7217 MD /	
MD: 7.035' TVD: 6.875' Inclination: 58° Azimuth: 270° VS: 175'		MD: 7.130' TVD: 6.921' Inclination: 64° Azimuth: 273° VS: 258'					
TVD (ft)		TVD (ft)		TVD (ft)		TVD (ft)	

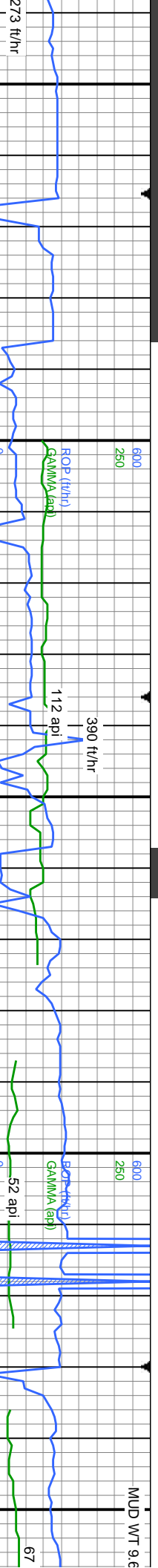








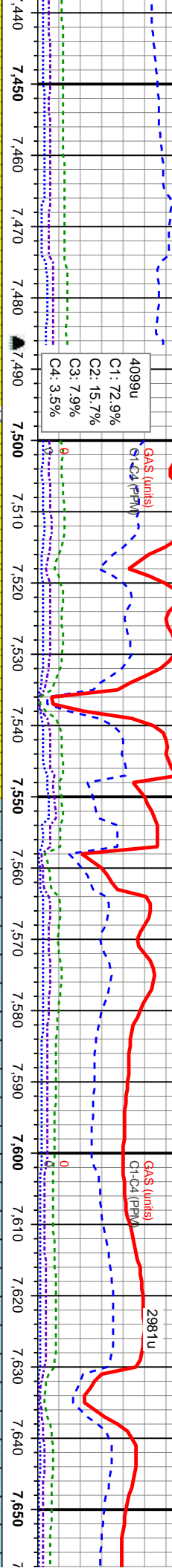
MUD WT 9.6



BloodHound 600000

Database Re-Created

4099u  
C1: 72.9%  
C2: 15.7%  
C3: 7.9%  
C4: 3.5%



100% SS: dk brn -dk gy - blk o strnd with op-wh  
clus, v-f-m gr, ply srt, sb md-sb ang, frm-brit clus,  
gy brn arg mod calc cnt, mod cons

65%L.S: brn-tan, sb blkyl - blkyl, sft-sl frm,  
mic xl, sl wxy tex  
35%SS: clr-rr wh- op-tt gy-ll gy brn, f-c gr, ply  
srt, sb md-sb ang, frm-brit, gy brn arg mod  
calc cnt, mod cons

100%L.S: brn-tan, sb blkyl - blkyl, sft-sl frm, mic  
xl, sl wxy tex, tr SS

100%L.S: brn-tan, sb blkyl - blkyl, sft-sl frm, mic  
xl, sl wxy tex, tr SS

100%L.S: brn-tan, sb blkyl - blkyl, sft-sl frm, mic  
xl, sl wxy tex, tr SS

Fault Just Out of Casing  
From Middle Codell  
To Bottom D Chalk / Fort Hayes

MD: 7,574'  
TVD: 7,001'  
Inclination: 91°  
Azimuth: 272°  
VS: 686'

TD Curve and TOO H for 7" Casing  
@ 7:48:6MD 9:15AM MDT 3/21/15  
Resumed drilling @ 15:12PM MDT 3/22/2015

7050

7050





VIS 45

MUD WT 9.3 VIS 45

355 ft/hr

440 ft/hr

426 ft/hr

api

78 api

85 api

102 api

ROP (ft/hr)  
GAMMA (api)

ROP (ft/hr)  
GAMMA (api)

6000

6000

600000

600000

3908u

3489u

2572u

C1: 71.9%  
C2: 16.7%  
C3: 7.6%  
C4: 3.8%

GA\$(t/mh)  
CI C4 (PPM)

7,660

7,670

7,680

7,690

7,700

7,710

7,720

7,730

7,740

7,750

7,760

7,770

7,780

7,790

7,800

7,810

7,820

7,830

7,840

7,850

7,860

7,870

7,880

7,890

7,900

7,910

7,920

7,930

7,940

7,950

LS: brn-tan, sb blkly - blkly, sft-sl frm, wxy tex, tr SS

100%LS: wht-brn-tan, sb blkly - blkly, sft-sl frm, mic xl, sl wxy tex

100%LS: wht-brn-tan, sb blkly - blkly, sft-sl frm, mic xl, sl wxy tex

100% LS- wht-tan-tyg, sb blkly - blkly, sl frm, mic xl, sl wxy tex, tr SS

100% LS- wht-tan-tyg, sb b

Limestone / D Chalk

MD: 7.666'  
TVD: 6.987'  
Inclination: 94°  
Azimuth: 272°  
VS: 780'

MD: 7.763'  
TVD: 6.995'  
Inclination: 90°  
Azimuth: 272°  
VS: 874'

MD: 7.857'  
TVD: 6.996'  
Inclination: 89°  
Azimuth: 272°  
VS: 968'

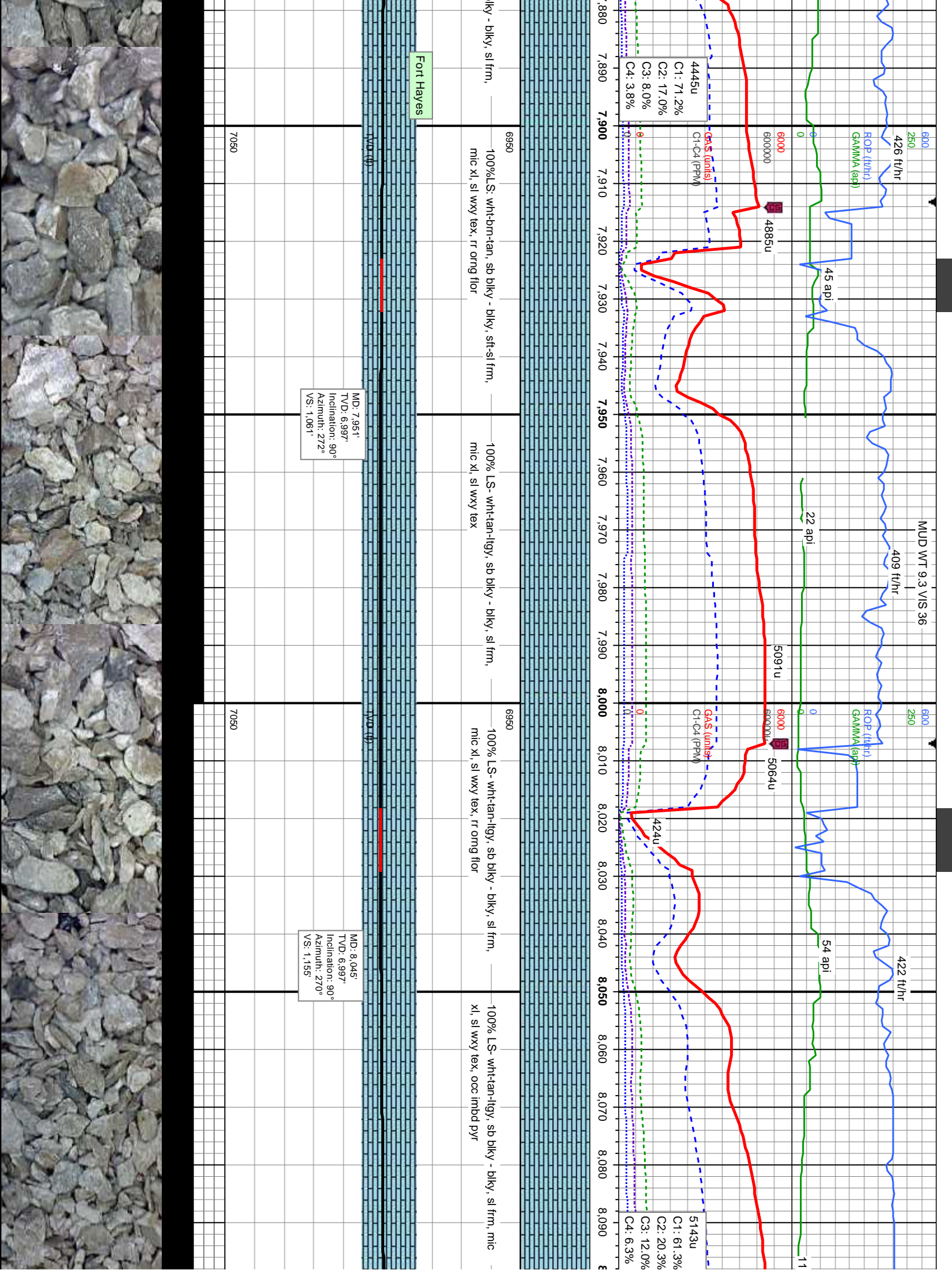
7050

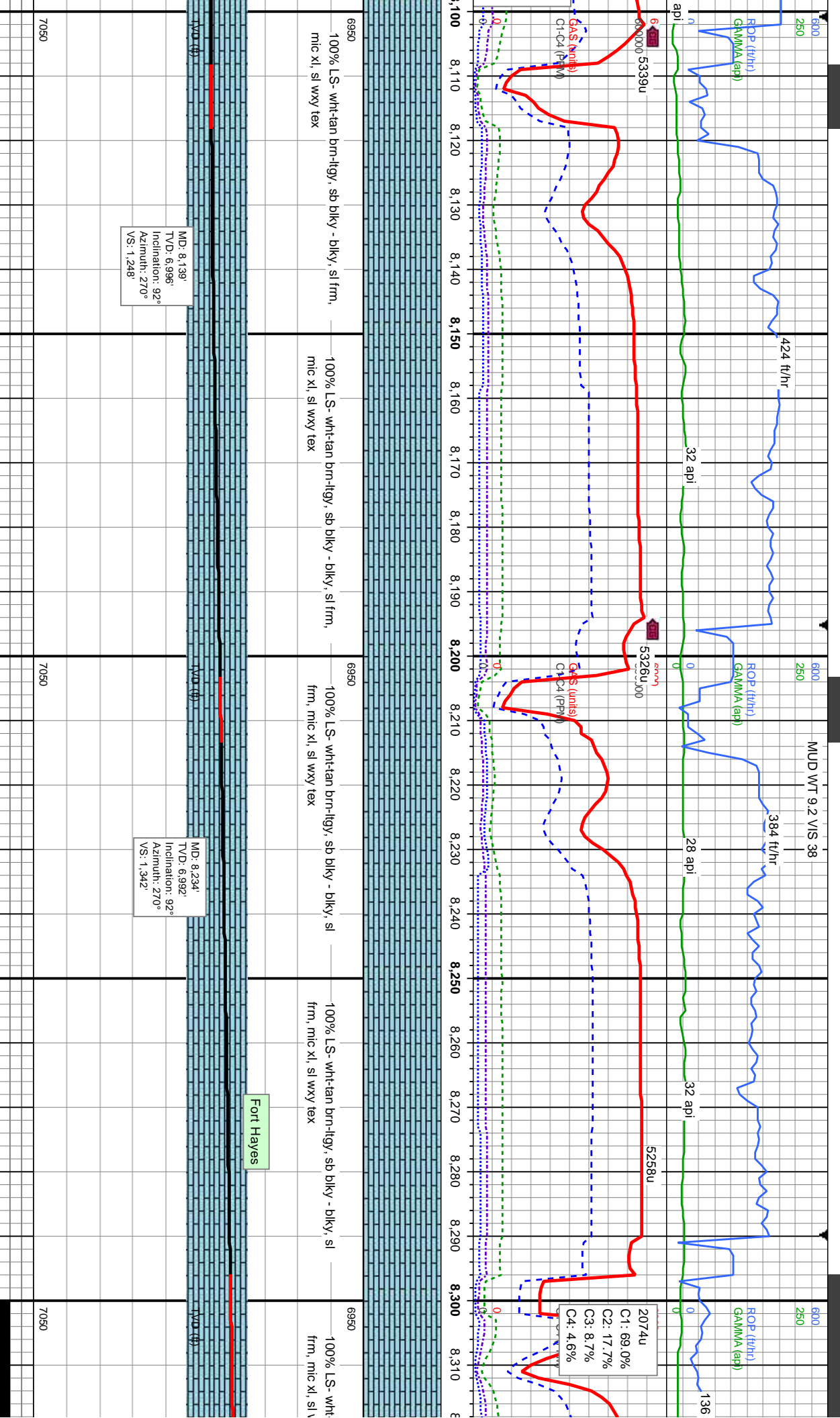
7050

7050



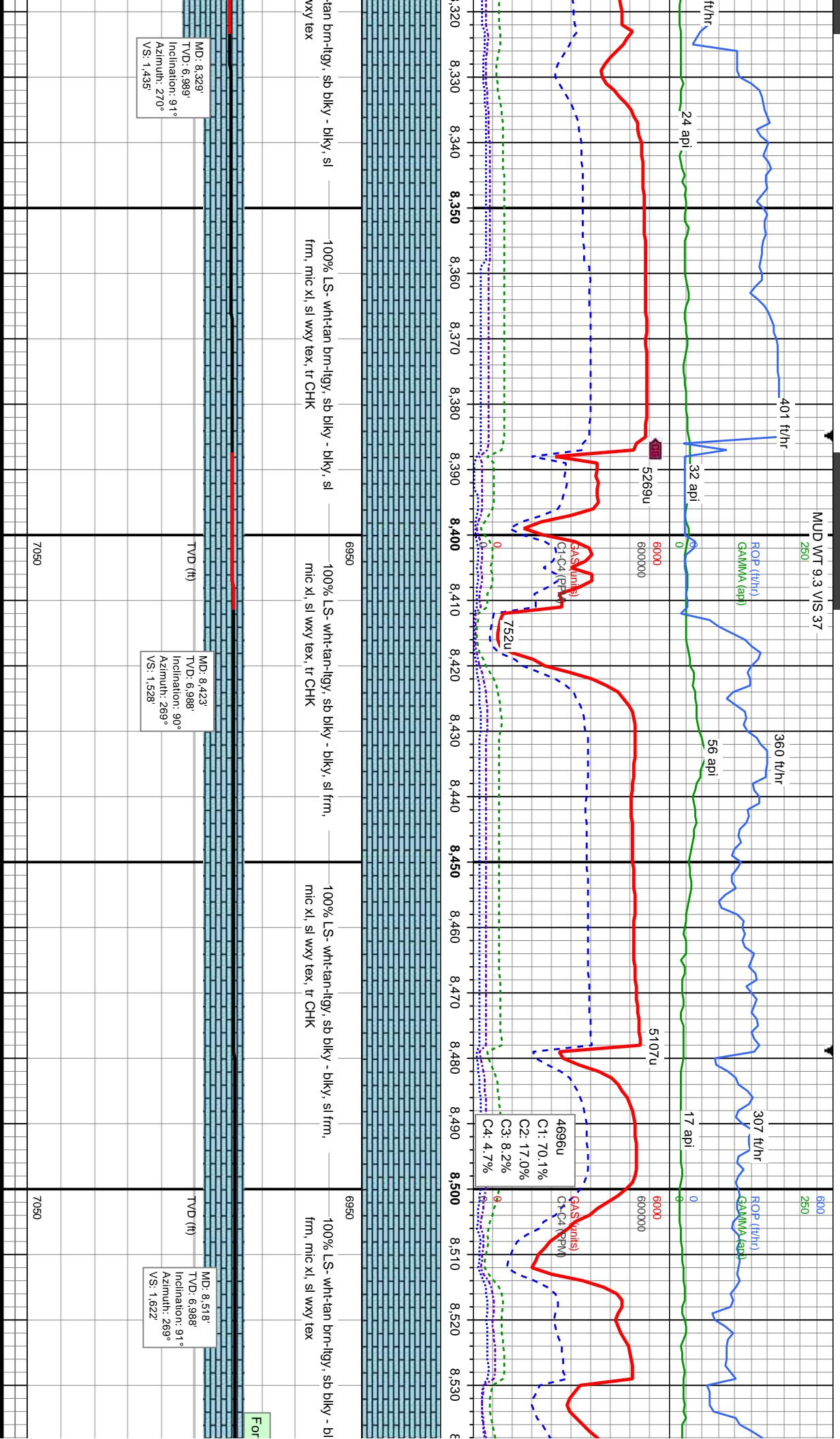








MUD WT 9.3 VIS 37



MD: 8,329  
TVD: 6,989  
Inclination: 91°  
Azimuth: 270°  
VS: 1,435

MD: 8,423  
TVD: 6,988  
Inclination: 90°  
Azimuth: 269°  
VS: 1,528

MD: 8,518  
TVD: 6,988  
Inclination: 91°  
Azimuth: 269°  
VS: 1,622

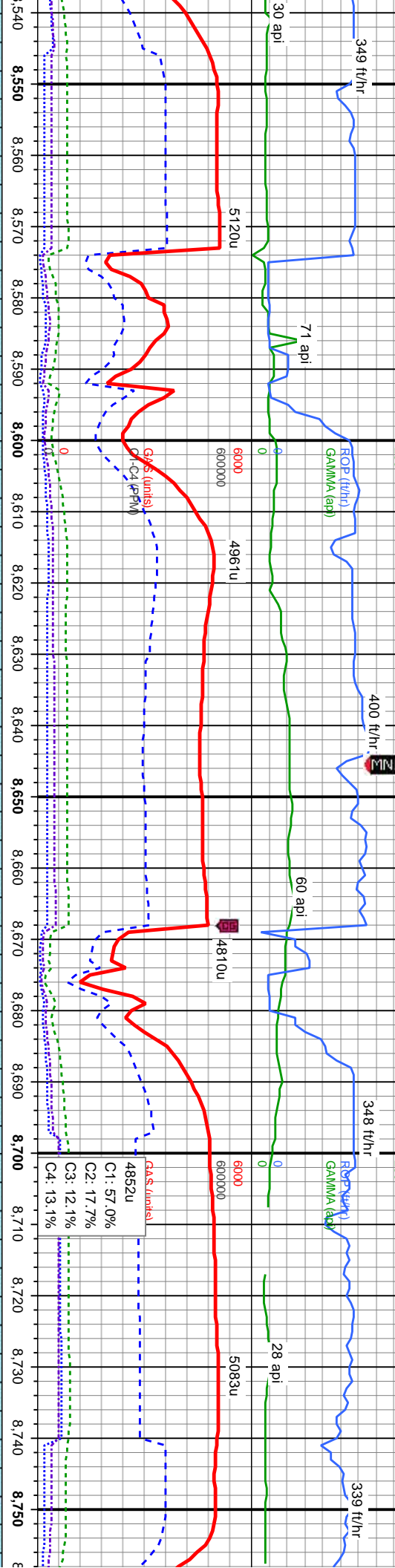




MUD WT 9.3 VIS 37

3/23/15

MUD WT 9.3 VIS 36



100% LS- wht-tan brn-figy, sb blkyl - blkyl, sl frm, mic xl, sl wxy tex

100% LS- wht-tan-figy, sb blkyl - blkyl, sl frm, mic xl, sl wxy tex, tr SS

100% LS- wht-tan-figy, sb blkyl - blkyl, sl frm, mic xl, sl wxy tex, tr SS, tr SLTY SH

100% LS- wht-tan-figy, sb blkyl - blkyl, sl frm, mic xl, sl wxy tex

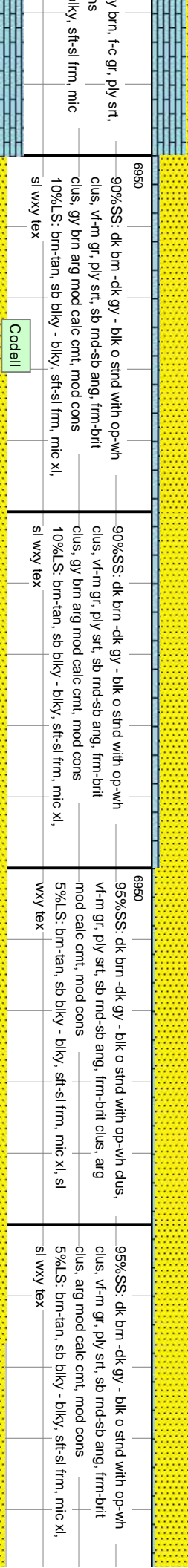
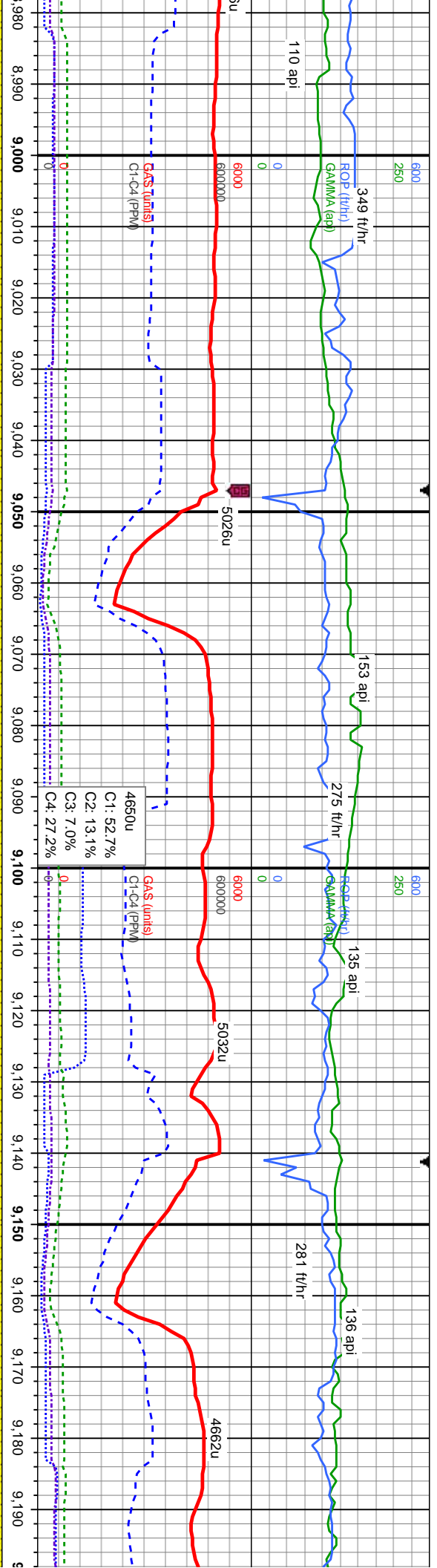
MD: 8.613  
TVD: 6.988  
Inclination: 89°  
Azimuth: 268°  
VS: 1.716'

MD: 8.707  
TVD: 6.990  
Inclination: 89°  
Azimuth: 267°  
VS: 1.808'









90%SS: dk brn -dk gy - blk o stnd with op-wh  
clus, vf-m gr, ply srt, sb md-sb ang, frm-brit  
clus, gy brn arg mod calc cnt, mod cons  
10%L.S: brn-tan, sb blk-y - blk-y, sft-sl frm, mic xl,  
sl wxy tex

90%SS: dk brn -dk gy - blk o stnd with op-wh  
clus, vf-m gr, ply srt, sb md-sb ang, frm-brit  
clus, gy brn arg mod calc cnt, mod cons  
10%L.S: brn-tan, sb blk-y - blk-y, sft-sl frm, mic xl,  
sl wxy tex

95%SS: dk brn -dk gy - blk o stnd with op-wh clus,  
vf-m gr, ply srt, sb md-sb ang, frm-brit clus, arg  
mod calc cnt, mod cons  
5%L.S: brn-tan, sb blk-y - blk-y, sft-sl frm, mic xl,  
wxy tex

95%SS: dk brn -dk gy - blk o stnd with op-wh  
clus, vf-m gr, ply srt, sb md-sb ang, frm-brit  
clus, arg mod calc cnt, mod cons  
5%L.S: brn-tan, sb blk-y - blk-y, sft-sl frm, mic xl,  
sl wxy tex

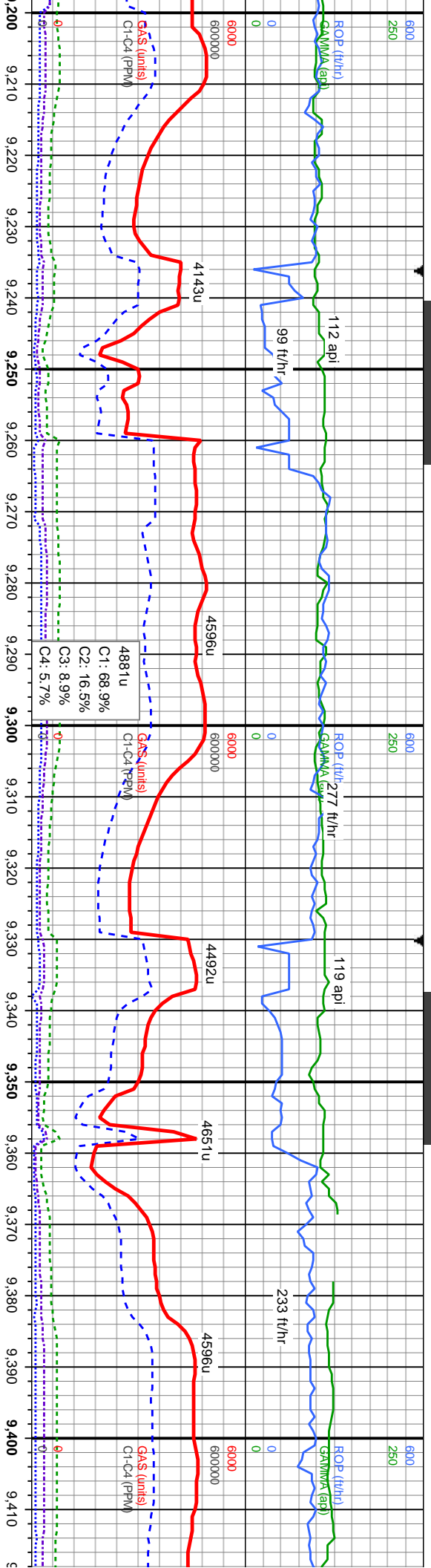
MD: 8,991'  
TVD: 6,996'  
Inclination: 88°  
Azimuth: 266°  
VS: 2.086'

MD: 9,085'  
TVD: 6,998'  
Inclination: 89°  
Azimuth: 266°  
VS: 2.178'

MD: 9,179'  
TVD: 6,999'  
Inclination: 90°  
Azimuth: 266°  
VS: 2.270'







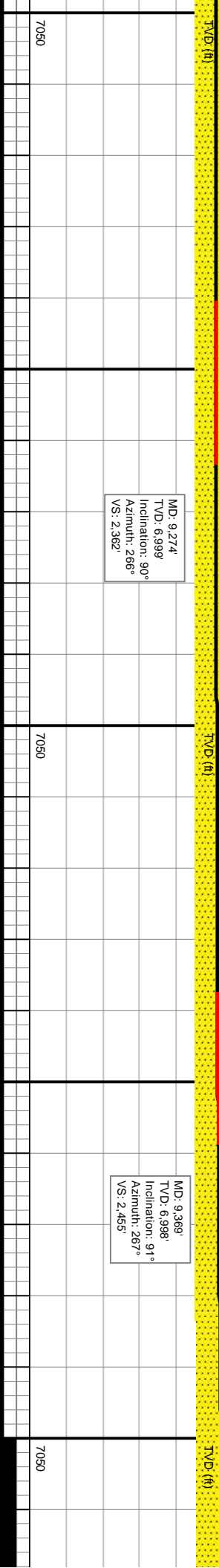
Depth (ft)	Description
6950	100% SS: dk brn -dk gy - blk o stnd with op-wh clus, vf-f gr, ply srt, sb md-sb ang, frm-brit clus, arg mod calc cmt, pred uncons
6950	100% SS: dk brn -dk gy - blk o stnd with op-wh clus, vf-f gr, ply srt, sb md-sb ang, frm-brit clus, arg mod calc cmt, pred uncons
6950	100% SS: dk brn -dk gy - blk o stnd with op-wh clus, vf-f gr, ply srt, sb md-sb ang, frm-brit clus, arg mod calc cmt, pred uncons

Codell

Codell

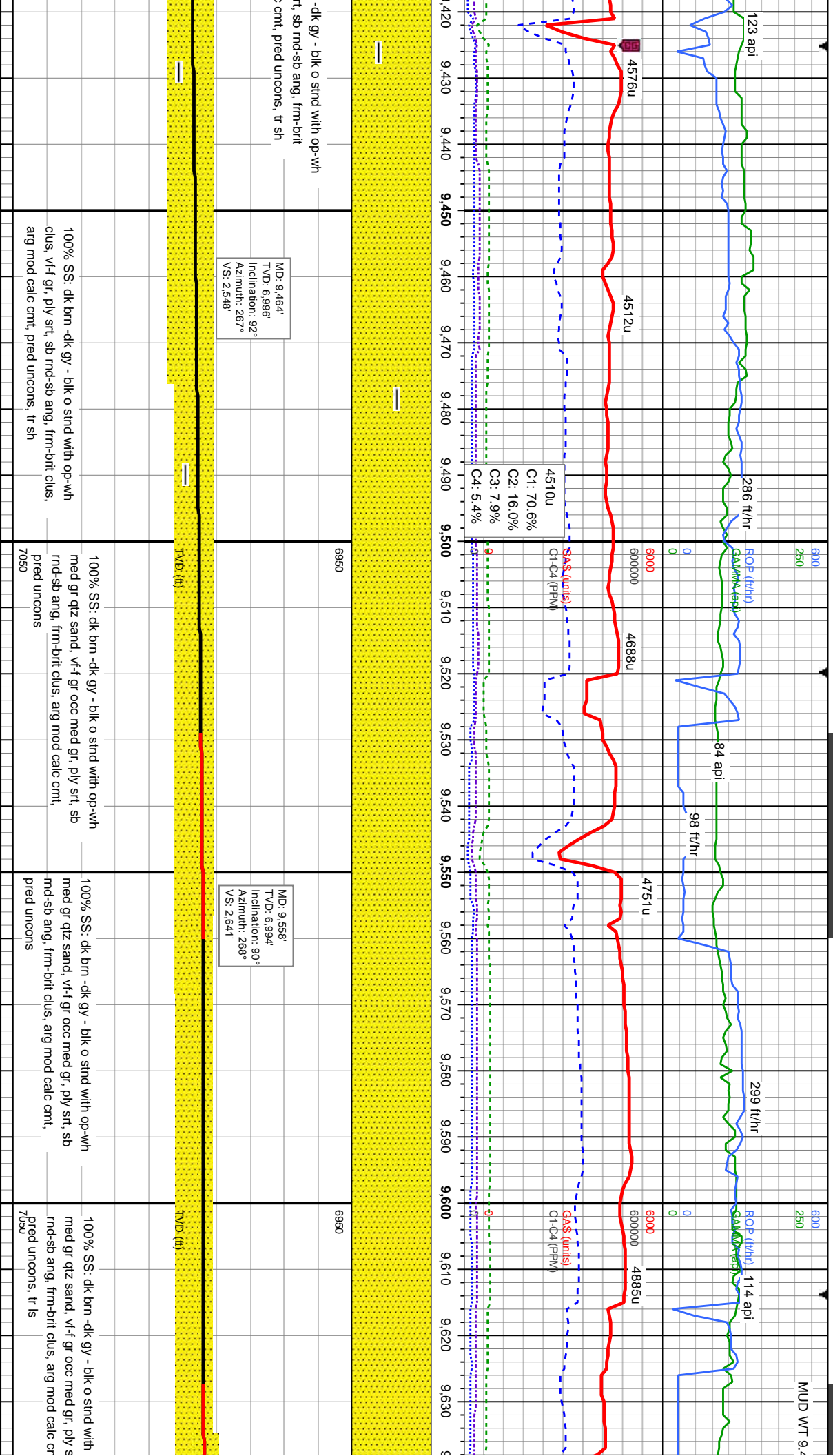
MD: 9,274'  
TVD: 6,999'  
Inclination: 90°  
Azimuth: 266°  
VS: 2,362'

MD: 9,369'  
TVD: 6,998'  
Inclination: 91°  
Azimuth: 267°  
VS: 2,455'





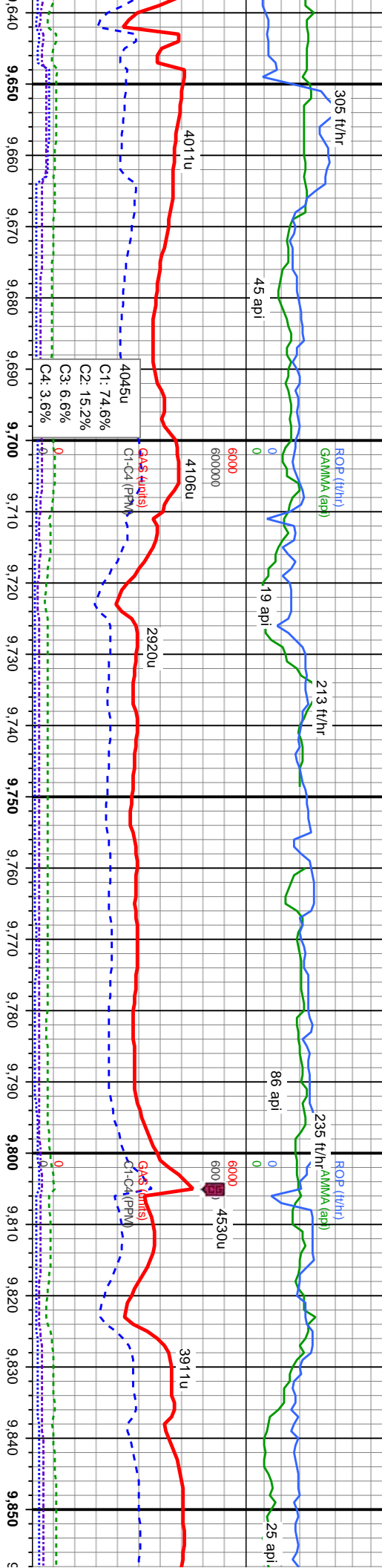
MUD WT 9.2





VIS 34

MUD WT 9.4 VIS 33



MD: 9.653  
TVD: 6.994  
Inclination: 90°  
Azimuth: 270°  
VS: 2.735

Codell

35' Fault  
From Upper Codell  
To Lower D Chalk

MD: 9.747  
TVD: 6.995  
Inclination: 89°  
Azimuth: 270°  
VS: 2.828

D Chalk

MD: 9.842  
TVD: 6.998  
Inclination: 88°  
Azimuth: 269°  
VS: 2.922

op-wh  
tr, sb  
100% SS: dk brn -dk gy - blk o stnd with op-wh  
med gr qtz sand, vf-f gr occ med gr, ply srl, sb  
md-sb ang, frm-brt clus, arg mod calc cntl,  
pred unconcs, tr ls

60% SS: dk brn -dk gy - blk o stnd with op-wh med  
gr qtz sand, vf-f gr occ med gr, ply srl, sb md-sb  
ang, frm-brt clus, arg mod calc cntl, pred unconcs  
25% CHK: brn- med gy-lt gy, sb blkyl, frm, sl suc, sl  
wxy-gt, v calc, sl grdg - ls  
15% LS: brn-tan-gy, sb blkyl - blkyl, sl frm - hd occ  
sft, sl suc -sl wxy tex, sl arg,gt, v calc

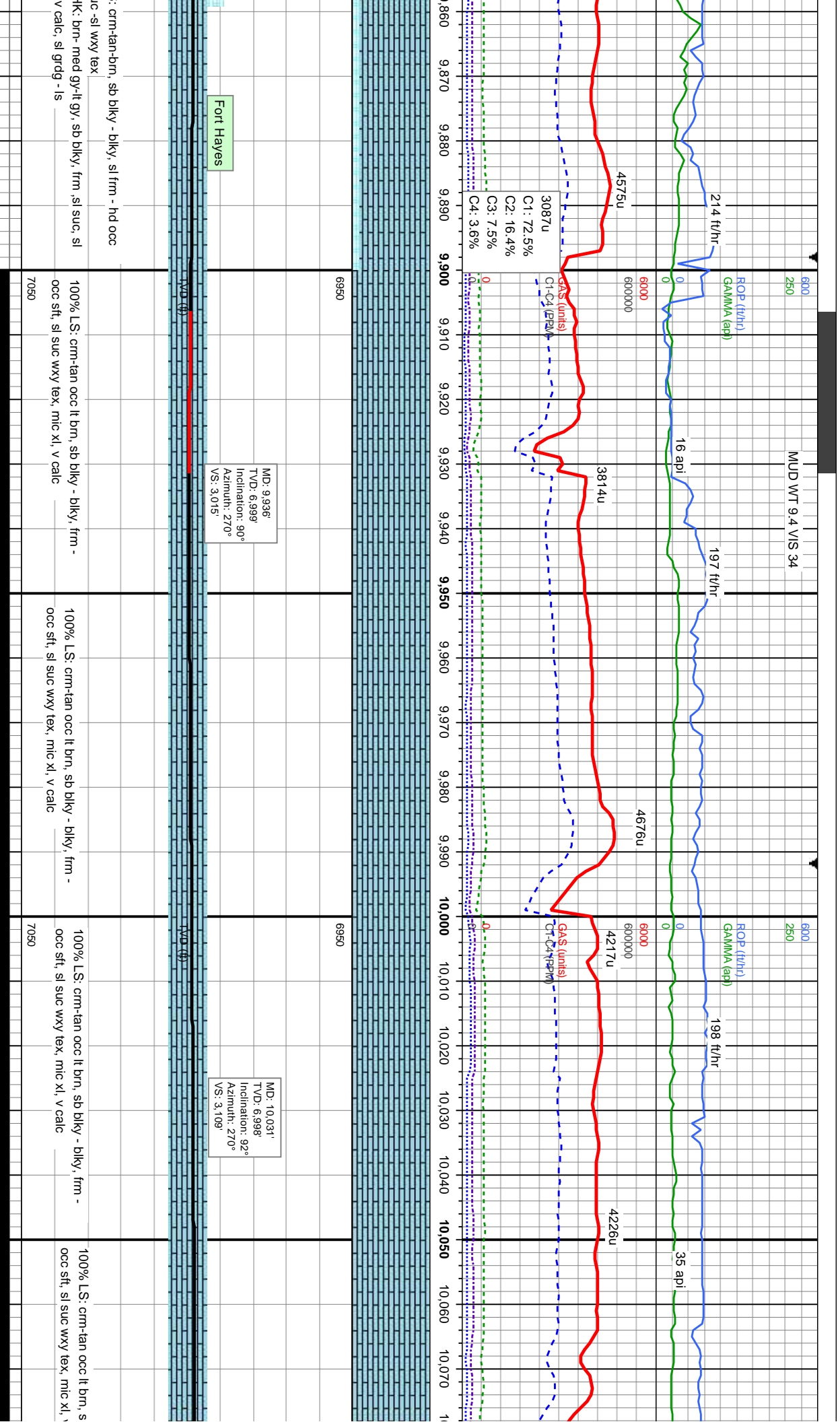
60% CHK: brn- med gy-lt gy, sb blkyl, frm, sl suc, sl  
wxy-gt, v calc, sl grdg - ls  
40% LS: brn-tan-gy, sb blkyl - blkyl, sl frm - hd occ  
sft, sl suc -sl wxy tex, sl arg,gt, v calc

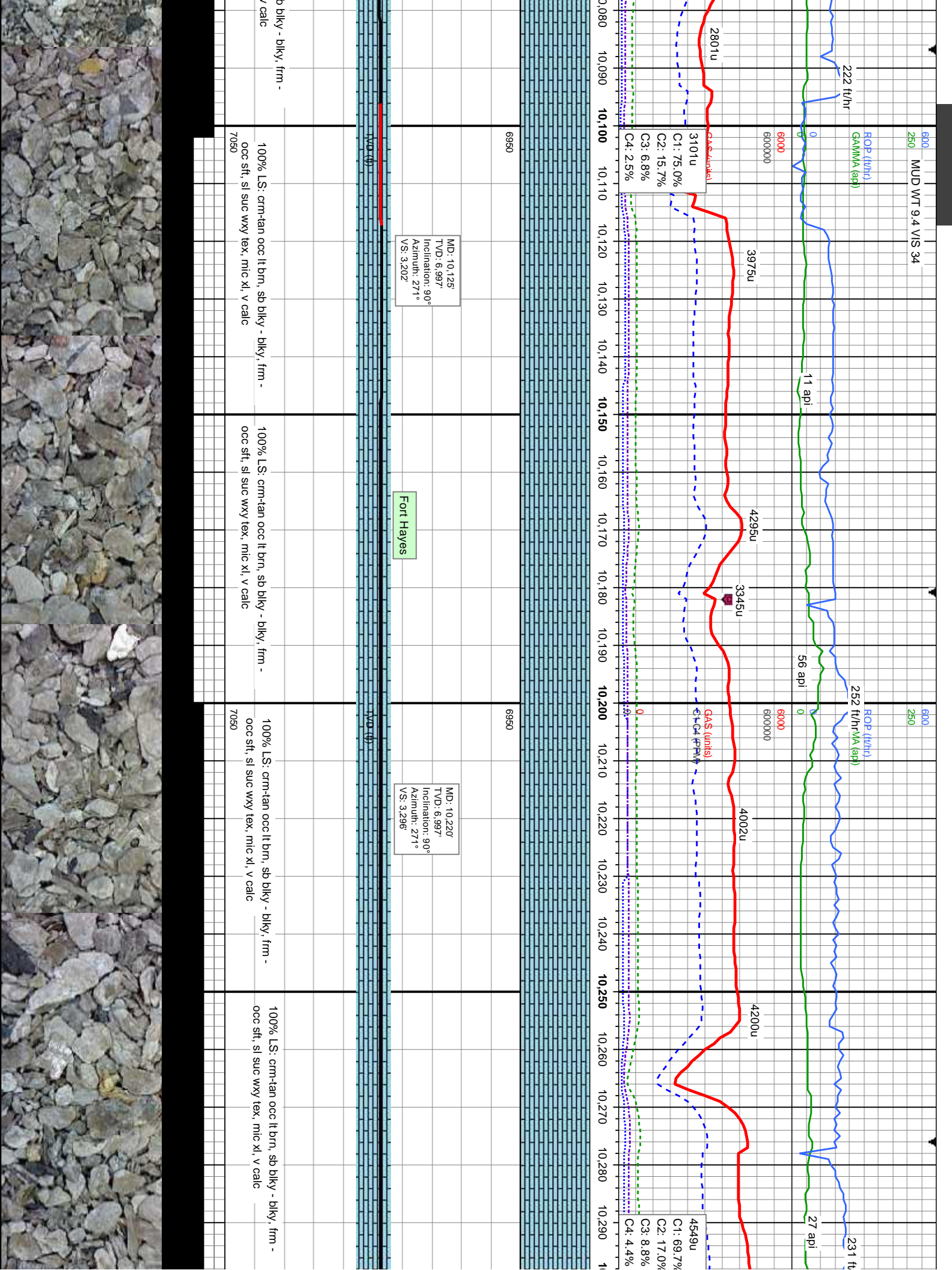
80% LS: brn-tan-gy, sb blkyl - blkyl, sl frm - hd occ  
sft, sl suc -sl wxy tex, sl arg,gt, v calc  
20% CHK: brn- med gy-lt gy, sb blkyl, frm, sl suc, sl  
wxy-gt, v calc, sl grdg - ls

90% LS  
sft, sl suc  
10% CH  
wxy-gt,



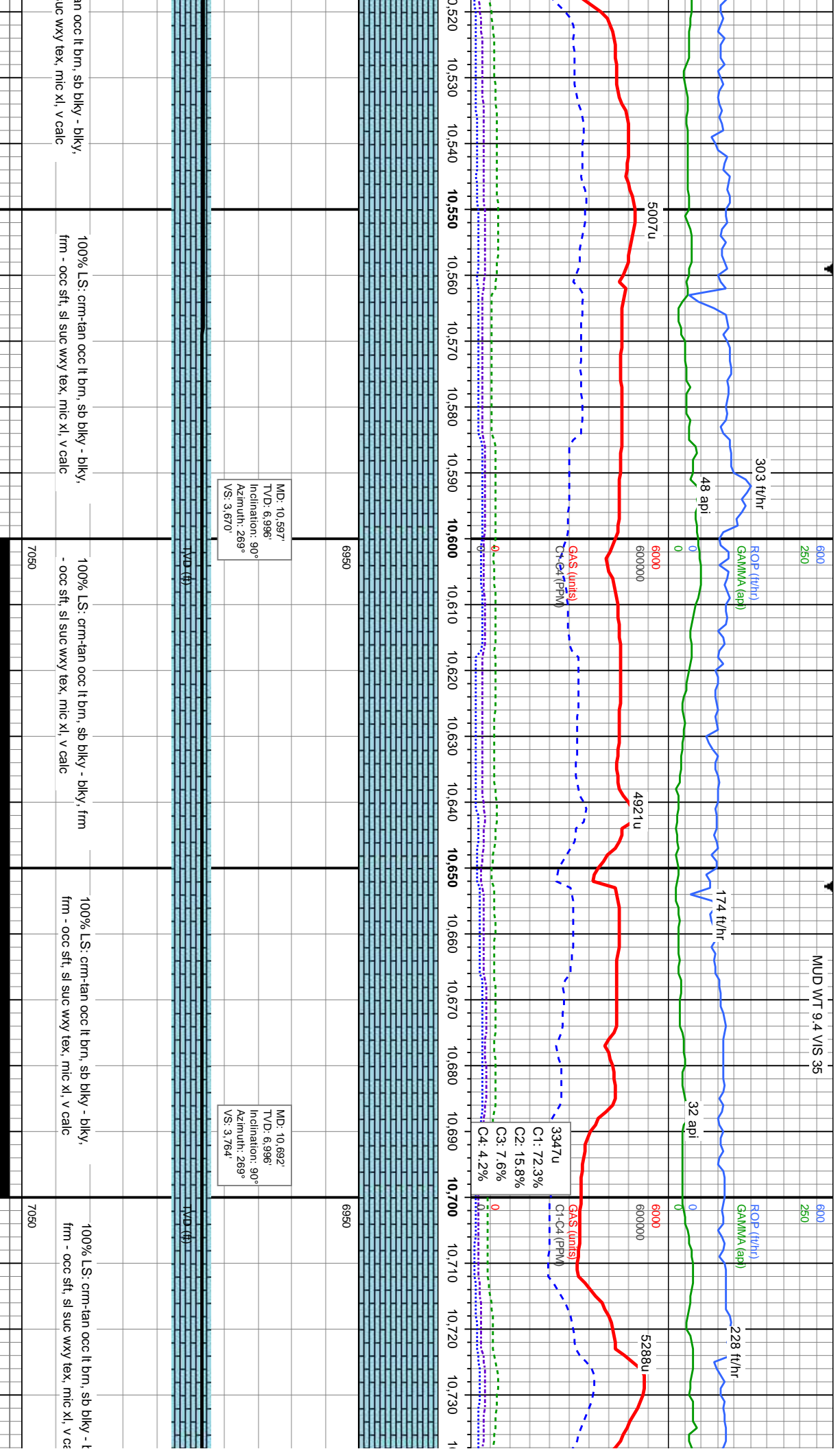




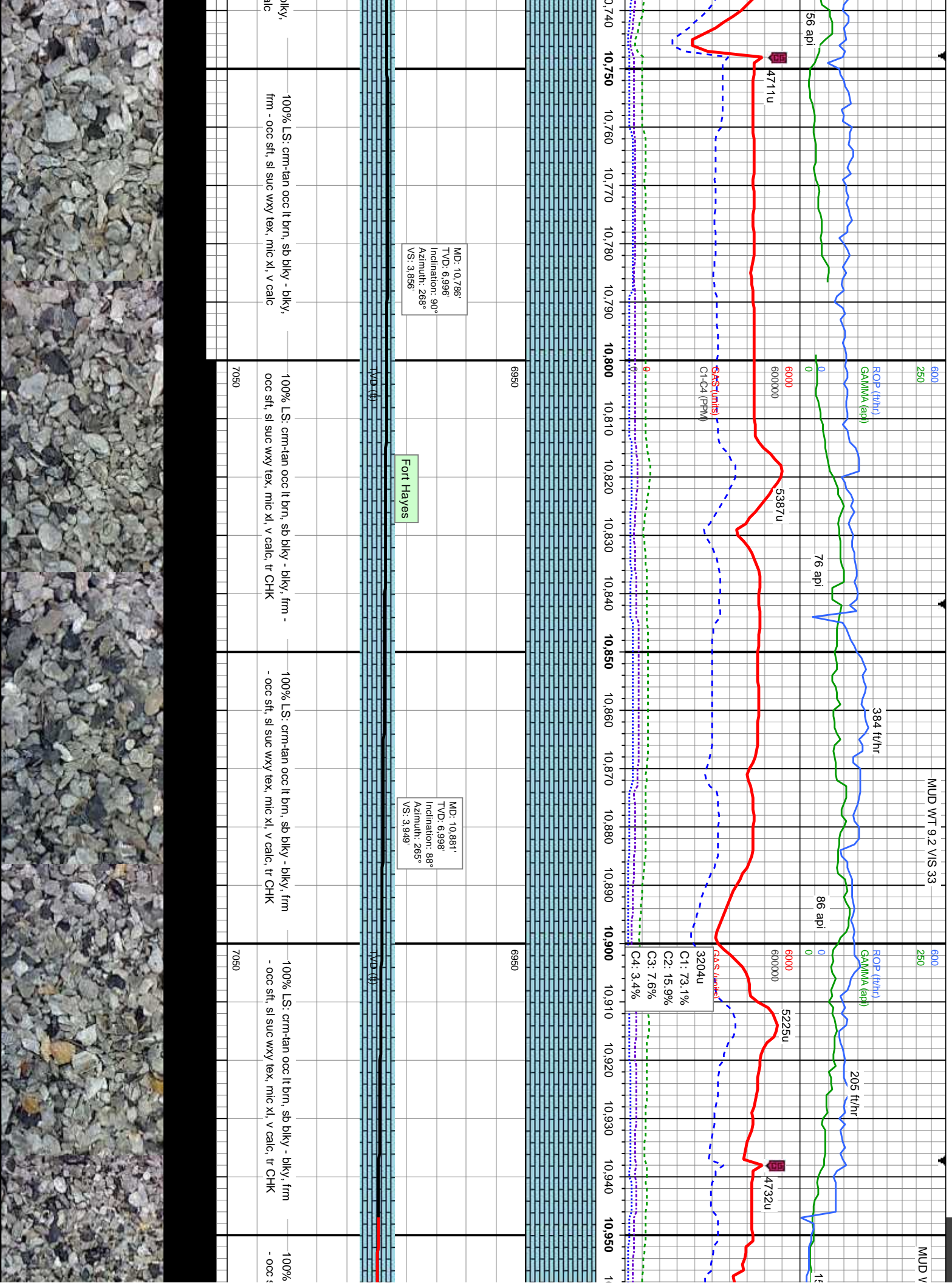


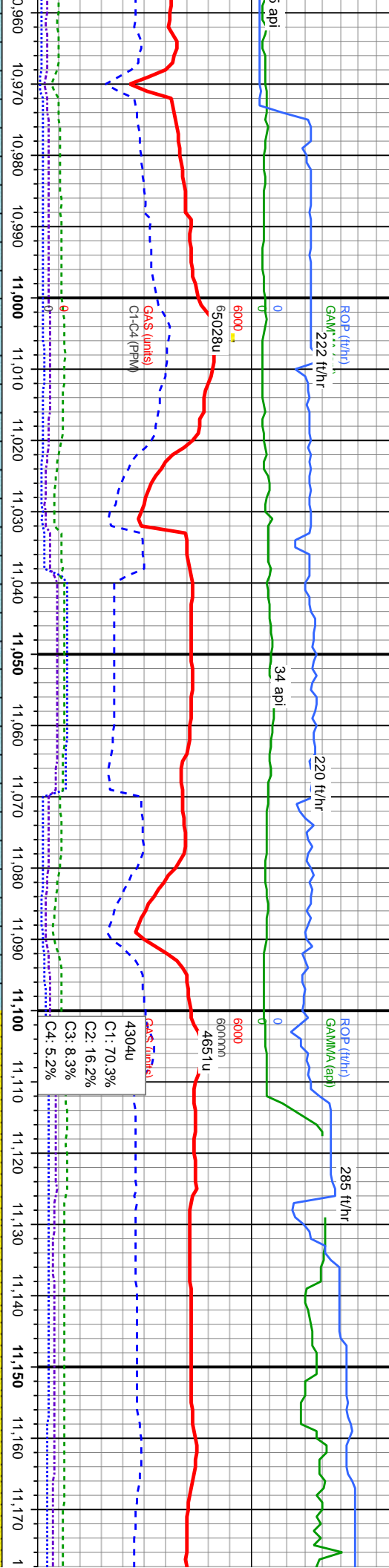












MD: 10.976'  
TVD: 7.000'  
Inclination: 89°  
Azimuth: 267°  
VS: 4.042'

MD: 11.070'  
TVD: 7.001'  
Inclination: 90°  
Azimuth: 267°  
VS: 4.134'

MD: 11.164'  
TVD: 7.000'  
Inclination: 90°  
Azimuth: 266°  
VS: 4.226'

LS: crm-tan occ lt brn, sb blkly - blkly, frm  
ft, sl suc wxy tex, mic xl, v calc

100% LS: crm-tan occ lt brn, sb blkly - blkly, frm -  
occ sft, sl suc wxy tex, mic xl, v calc

100% LS: crm-tan occ lt brn, sb blkly - blkly,  
frm - occ sft, sl suc wxy tex, mic xl, v calc

50%SS: cl-r-r wh-op-lt gy-lt gy brn, f-c gr, ply  
srt, sb md-sb ang, frm-brt, uncons  
50%LS: brn-tan, sb blkly - blkly, sft-sl frm, mic xl,  
sl wxy tex

70%SS: dk brn -dk gy - blk c  
med gr qtz sand, vt-f gr occ  
md-sb ang, frm-brt clus, gy  
cmt, pred uncons  
30%LS: brn-tan, sb blkly - blkly,  
sl wxy tex





