

2D T₁-T₂ NMR Log
Integrated Fluid Interpretation
6899.00ft - 8350.00ft

COMPANY: North East Natural Energy LLC
WELL: Boggess 17H
FIELD: Wildcat
COUNTY: Monongalia
STATE: West Virginia
COUNTRY: United States

API No.: 47-001-01812-00-00

Location: Lat and Long: 39.4612, 81.5558 W

Permanent Datum: Elev: 1288 ft
Log Measured From: K.B. 1296 ft
Drilling Measured From: G.L. 1288 ft

Date	15-Apr-2019
Run No.	18
Depth Driver	8400 ft
Depth Logger (Sht)	8400 ft
Bin. Log Interval	8400 ft
Top Log Interval	8900 ft
Coring-Depth	9.625 ft @ 2538 ft
Coring-Logger	2543 ft
Bit Size	8.5 in
Type Fluid in Hole	WATER
Dens. Visc.	9.5 lbm/gal .999 25 cP
pH Fluid loss	-999.25 -.999 25 in3
Source of Sample	Active Tank
Rm @ Mass Temp.	0.04 ohm.m @ 103 degF
Rm @ Meas. Temp.	0.0295 ohm.m @ 103 degF
Rm @ Mass Temp.	0.04 ohm.m @ degF
Rm @ Meas. Temp.	Passed
Core @ BHT	0.0286805 @ 158 degF
Core @ Meas. Temp.	22.0000
Log on Bottom	22.4400
Max Rec. Temp.	158 deg F
Equipment Location	3703 Bradford PA
Recorded by:	Elizabeth Morrow
Witnessed by:	BJ Marney

The well name, location and borehole reference data were furnished by the customer

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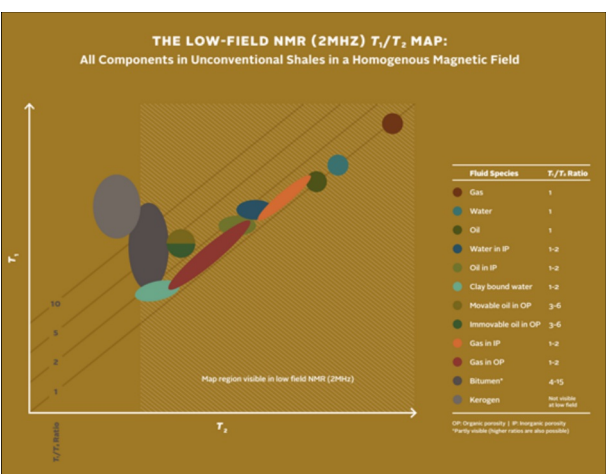
Ser. Order #	Process Date: 5/1/2019	Center: Pittsburg	Baseline: Techlog 2018.2	Log Analyst: USCHNER-ARROYO
Remarks:				

Service Description:
 The CMR NG is the latest generation Schlumberger CMR logging tool, providing continuous, two-dimensional T₁-T₂ relaxation maps as a downhole log.
 The standard one-dimensional T₂ interpretation uses pre-defined T₂ cut-offs to determine fluid bin porosities, bound fluid volume, free fluid volume, and permeability. The new-generation technique leverages the differences in T₁/T₂ ratios of various poro-fluid components to separate out the various fluid volumes in T₁-T₂ space. This is performed using a two-dimensional data analytics clustering technique that identifies common signatures throughout the 2D log and defines 2D cutoffs, or regions, for each poro-fluid component. The analyst then identifies each component as a petrophysical fluid component, and final fluid porosities and saturations are computed as a depth log.

- Log Legend:**
- Track 1: Bin porosities from T₂ distribution cut-offs, caliper, and bit size
 - Track 2: Measured depth, tool tension, and gamma ray
 - Track 3: Resistivities
 - Track 4: NMR permeability from SDR and Timur-Coates equations
 - Track 5: NMR BFV, NMR FFV, density porosity, neutron porosity
 - Track 6: Zonation track
 - Track 7: CMR NG T₁ distribution projection with T₁ log-mean (T1LM)
 - Track 8: CMR NG T₂ distribution projection with T₂ log-mean (T2LM)
 - Track 9: Porosity of each cluster region computed from the 2D analytics algorithm
 - Track 10: Fluid porosities based on analyst's cluster region interpretations
 - Track 11: Water porosities from 2D NMR fluids interpretation
 - Track 12: Hydrocarbon porosities from 2D NMR fluids interpretation
 - Track 13: Water saturation from 2D NMR fluids interpretation

Processing Parameters Summary (Advanced):

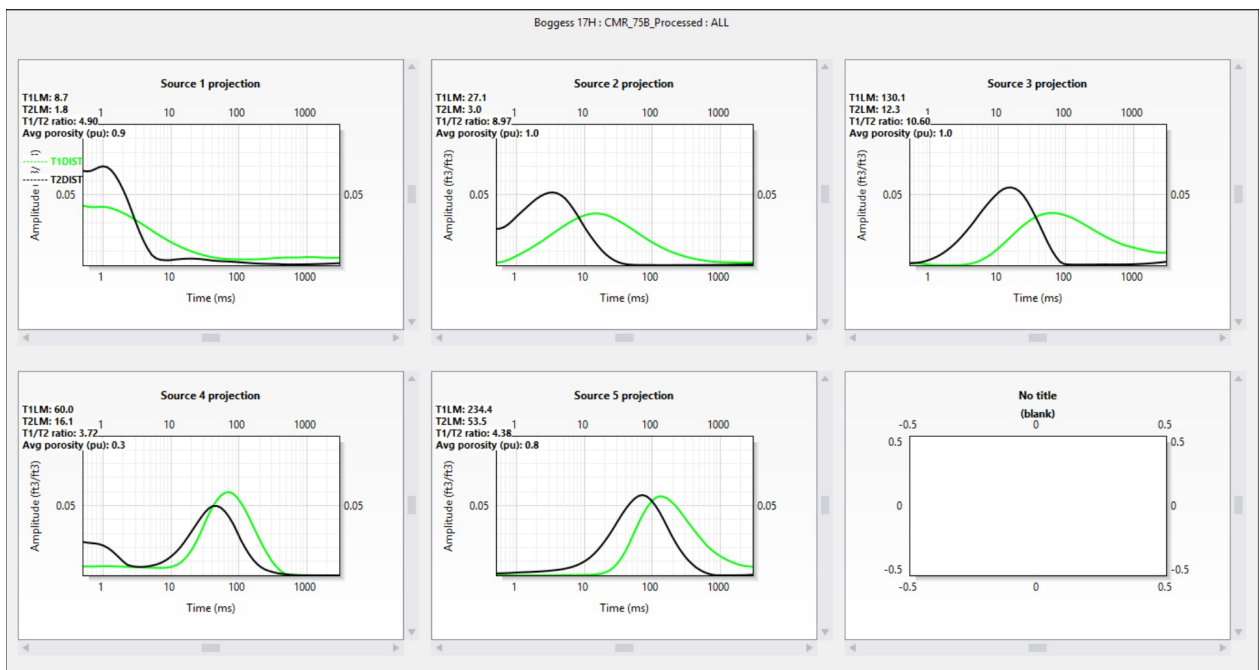
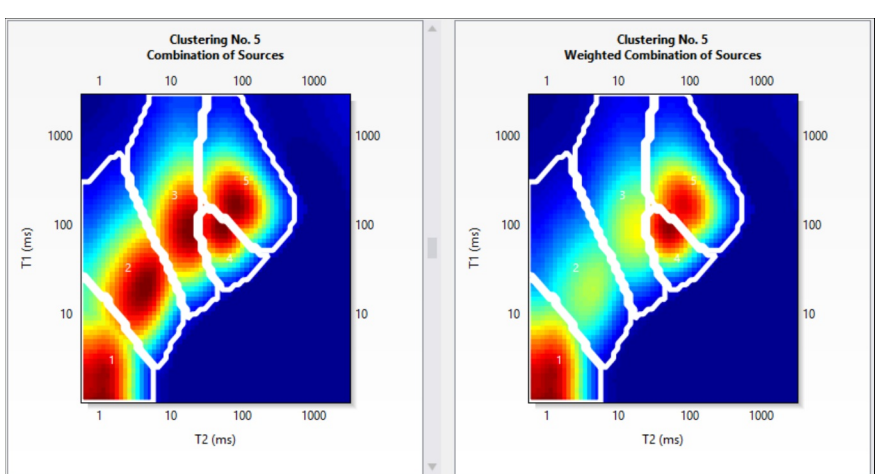
Starting echo: 2;2;2;2;2
 T₁ minimum: 1 ms
 T₂ minimum: 0.5 ms
 Phase option/value: Manual/-144.501
 Artifact corr. option: Yes
 Artifact corr. T₁ cut: 600 600
 Artifact corr. T₂ cut: 600 600
 Cluster proc. mode: Recommended
 Cluster max comp.: 10
 Cluster subsam. rate: 50 50
 Clustering num. trials:
 Cluster size: 50
 Cluster size after mask: 50
 Footprint: 12
 Mask Size: 12



General fluid interpretation concept diagram for T₁-T₂ NMR maps.

2D Clustering Analysis:

Zone: Middlesex - Marcellus



Standard Answers

Parameters		Permeability		Timur		SDR	
T2 Cutoff:	3 (ms)	Computed:	yes	yes	yes	yes	yes
		Multiplier:	1	1	0.35	0.35	0.35
		Porosity Exponent:	4	4	2	2	2
		Phi Ratio/T2LM Exp:	2	2	2	2	2
		Bound Fluid Min:	0.02 (ft3/ft3)	0.02 (ft3/ft3)	0.02 (ft3/ft3)	0.02 (ft3/ft3)	0.02 (ft3/ft3)
Bin Porosities (ms)							
0.5	1	3	10	33	100	300	1000 3000

CMR T2 Analysis

Washout/Mudcake							
MRP_UNC_T1_EDIT							
MBF6_CMR	TENS 1000 lbf 4000						
MBF5_CMR	ECGR 0 gAPI 150	RXOZ 0.2 ohm.m 2000	KTIM 1 mD 1e-5	MRP_UNC_T1 0.4 ft3/ft3 0	BFV_6IN		
MBF4_CMR	MD (ft) 1:240	RLAS 0.2 ohm.m 2000	KSDR 1 mD 1e-5	MRP_UNC_T1_EDIT 0.4 ft3/ft3 0	BFV_3MS_CMR		
MBF3_CMR				TNPH 0.4 ft3/ft3 0			
MBF2_CMR				DPHI_LIM 0.4 ft3/ft3 0			

Client Supplied Tops

QuantiELAN Volume	0	1
UGas_QE		
UWater_QE		
Kerogen_QE		
Dolomite_QE		
Calcite_QE		
Quartz_QE		
Bound Water_QE		
Chlorite_QE		
Illite_QE		

NMR	0.00	0.02
T1_DIST (t3/t3)	0.03	0.03
T1LM_UNC_T1	1 (ms) 3000	0.5 (ms) 3000
NMR	0.00	0.02
T2DIST (t3/t3)	0.03	0.03
T2LM_DI_UNC_T1	0.5 (ms) 3000	0.5 (ms) 3000

Density Standoff	0	in 0.5
DSOZ		

NMR Fluid	0.25	ft3/ft3 0
VG_T1T2		
VW_T1T2		
VCBW_T1T2		

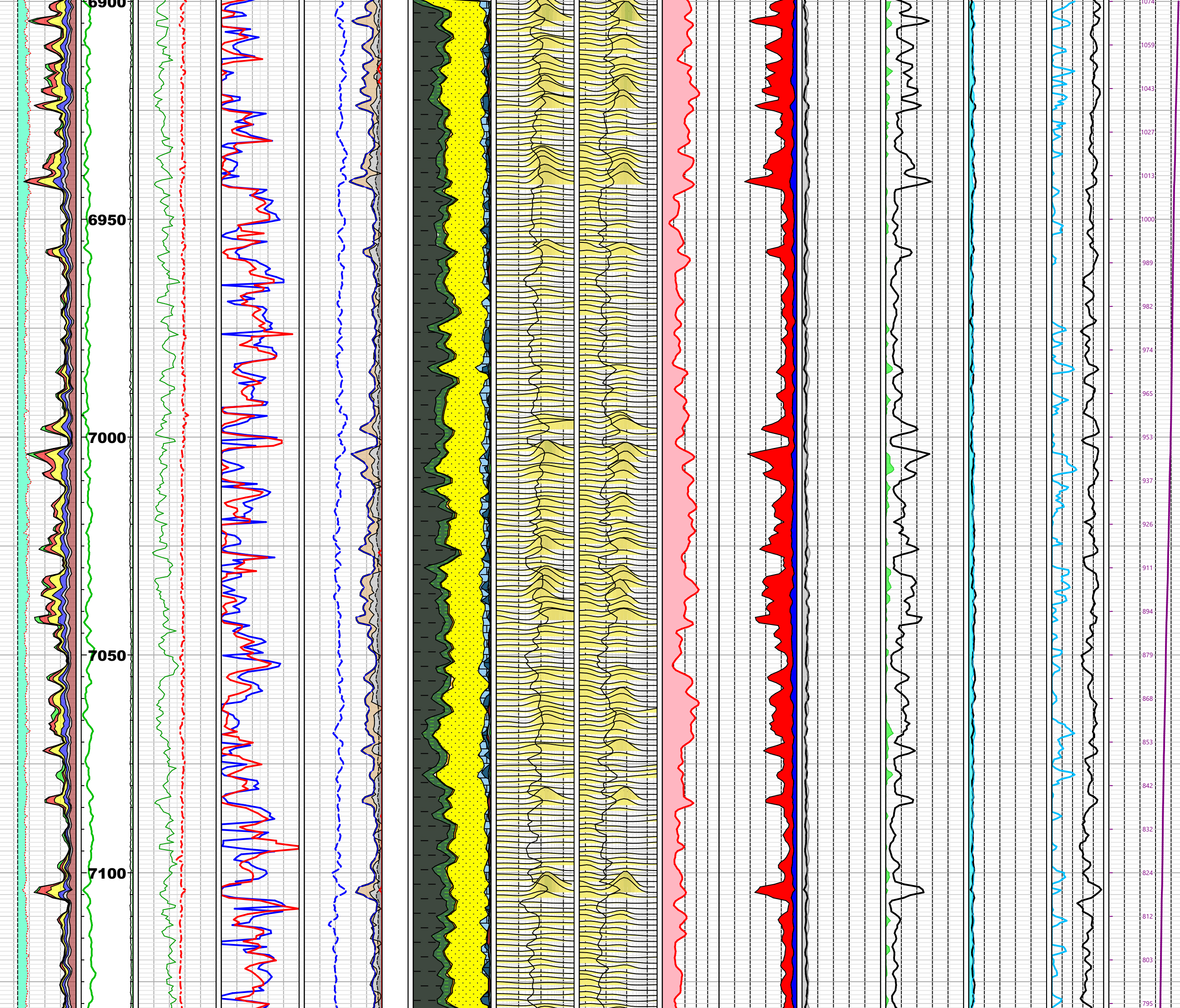
Bound Water_QE	0	ft3/ft3 0.25
UGas_QE	0	ft3/ft3 0.25
UWater_QE	0	ft3/ft3 0.25
VCBW_T1T2	0	ft3/ft3 0.25

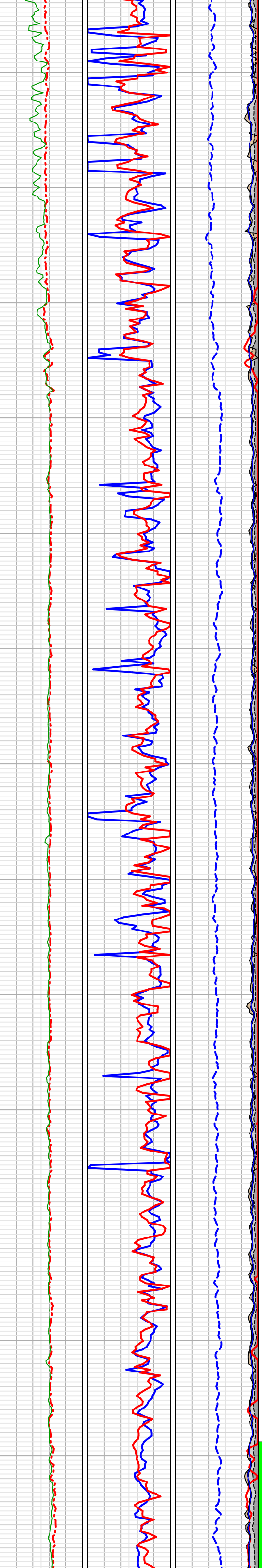
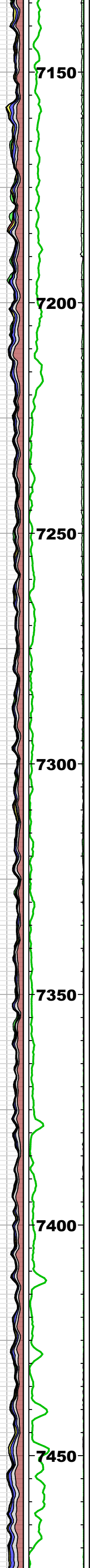
UGas_QE	0	ft3/ft3 0.25
VG_T1T2		

UWater_QE	0	ft3/ft3 0.25
VW_T1T2		
VTW_T1T2	0	ft3/ft3 0.25

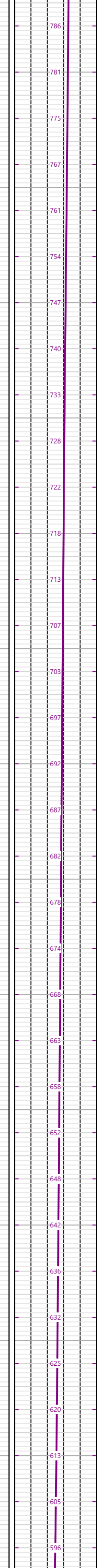
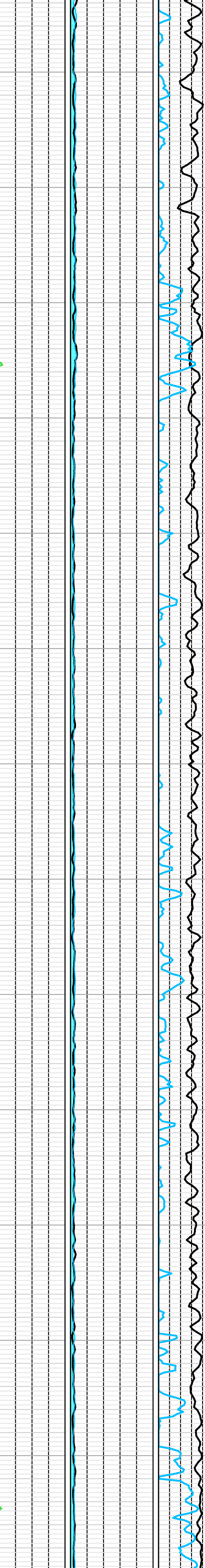
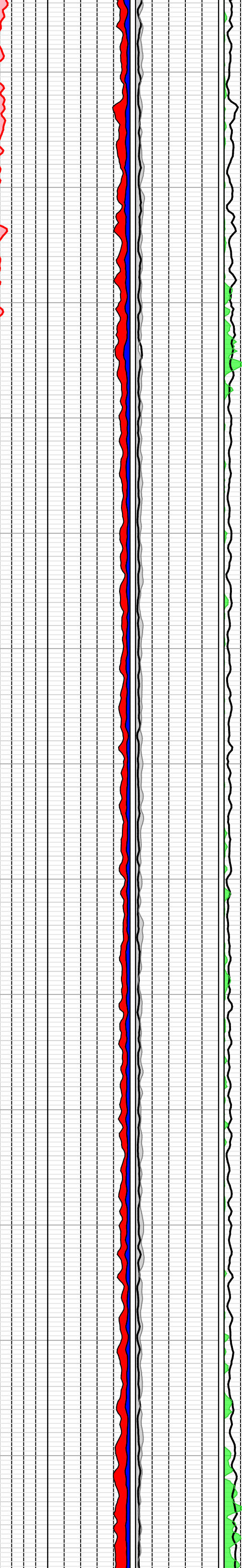
SW_QE	1	ft3/ft3 0
VCBW_T1T2	0	ft3/ft3 0.25
VTW_T1T2	0	ft3/ft3 0.25
SWT_T1T2	1	ft3/ft3 0

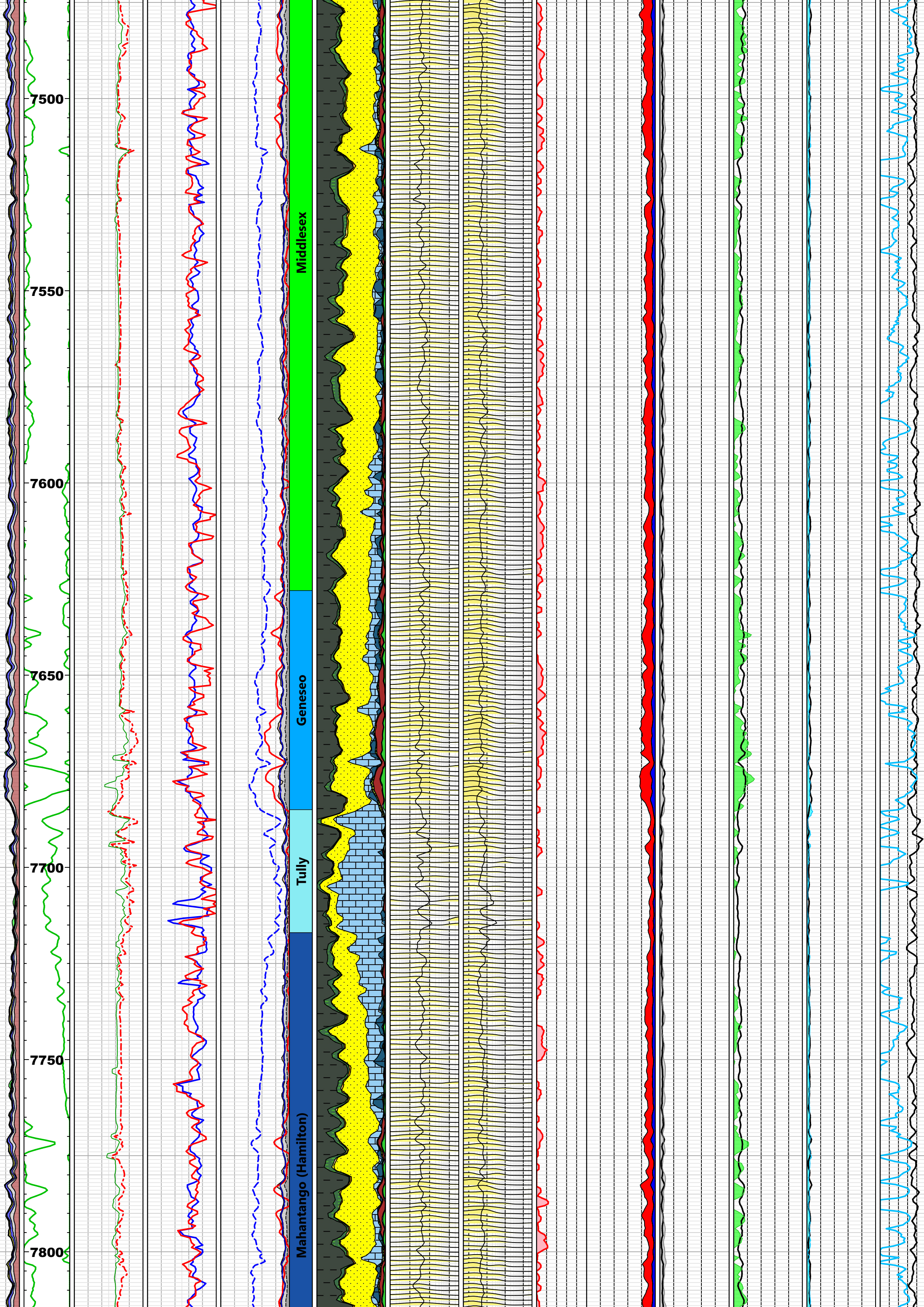
Cum TGIP_CMR	0	bbl/section 1200
Cum TGIP_CMR	0	bbl/section 1200





sex





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7550
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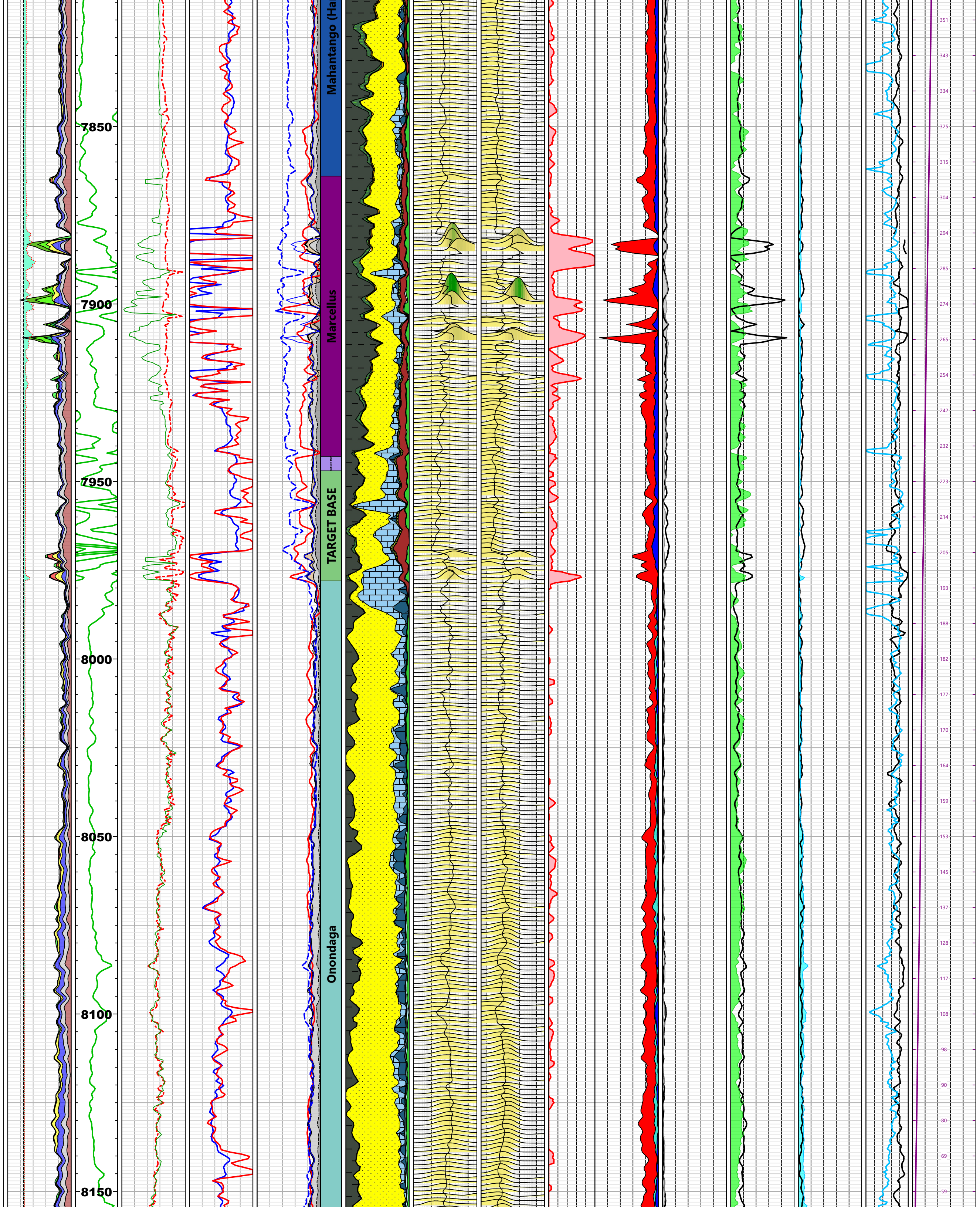
Middlesex

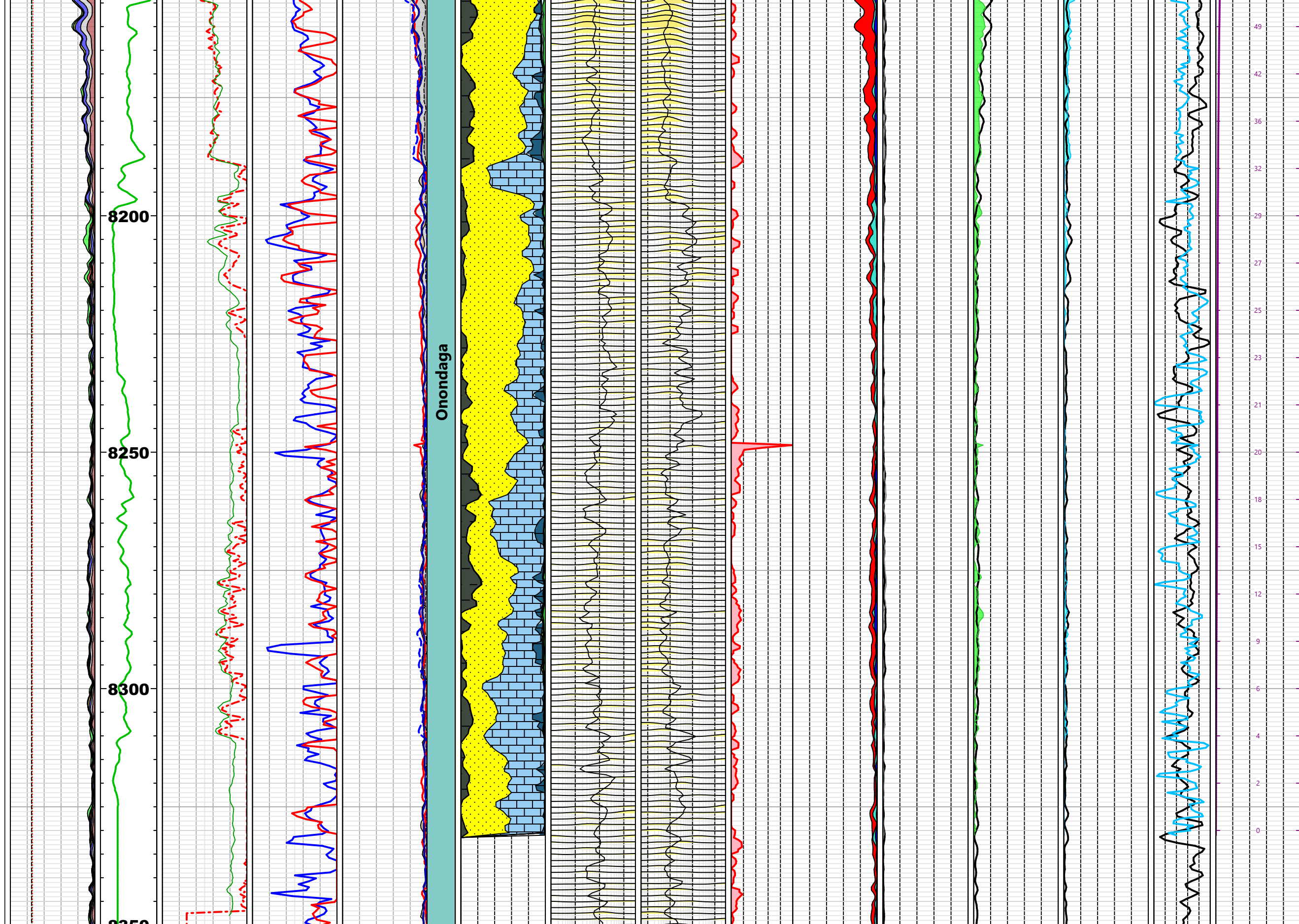
Genesee

Tully

Mahantango (Hamilton)

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Washout/Mudcake	MBF6_CMR	MBF5_CMR	MBF4_CMR	MBF3_CMR	MBF2_CMR	MRP_UNC_T1_EDIT	BFV_6IN	BFV_3MS_CMR	MRP_UNC_T1	TNPH	DPHI_LIM	BFV	BFV_3MS_CMR	MRP_UNC_T1_EDIT	Uranium	ELAN Volume	UGas_QE	UWater_QE	Kerogen_QE	Dolomite_QE	Calcite_QE	Quartz_QE	Bound Water_QE	Chlorite_QE	Illite_QE	Supplied_Tops	NMR	NMR	Density Standoff	DSOZ	NMR Fluid	Bound Water_QE	Bound Water_QE	UGas_QE	UWater_QE	SW_QE	Cum TGIP_CMR				
	TENS	ECGR	RXOZ	KTIM	RLAS	KSDR	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0	0	0.25 ft3/ft3	0	0	0	0	0	0	0	0	0	0.00	0.00	0	0	0	0	0	0	0	0	0	0		
	1000 lbf 4000	0 gAPI 150	0.2 ohm.m 2000	1 mD 1e-5	0.2 ohm.m 2000	1 mD 1e-5	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0.4 ft3/ft3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)	MD (ft)
	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240	1:240

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Schlumberger

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