Salinity Analysis of 9 Wells in Townships 6 and 7 South, Ranges 95 and 96 West, 6th P.M. Parachute Field, Piceance Basin, Colorado

Prepared for
COGCC

By Digital Formation, Inc.
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Tabulations

All wells:

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Introduction

We were contacted in May 2016 by Dave Andrews of COGCC to assist in estimating water salinities in order to map the vertical distribution of fresh water in selected wells located in Townships 6 and 7 South, Ranges 95 and 96 West, 6th P.M. Parachute Field, Piceance Basin, Colorado. COGCC's goal is to evaluate suitable surface casing setting depths to protect useable fresh water in the Wasatch and Upper Mesa Verde Group. For the purpose of this study, "fresh water" is defined as having a salinity of less than 10,000 ppm.

Similar to the previous studies in Rulison Field and Mamm Creek Field, Piceance Basin, Colorado, completed in July 2014 and June 2015, respectively, it was decided that a study of eight wells would be used to determine if comparisons between Spontaneous Potential (SP) analysis and traditional Archie analysis could be correlated to help in mapping the fresh water depths. A purchase order for this project was issued in May 2016, when digitizing of six of eight wells commenced. LAS was provided for the two remaining wells.

It was discovered that two of the selected wells had logs which did not show backup scales for the neutron log, resulting in data that would be unsuitable for Archie analysis. Replacement data was found in three other wells, and it was decided to include them all and bring the project up to nine wells in total. Both an SP analysis as well as a full Archie Analysis was performed on all these wells.

This report is a documentation of the results of this study.

Summary

For nine wells selected by COGCC, Digital Formation identified individual sand intervals using gamma ray (GR) logs down to about 200 feet below the top of the Mesa Verde, using the automated identification approach designed in the Mamm Creek project:

05045066230000 Union GV 10-34

05045068420000 Unocal GR 31-2

05045071900000 Federal GM 34-3

05045074160000 PA 14-32

05045089740000 Brouch GM 314-12

05045126040000 Enyeart 16-4 (PD16)

05045184250000 Williams GM 931-1D

05045222650000 C&C Energy GM 23-13

05045224090000 Hicks PA 44-6

The previously developed approach to automatically calculate salinity from the SP log was made on each of these intervals.

Archie calculations for total porosity (from a density and neutron cross plot) and saturation from formation resistivity are calculated for all wells. An automated interpretation of Pickett Plots was used to choose water resistivity (R_W) for each interval. Archie cementation and saturation values of m = n = 1.8 were used for all wells. The values were chosen based on interpretation of the sands and Digital Formation's professional experience in the Piceance Basin.

Using the calculated formation temperature – based on an average annual surface temperature of 50°F, and the log header bottom hole temperature (BHT) – an equivalent salinity is calculated from the R_W value. For many of the sands, there is a scatter of data on the Pickett Plots suggesting either:

1. Small amounts of residual hydrocarbons
2. Variable water salinity – thought to be unlikely

Overall, the data suggests wide variation in R_W, with no consistent depth trend. Water of less than 10,000 ppm is calculated within the Mesa Verde, using m = n = 1.8. There is little correlation between the salinities from Archie analysis and from the SP log.

Data Preparation

Log ASCII Standard (LAS) files were loaded into Digital Formation's ***LESA*** petrophysical software. Curves from logging service companies were renamed for consistency:

Log	Mnemonic	Description
Caliper	DF_CALI	Copy of CALI, or other service company mnemonic
Gamma Ray	DF_GR	Copy of GR or other service company mnemonic
SP	DF_SP	Copy of SP or other service company mnemonic
Density	DF_RHOB	Copy of RhoB, or other service company mnemonic
Neutron	DF_NPHI_L	Copy of NPhi, or other service company mnemonic
Acoustic compressional	DF_DT	Copy of DT, or other service company mnemonic
Deep Resistivity	DF_DEEP	Copy of resistivity curve identified as "deep"
Medium Resistivity	DF_MEDIUM	Copy of resistivity curve identified as medium or intermediate
Shallow Resistivity	DF_SHALLOW	Copy of resistivity curve identified as shallow

Programmatic despiking of the porosity logs was performed, to eliminate obvious levels of invalid readings due to bad hole. Whenever the hole is out of gauge, the porosity logs tend to read anomalously high values. The despiking routines identify and eliminate these levels. De-spiked Curves were named adding "DS" – for example:

DF_RHOB_DS

From the data shown on the log header, environmental factors were corrected on the density and GR log curves for hole size, and application of the appropriate tornado chart was used to determine deep resistivity, total resistivity (Rt), and flushed zone resistivity (Rxo). If no match was available, it was assumed that Rt = deep, and Rxo = shallow.

Basic Clean Formation Analysis

Shale Volume

Shale volume (V_{SH}) was determined from the GR log, using the standard non-linear "Stieber" equation:

$$GRI = \frac{GR - GR_{clean}}{GR_{shale} - GR_{clean}}$$

$$V_{SH} = \frac{0.5 \times GRI}{1.5 - GRI}$$

GR_{clean} and GR_{shale} were chosen using interactive graphics, on a petrophysical zone basis.

Shale Responses

Shale responses of porosity logs were determined, on a zone-by-zone basis, using interactive porosity cross plots.

Porosity

Total porosity (Phi_X) was determined using a density/neutron cross plot porosity. Effective porosity (Phi_E) was determined using the equation:

$$Phi_E = Phi_X - (V_{SH} \times Phi_{shale})$$

Water Saturation

The Archie parameters, water resistivity (R_W) and cementation exponent (*m*), were determined automatically from porosity/resistivity (Pickett) cross plots. The apparent R_W (R_{Wa}) assuming 100% water saturation was calculated at each depth.

$$R_{Wa} = Phi^m \times R_t$$

The minimum value of this calculation over each interval is used as R_W. Saturation exponent (*n*) was assumed equal to m, consistent with industry practice in the Piceance Basin.

Water saturation (S_W) was calculated using the Archie Model:

$$S_W^n = \sqrt{\frac{a \times R_W}{\varphi^m \times R_t}}$$

Permeability

Permeability was determined using a modified Timur equation:

$$k = \frac{62500 \times {Phi_E}^6}{{S_{Wi}}^2}$$

S_{Wi} is the lower of log-calculated S_W or theoretical S_{Wi} from a Buckles equation:

$$Phi_E \times S_{Wi} = Constant$$

A constant of 0.05 was used. This value is suitable for most reservoirs in the Piceance Basin.

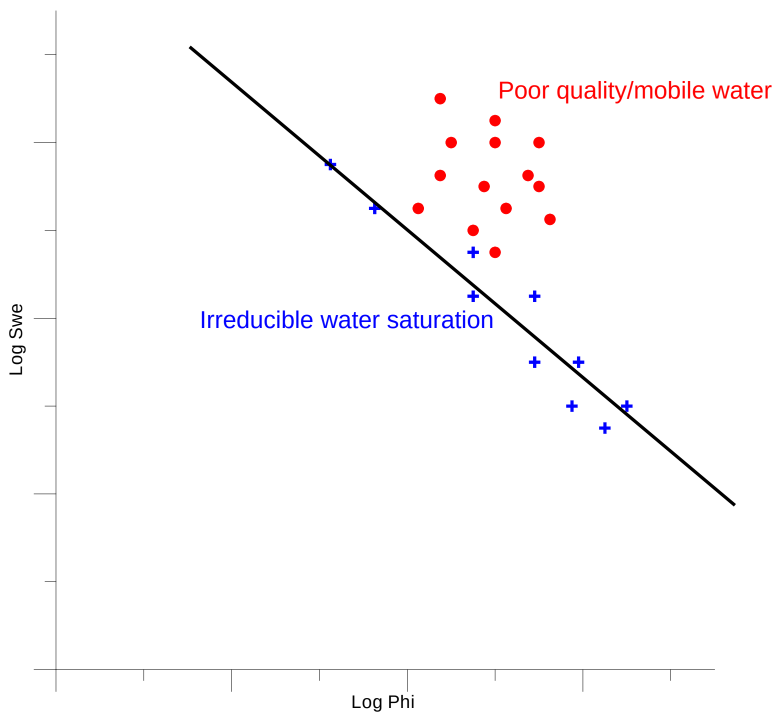
Effective Porosity and Effective Water Saturation

Effective water saturation (S_{WE}) was calculated using Dewan's equation:

$$S_{WB} = V_{SH} \times \frac{Phi_{SH}}{Phi_X} = \text{Bound Water Saturation}$$

$$S_{WE} = \frac{(S_W - S_{WB})}{(1 - S_{WB})}$$

From log/log cross plots of S_{WE} vs. Phi_E, by petrophysical zone, levels interpreted to be at irreducible water saturation (S_{Wi}) were identified. Points with $S_{WE} > S_{Wi}$ contain potential mobile water (or belong to a poorer reservoir quality rock with higher values of S_{Wi}). Poorer reservoir qualities indicate high values of irreducible water saturation, and consequent low permeability.



Analysis of many reservoirs, including tight gas sands, suggests relations exist between porosity and irreducible water saturations.

$$Phi^Q \times Swi = \text{Constant}$$

In literature, it is normally assumed that the exponent Q is equal to 1.0. Digital Formation's work, in a very extensive data base of all types of reservoirs, suggests that

Q often diverges from (and is usually larger than) unity. A log/log cross plot of porosity vs. water saturation can be interpreted to distinguish rocks at irreducible saturation from others where $S_w > S_{wi}$. The inequality may be due to one of two possibilities:

1. Poorer rock quality than the choice made by the interpreter
2. Presence of mobile water

Values of Q and the constant have been selected for each sand identified, accounting for these factors.

Automatic Sand Interval Identification

The procedure for identifying sands has been partially automated by looking and sand and non-sand interval thicknesses. Sands are identified as have a 70 API reading or less, and being at least 5 ft. thick, with the possibility of small non-sand streaks within them of no more than 2.5 ft. The 70 API cutoff had to be manually adjusted well-by-well to accurately model the data in a reasonable manner. Additionally a cutoff is used to eliminate any intervals that only barely meet these requirements based on the original GR cutoff. This automatic identification was then manually reviewed to:

- Remove intervals that still did not appear to be sufficient sand intervals
- Merge nearby intervals that appear to be part of the same sand body
- Extend or reduce intervals as appropriate

Salinity from SP Analysis

As developed previously on the Mamm Creek project, this process has also been automated. The average value of Ri/Rm is determined over the interval for input to the Schlumberger SP-5 chart (2009), which is used to correct the SP for the effects of invasion and bed thickness. For this calculation, R_i was assumed to be equal to the deep resistivity, and mud resistivity (R_m) was read from the log header and temperature corrected to depth. Using the sand thickness and this average Ri/Rm, a corrected SP is calculated.

The minimum value of this corrected SP over the interval is used as the SP Clean value. Since the intervals are defined as the sands, an expanded interval of +/- 5 ft. is used to determine the maximum SP value, which is used as the shale base line. Using these values and the R_{mf} from the log header, temperature corrected to depth, an R_{Weq} value is calculated using the Schlumberger transform:

$$R_{Weq} = 0.85 \times R_{mf} \times 10^{\frac{SP}{60.5+0.133\times Temp}}.$$

This R_{Weq} was then corrected using Schlumberger SP-2 (2009) to get R_W, and R_W was then converted to salinity using Schlumberger Gen-9.

A plot showing the Salinity vs Depth is provided for each well. This plot also includes the salinity from Archie analysis.

Anomalous Wells

Two wells are calculating consistently much higher salinities from the SP analysis than the other seven:

05045184250000 Williams GM 931-1D

05045222650000 C&C Energy GM 23-13

Investigation into the issue would suggest this is being driven by the mud filtrate resistivity (R_{mf}) and sample temperature. Uncertainty in the accuracy of the service company to properly record this information may be the root cause.

Comments on the Major Intervals

There are fairly consistent salinity increases from the SP analysis near the top of the Wasatch G and Mesaverde picks that could suggest there is saltier water associated with these intervals. Less consistent spikes are seen in the Fort Union, Wasatch, and Ohio Creek intervals.

The analysis of mobile water and/or poor quality rock shows some trends across the wells. The Wasatch G and Fort Union intervals generally shows sparse indications in this analysis which would generally be interpreted as being more likely a rock quality issue. The Wasatch interval would similarly be interpreted as having potential rock quality issues, although a couple of wells could be interpreted as having mobile water. The Ohio Creek is more likely to have mobile water, although a few wells could be interpreted as a rock quality issue. The Mesaverde and the interval just above the Wasatch G are similar to the Ohio Creek and fairly consistently show large indications from this analysis and would generally be interpreted as having mobile water, but again in a few wells this could be interpreted as rock quality issues.

Tabulations

05045066230000 Union GV 10-34

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
300	324	24	56.7	-68	1.027	0.087	0.103	103,456	315.871	21
1010	1028.5	18.5	72.0	-31	0.828	0.250	0.253	25,149	0.751	7,544
1467.5	1481.5	14	81.8	-2	0.736	0.585	0.850	5,846	0.784	6,365
1555.5	1566	10.5	83.7	-4	0.721	0.538	0.750	6,527	1.093	4,404
1570	1579	9	84.0	-2	0.719	0.569	0.823	5,895	1.087	4,412
1596.5	1629.5	33	84.8	-14	0.712	0.384	0.454	11,003	0.611	7,995
1727.5	1748.5	21	87.5	-21	0.692	0.305	0.336	14,810	0.845	5,514
1852.5	1860.5	8	90.1	-1	0.674	0.560	0.837	5,416	0.767	5,932
1896.5	1910	13.5	91.1	-4	0.667	0.495	0.687	6,587	1.190	3,719
1999.5	2005	5.5	93.2	-7	0.652	0.450	0.599	7,441	1.103	3,933
2121.5	2127.5	6	95.8	-7	0.636	0.437	0.581	7,471	0.666	6,472
2144.5	2149.5	5	96.3	-20	0.633	0.285	0.319	14,239	1.184	3,542
2337	2342	5	100.5	-3	0.608	0.476	0.684	6,010	0.701	5,858
2410	2418	8	102.1	-1	0.599	0.498	0.744	5,416	0.793	5,071
2647	2669	22	107.4	-5	0.572	0.416	0.574	6,773	0.677	5,691
2878	2896.5	18.5	112.3	-5	0.548	0.396	0.545	6,832	0.657	5,620
2930	2935	5	113.3	-1	0.543	0.444	0.658	5,563	0.606	6,060
2970	2985.5	15.5	114.3	-8	0.539	0.364	0.484	7,622	0.489	7,543
3011	3058	47	115.5	-6	0.534	0.378	0.517	7,032	0.560	6,465
3148.5	3169.5	21	118.2	-18	0.522	0.259	0.304	12,129	0.516	6,885
3224.5	3242.5	18	119.8	-18	0.515	0.255	0.299	12,191	0.593	5,869
3246.5	3295	48.5	120.6	-51	0.512	0.094	0.104	40,968	0.693	4,952
3309	3319.5	10.5	121.5	-8	0.508	0.338	0.447	7,786	0.917	3,680
3343.5	3393.5	50	122.7	-8	0.504	0.333	0.441	7,830	0.895	3,739
3397	3408	11	123.4	-7	0.501	0.342	0.461	7,429	1.006	3,295
3411.5	3420.5	9	123.7	-12	0.500	0.300	0.379	9,119	0.879	3,774
3430.5	3469.5	39	124.5	-14	0.497	0.275	0.336	10,322	0.658	5,069
3485	3512.5	27.5	125.5	-18	0.493	0.246	0.290	12,005	0.816	4,023
3520.5	3535.5	15	126.1	-15	0.491	0.269	0.328	10,444	0.869	3,748
3577	3584	7	127.3	-18	0.487	0.243	0.288	11,929	1.028	3,126
3628.5	3655.5	27	128.6	-19	0.482	0.235	0.277	12,333	1.213	2,612
3670	3698.5	28.5	129.5	-15	0.479	0.262	0.321	10,418	0.731	4,371

05045068420000 Unocal GR 31-2

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
310	319.5	9.5	56.2	-7	3.626	2.443	13.749	487	0.755	9,511
426	435	9	58.5	-17	3.499	1.672	5.478	1,186	1.535	4,343
492	503	11	59.8	-20	3.429	1.496	4.314	1,479	0.812	8,291
952	970.5	18.5	69.0	-13	3.014	1.656	6.152	908	0.988	5,882
1037.5	1047.5	10	70.6	-31	2.952	0.903	1.689	3,303	0.844	6,792
1235.5	1243.5	8	74.5	-8	2.810	1.842	8.619	602	0.405	14,223
1294	1312.5	18.5	75.8	-37	2.767	0.704	1.116	4,740	0.594	9,203
1384	1436	52	77.9	-55	2.698	0.387	0.443	12,316	0.581	9,177
1455	1482.5	27.5	79.0	-37	2.662	0.685	1.091	4,659	0.610	8,590
1523	1528.5	5.5	80.2	-21	2.627	1.145	3.023	1,620	0.466	11,314
1606.5	1624	17.5	81.9	-20	2.575	1.146	3.088	1,553	0.726	6,896
1846	1858	12	86.6	-5	2.446	1.761	9.084	497	0.751	6,303
1928.5	1935	6.5	88.2	-21	2.405	1.057	2.769	1,619	1.442	3,147
2207	2211.5	4.5	93.7	-20	2.274	1.039	2.826	1,498	1.226	3,509
2409	2415.5	6.5	97.7	-4	2.187	1.638	8.736	462	0.672	6,290
2432	2446.5	14.5	98.2	-5	2.176	1.595	8.219	489	0.616	6,864
2469	2473.5	4.5	98.8	-3	2.163	1.690	9.626	414	0.746	5,576
2568	2576	8	100.8	-6	2.123	1.515	7.453	526	0.599	6,883
2616.5	2624	7.5	101.8	-5	2.104	1.517	7.568	513	0.740	5,462
2842	2849	7	106.2	-4	2.021	1.533	8.226	453	0.487	8,132
2954	2976.5	22.5	108.6	-7	1.980	1.350	6.137	596	0.335	11,905
2986	2992	6	109.1	-5	1.972	1.443	7.301	498	0.354	11,175
3008.5	3021.5	13	109.6	-15	1.963	1.057	3.465	1,051	0.464	8,316
3043	3068.5	25.5	110.4	-8	1.949	1.316	5.882	612	0.356	10,973
3079.5	3088	8.5	110.9	-35	1.940	0.561	0.968	3,803	0.334	11,674
3297	3303.5	6.5	115.2	-8	1.872	1.230	5.271	657	0.405	9,144
3323	3333.5	10.5	115.8	-32	1.864	0.602	1.142	3,078	0.620	5,795
3385.5	3406	20.5	117.1	-25	1.844	0.743	1.740	1,981	0.397	9,171
3414.5	3455.5	41	117.9	-33	1.832	0.574	1.060	3,264	0.666	5,276
3563	3587.5	24.5	120.7	-35	1.792	0.526	0.923	3,679	0.631	5,454
3591.5	3660.5	69	121.7	-35	1.778	0.530	0.942	3,574	0.569	6,033
3669	3675.5	6.5	122.6	-10	1.766	1.096	4.329	755	1.007	3,314
3697	3726.5	29.5	123.4	-24	1.755	0.722	1.729	1,896	0.435	7,895
3799.5	3819	19.5	125.3	-17	1.729	0.896	2.792	1,150	0.788	4,178
3903	3915	12	127.3	-10	1.704	1.079	4.391	718	0.910	3,543

05045071900000 Federal GM 34-3

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
1258	1281.5	23.5	71.5	-50	1.766	0.289	0.297	20,975	0.798	7,115
1325	1340	15	72.6	-22	1.743	0.723	1.140	4,829	0.837	6,669
1479.5	1491	11.5	75.2	-4	1.688	1.257	3.508	1,479	0.623	8,826
1501	1516	15	75.5	-3	1.680	1.293	3.750	1,376	0.489	11,394
1564.5	1593	28.5	76.7	-31	1.656	0.506	0.651	8,245	0.481	11,413
1613	1638	25	77.5	-7	1.640	1.125	2.825	1,790	0.357	15,713
1666.5	1671	4.5	78.3	-18	1.626	0.782	1.379	3,692	0.636	8,296
1698.5	1706	7.5	78.8	-32	1.615	0.481	0.610	8,606	0.472	11,348
1820	1856.5	36.5	81.1	-54	1.573	0.237	0.245	22,999	0.722	6,997
1985.5	1999	13.5	83.7	-24	1.528	0.598	0.893	5,427	0.544	9,173
2002.5	2020.5	18	84.1	-15	1.522	0.793	1.489	3,188	0.621	7,925
2040.5	2056.5	16	84.7	-8	1.512	0.986	2.305	2,026	0.689	7,046
2145.5	2152.5	7	86.4	-10	1.484	0.920	2.035	2,257	0.808	5,847
2399	2405.5	6.5	90.7	-21	1.419	0.627	1.020	4,377	0.596	7,692
2739	2745.5	6.5	96.4	-1	1.340	1.090	3.229	1,273	0.352	12,750
2805.5	2814	8.5	97.6	-8	1.325	0.867	2.003	2,043	0.386	11,383
2831.5	2838.5	7	98.0	-4	1.320	1.002	2.729	1,487	0.457	9,436
2847	2859.5	12.5	98.3	-3	1.316	1.023	2.862	1,413	0.328	13,499
2890.5	2897	6.5	99.0	-2	1.307	1.056	3.094	1,297	0.451	9,478
2983.5	2991.5	8	100.6	-5	1.288	0.938	2.432	1,630	0.260	17,108
3012	3042.5	30.5	101.3	-52	1.280	0.213	0.228	19,675	0.234	19,066
3099	3109.5	10.5	102.6	-1	1.265	1.033	3.060	1,268	0.384	10,874
3166	3177	11	103.7	-7	1.252	0.868	2.128	1,813	0.307	13,739
3188.5	3204.5	16	104.1	-6	1.247	0.879	2.193	1,752	0.235	18,410
3409.5	3420	10.5	107.8	-11	1.207	0.725	1.533	2,439	0.362	11,043
3434	3449.5	15.5	108.3	-31	1.202	0.400	0.542	7,128	0.504	7,705
3464.5	3477.5	13	108.8	-17	1.197	0.598	1.072	3,490	0.528	7,291
3498	3536.5	38.5	109.6	-24	1.189	0.478	0.727	5,177	0.557	6,847
3553	3585	32	110.4	-9	1.180	0.769	1.759	2,072	0.342	11,433
3611	3623	12	111.2	-10	1.172	0.733	1.610	2,252	0.562	6,685
3648.5	3685.5	37	112.1	-20	1.163	0.539	0.909	4,017	0.459	8,219
3701.5	3710	8.5	112.8	-13	1.157	0.659	1.325	2,712	0.692	5,304
3715.5	3720.5	5	113.0	-4	1.155	0.856	2.251	1,578	0.431	8,715
3741	3750	9	113.4	-14	1.150	0.643	1.268	2,821	0.560	6,579
3763	3773.5	10.5	113.8	-6	1.147	0.822	2.080	1,698	0.408	9,179
3789	3794	5	114.2	-7	1.143	0.776	1.854	1,902	0.855	4,203
3808	3834.5	26.5	114.7	-26	1.138	0.445	0.667	5,411	0.360	10,417
3869	3898.5	29.5	115.8	-60	1.128	0.154	0.165	24,735	0.549	6,584
3978	3997.5	19.5	117.5	-25	1.112	0.438	0.659	5,353	0.615	5,759

05045074160000 PA 14-32

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
700	732	32	64.0	-90	3.296	0.138	0.142	58,368	0.361	18,904
846.5	857.5	11	66.6	-6	3.177	2.219	12.488	460	0.861	7,027
1000.5	1005.5	5	69.6	-9	3.055	1.949	9.289	595	0.371	16,808
1107	1126.5	19.5	71.8	-45	2.968	0.568	0.756	7,509	0.475	12,379
1180	1186	6	73.1	-3	2.920	2.251	14.324	368	0.339	17,704
1189.5	1199	9.5	73.3	-6	2.912	2.025	10.823	487	0.407	14,378
1224.5	1234	9.5	74.0	-10	2.888	1.787	7.936	659	0.435	13,216
1240	1247.5	7.5	74.3	-36	2.878	0.754	1.247	4,306	0.533	10,547
1299	1318	19	75.5	-10	2.834	1.726	7.421	692	0.264	22,745
1388	1403.5	15.5	77.2	-30	2.776	0.886	1.732	2,957	0.763	6,923
1421	1474	53	78.2	-47	2.743	0.515	0.675	7,782	0.704	7,446
1553	1563.5	10.5	80.4	-8	2.675	1.746	8.160	593	0.524	9,938
1581.5	1597.5	16	81.0	-13	2.657	1.504	5.693	846	0.558	9,222
1609.5	1619.5	10	81.5	-12	2.642	1.547	6.137	780	0.494	10,447
1754.5	1767	12.5	84.3	-12	2.559	1.504	5.933	782	0.524	9,466
1970	1977	7	88.5	-19	2.448	1.126	3.187	1,399	0.593	7,918
2333.5	2340.5	7	95.6	-2	2.278	1.817	11.152	369	0.526	8,324
2410.5	2420.5	10	97.1	-4	2.245	1.668	9.089	446	0.610	7,004
2488.5	2498	9.5	98.6	-5	2.212	1.584	8.116	493	0.374	11,651
2515.5	2528.5	13	99.2	-5	2.201	1.579	8.112	490	0.342	12,760
2610	2618	8	101.0	-2	2.164	1.739	10.696	365	0.423	9,950
2890.5	2898.5	8	106.5	-3	2.059	1.613	9.419	395	0.290	14,249
2914	2926	12	107.0	-44	2.050	0.453	0.656	5,906	0.438	9,061
2940	2961	21	107.5	-19	2.040	0.968	2.786	1,333	0.520	7,500
2991	3013.5	22.5	108.6	-48	2.022	0.389	0.521	7,419	0.366	10,836
3076	3090.5	14.5	110.1	-7	1.995	1.381	6.616	545	0.379	10,267
3176	3193.5	17.5	112.1	-25	1.961	0.770	1.793	2,003	0.491	7,640
3265.5	3279	13.5	113.8	-51	1.934	0.343	0.443	8,408	0.393	9,549
3282.5	3292.5	10	114.1	-18	1.929	0.957	2.898	1,211	0.487	7,571
3343.5	3375	31.5	115.5	-69	1.907	0.198	0.216	18,183	0.368	10,094
3405.5	3424	18.5	116.6	-75	1.890	0.168	0.180	22,083	0.720	4,922
3427.5	3459.5	32	117.2	-44	1.881	0.417	0.608	5,844	0.696	5,071
3540.5	3584	43.5	119.5	-26	1.847	0.707	1.604	2,111	0.510	6,888
3616	3653	37	120.9	-33	1.827	0.569	1.066	3,168	0.640	5,370
3675.5	3694.5	19	121.9	-28	1.813	0.670	1.469	2,264	0.555	6,185
3702	3719.5	17.5	122.4	-21	1.806	0.805	2.155	1,528	0.732	4,611
3734	3745	11	122.9	-18	1.798	0.883	2.646	1,236	0.484	7,076
3806.5	3828	21.5	124.5	-14	1.777	1.004	3.594	897	0.257	13,833
3844	3897.5	53.5	125.5	-35	1.763	0.527	0.956	3,417	0.345	9,936

05045089740000 Brouch GM 314-12

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
626	631	5	62.1	-80	3.646	0.214	0.209	37,141		
763	773.5	10.5	64.8	-22	3.509	1.445	4.235	1,402		
903.5	915.5	12	67.5	-37	3.381	0.844	1.446	4,043		
1024	1040	16	69.8	-30	3.277	1.026	2.155	2,599	0.706	8,294
1052.5	1065	12.5	70.4	-10	3.255	1.981	9.803	558	0.603	9,742
1098.5	1131.5	33	71.4	-55	3.210	0.449	0.528	11,084	0.523	11,207
1136	1141.5	5.5	71.9	-30	3.192	1.013	2.145	2,541	0.660	8,662
1146	1150.5	4.5	72.1	-29	3.184	1.032	2.233	2,433	0.445	13,255
1498.5	1508	9.5	78.9	-45	2.930	0.576	0.812	6,354		
1833	1845	12	85.4	-33	2.725	0.801	1.535	3,045		
1863	1868.5	5.5	85.9	-17	2.710	1.350	4.680	976		
2011.5	2016	4.5	88.7	-3	2.629	2.046	13.946	316		
2197.5	2202	4.5	92.3	-4	2.534	1.875	11.591	367		
2505	2517	12	98.3	-6	2.390	1.703	9.745	412		
2609.5	2627.5	18	100.4	-49	2.344	0.437	0.597	6,937		
2662.5	2667	4.5	101.2	-22	2.324	0.992	2.761	1,425		
2674	2685	11	101.5	-6	2.318	1.628	9.051	430		
2721	2750.5	29.5	102.6	-35	2.295	0.665	1.244	3,167		
2854.5	2866.5	12	105.0	-17	2.246	1.113	3.716	1,019	0.380	10,741
2946	2954.5	8.5	106.7	-18	2.212	1.089	3.602	1,036	0.386	10,388
2960.5	2993.5	33	107.3	-35	2.202	0.644	1.213	3,116	0.924	4,124
3003	3009.5	6.5	107.8	-24	2.191	0.891	2.334	1,591	1.211	3,105
3066.5	3072	5.5	109.0	-17	2.168	1.096	3.744	976	0.757	4,991
3082	3112.5	30.5	109.6	-24	2.158	0.889	2.366	1,545	0.517	7,409
3132	3163	31	110.5	-20	2.141	0.973	2.906	1,245	0.780	4,774
3169	3194.5	25.5	111.2	-24	2.129	0.871	2.299	1,569	0.748	4,956
3209.5	3217.5	8	111.8	-34	2.118	0.640	1.244	2,916	0.943	3,876
3242.5	3264	21.5	112.6	-20	2.104	0.967	2.920	1,217	0.657	5,607
3331	3348	17	114.2	-27	2.075	0.783	1.891	1,864	0.883	4,066
3366.5	3377.5	11	114.8	-28	2.065	0.749	1.733	2,026	0.709	5,078
3412.5	3432	19.5	115.8	-33	2.048	0.637	1.271	2,758	0.892	3,965

05045126040000 Enyeart 16-4 (PD16)

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
289	424	135	57.0	-57	0.893	0.110	0.120	83,825	0.006	75,917
427.5	695	267.5	61.1	-25	0.840	0.306	0.306	23,976	0.008	97,020
699	816	117	64.9	-63	0.794	0.083	0.099	92,577	0.005	68,293
905	910.5	5.5	67.9	-7	0.763	0.507	0.618	9,829	0.457	13,665
925	940	15	68.4	-7	0.758	0.519	0.641	9,377	0.461	13,431
954.5	966	11.5	68.9	-5	0.752	0.536	0.678	8,771	0.353	17,943
1243.5	1254.5	11	74.6	-22	0.700	0.291	0.304	19,596	0.587	9,466
1270.5	1287.5	17	75.2	-21	0.695	0.296	0.310	18,973	0.508	10,974
1406	1420.5	14.5	77.9	-17	0.673	0.334	0.364	15,272	0.508	10,599
1424	1430.5	6.5	78.1	-21	0.671	0.291	0.307	18,439	0.477	11,316
1603.5	1612	8.5	81.7	-3	0.644	0.497	0.654	7,723	0.395	13,297
1631	1649	18	82.3	-6	0.639	0.446	0.555	9,117	0.365	14,406
1739	1753.5	14.5	84.4	-4	0.625	0.473	0.615	7,975	0.359	14,278
1917	1951.5	34.5	88.1	-21	0.600	0.265	0.283	17,809	0.514	9,267
2228	2234	6	94.0	-8	0.565	0.369	0.448	10,055	0.533	8,359
2612	2619	7	101.6	-4	0.526	0.399	0.523	7,895	0.462	9,012
2652.5	2658	5.5	102.4	-4	0.522	0.393	0.512	8,007	0.561	7,274
2664	2670.5	6.5	102.6	-3	0.521	0.401	0.528	7,728	0.385	10,858
3075	3097	22	110.8	-4	0.484	0.368	0.485	7,839	0.382	10,121
3169	3184.5	15.5	112.6	-4	0.477	0.357	0.467	8,017	0.348	11,006
3313.5	3323.5	10	115.4	-2	0.466	0.368	0.495	7,368	0.365	10,197
3405.5	3413.5	8	117.2	-3	0.459	0.351	0.465	7,741	0.270	13,937
3425	3449	24	117.8	-38	0.457	0.122	0.131	31,945	0.327	11,256
3466.5	3472.5	6	118.4	-24	0.455	0.187	0.203	18,932	0.439	8,148
3478	3489.5	11.5	118.7	-14	0.454	0.251	0.293	12,598	0.367	9,853
3568	3582.5	14.5	120.5	-3	0.448	0.346	0.462	7,580	0.241	15,364
3637	3648.5	11.5	121.8	-5	0.443	0.324	0.420	8,297	0.280	12,853
3699.5	3706.5	7	123.0	-8	0.439	0.294	0.368	9,466	0.289	12,294
3710	3719	9	123.2	-7	0.438	0.301	0.381	9,100	0.463	7,393
3807.5	3812	4.5	125.1	-10	0.432	0.272	0.332	10,394	0.175	21,121
3825	3832	7	125.5	-33	0.431	0.136	0.146	26,100	0.576	5,772
3846.5	3855	8.5	125.9	-55	0.429	0.070	0.082	52,356	1.526	2,110
3881.5	3925.5	44	127.0	-41	0.426	0.108	0.118	33,272	0.692	4,712
3969	4003	34	128.6	-16	0.421	0.225	0.260	13,168	0.174	20,721
4015.5	4037.5	22	129.4	-30	0.418	0.144	0.156	23,318	0.167	21,531
4065	4095.5	30.5	130.5	-23	0.415	0.179	0.198	17,554	0.415	7,843
4124	4154.5	30.5	131.6	-22	0.412	0.185	0.206	16,674	0.355	9,188
4174	4179.5	5.5	132.4	-18	0.409	0.205	0.234	14,357	0.461	6,920
4208.5	4234	25.5	133.2	-32	0.407	0.134	0.145	24,610	0.353	9,137
4307	4329	22	135.1	-28	0.401	0.152	0.166	20,677	0.515	6,034

4352.5	4360	7.5	135.9	-35	0.399	0.121	0.131	27,171	0.216	15,287
4381.5	4387	5.5	136.4	-26	0.398	0.156	0.171	19,773	0.540	5,685
4407.5	4420.5	13	137.0	-30	0.396	0.141	0.153	22,400	0.230	14,121
4463.5	4478.5	15	138.2	-10	0.393	0.249	0.307	10,220	0.253	12,610
4482	4502.5	20.5	138.6	-24	0.392	0.167	0.186	17,686	0.325	9,574
4506	4551.5	45.5	139.3	-19	0.390	0.191	0.218	14,707	0.397	7,703
4586.5	4592.5	6	140.5	-14	0.387	0.217	0.258	12,141	0.392	7,746
4780.5	4796.5	16	144.4	-17	0.377	0.198	0.231	13,333	0.294	10,241
4832	4843.5	11.5	145.4	-23	0.374	0.163	0.182	17,205	0.226	13,531
4883	4936	53	146.8	-29	0.371	0.138	0.151	21,074	0.342	8,551
4956.5	4989	32.5	148.1	-32	0.368	0.127	0.138	23,139	0.247	12,072
5056.5	5112.5	56	150.3	-30	0.363	0.130	0.142	22,054	0.117	27,668
5122	5141.5	19.5	151.2	-24	0.361	0.156	0.175	17,306	0.204	14,576
5145.5	5158	12.5	151.6	-13	0.360	0.211	0.255	11,341	0.238	12,262
5209	5238	29	153.0	-21	0.357	0.167	0.190	15,571	0.196	15,005
5248	5308.5	60.5	154.1	-21	0.354	0.168	0.192	15,291	0.242	11,814
5354.5	5388	33.5	155.9	-25	0.350	0.144	0.161	18,336	0.287	9,716
5407	5412.5	5.5	156.7	-15	0.349	0.193	0.230	12,258	0.271	10,261
5454.5	5467.5	13	157.7	-13	0.346	0.202	0.244	11,413	0.442	6,062
5476	5490	14	158.1	-14	0.345	0.197	0.238	11,729	0.298	9,195
5497.5	5533.5	36	158.8	-14	0.344	0.196	0.235	11,820	0.283	9,661
5587.5	5605.5	18	160.4	-12	0.341	0.207	0.256	10,686	0.152	18,968
5640.5	5649	8.5	161.3	-14	0.339	0.193	0.232	11,801	0.230	11,906
5777	5783	6	164.0	-12	0.334	0.205	0.253	10,532	0.293	9,028
5839.5	5864	24.5	165.4	-20	0.331	0.160	0.184	14,798	0.297	8,813
5901	5905.5	4.5	166.4	-10	0.329	0.213	0.270	9,703	0.257	10,205
6009	6037.5	28.5	168.8	-33	0.324	0.110	0.120	23,487	0.185	14,416
6042	6048	6	169.2	-32	0.324	0.113	0.124	22,680	0.258	9,992
6054.5	6062.5	8	169.5	-28	0.323	0.125	0.138	19,897	0.215	12,179
6130.5	6135.5	5	170.9	-10	0.321	0.208	0.264	9,640	0.062	52,171
6152.5	6159.5	7	171.4	-13	0.320	0.191	0.234	10,945	0.188	13,901
6242	6250.5	8.5	173.2	-19	0.317	0.159	0.186	13,944	0.205	12,525
6296	6305.5	9.5	174.2	-12	0.315	0.190	0.235	10,712	0.108	25,675
6334	6349	15	175.0	-16	0.313	0.174	0.209	12,158	0.167	15,509
6499.5	6532	32.5	178.5	-30	0.307	0.114	0.126	20,847	0.076	38,153
6540	6547.5	7.5	179.0	-28	0.307	0.121	0.135	19,277	0.363	6,559
6570	6589	19	179.7	-42	0.305	0.083	0.091	30,307	0.260	9,307
6674	6692.5	18.5	181.8	-25	0.302	0.130	0.147	17,260	0.202	12,081
6765	6807.5	42.5	183.8	-42	0.299	0.082	0.089	30,297	0.184	13,232
6812	6823.5	11.5	184.4	-67	0.298	0.042	0.051	60,689	2.904	761
6827	6838.5	11.5	184.7	-42	0.297	0.080	0.088	30,690	0.284	8,254
6863	6979	116	186.5	-20	0.295	0.146	0.170	14,203	0.120	20,976
7204.5	7211	6.5	192.1	-15	0.286	0.163	0.198	11,692	0.142	16,853

7232	7273.5	41.5	193.0	-25	0.285	0.123	0.140	17,088	0.189	12,190
7316.5	7337.5	21	194.5	-2	0.283	0.226	0.320	6,883	0.203	11,227
7364	7368.5	4.5	195.2	-4	0.282	0.218	0.303	7,276	0.141	16,711
7491	7496.5	5.5	197.8	-14	0.278	0.164	0.202	11,084	6.129	336
7501	7553	52	198.4	-51	0.278	0.061	0.068	38,516	0.172	13,149

05045184250000 Williams GM 931-1D

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
8	81	73	50.9		0.466					
87.5	227.5	140	53.2		0.449					
243.5	289.5	46	55.4		0.433					
295	329	34	56.3		0.427					
334.5	364.5	30	57.0		0.421					
373	415	42	57.9		0.416					
418.5	450.5	32	58.7		0.410					
483.5	513	29.5	60.0		0.403					
519	573.5	54.5	61.0		0.397					
577	600	23	61.8	-51	0.392	0.061	0.083	124,669		
621	668.5	47.5	63.0	-53	0.386	0.056	0.079	130,206	0.591	11,116
808.5	822	13.5	66.4	-18	0.368	0.170	0.170	44,545	0.601	10,357
1128.5	1135	6.5	72.8	-14	0.338	0.182	0.182	36,809	0.672	8,394
1143.5	1159.5	16	73.1	-22	0.336	0.140	0.145	48,673	0.545	10,464
1166.5	1181	14.5	73.6	-24	0.335	0.128	0.135	53,099	0.356	16,605
1184.5	1196.5	12	73.9	-8	0.333	0.221	0.222	28,529	0.446	12,861
1371.5	1406.5	35	77.9	-23	0.317	0.127	0.134	50,046	0.496	10,888
1454	1465.5	11.5	79.3	-36	0.312	0.082	0.096	75,086	0.629	8,272
1471	1496.5	25.5	79.8	-14	0.311	0.168	0.171	35,737	0.554	9,421
1508	1528	20	80.5	-24	0.308	0.120	0.128	51,157	0.511	10,203
1581	1587.5	6.5	81.8	-7	0.303	0.204	0.208	27,584	0.436	11,912
1675.5	1687.5	12	83.8	-43	0.297	0.063	0.082	87,569	0.707	6,934
1695.5	1716.5	21	84.3	-43	0.295	0.063	0.081	87,582	0.638	7,690
1951	1958	7	89.3	-18	0.280	0.133	0.140	40,502	0.962	4,724
2261	2266	5	95.5	-44	0.263	0.057	0.075	83,969	0.983	4,325
2484.5	2495.5	11	100.1	-7	0.252	0.171	0.179	26,293	0.564	7,392
2620	2636	16	102.8	-7	0.245	0.168	0.176	26,014	0.498	8,207
2787.5	2797	9.5	106.1	-13	0.238	0.134	0.142	32,477	0.394	10,226
2808.5	2813.5	5	106.5	-21	0.237	0.107	0.116	41,522	0.495	7,982
2962.5	2978	15.5	109.7	-9	0.231	0.148	0.157	27,821	0.442	8,729
3058	3072.5	14.5	111.6	-8	0.227	0.153	0.163	26,144	0.387	9,915
3141	3151	10	113.2	-37	0.224	0.063	0.077	64,993	0.784	4,632
3184.5	3194	9.5	114.1	-14	0.222	0.122	0.131	33,000	0.417	8,933
3207.5	3216	8.5	114.6	-15	0.222	0.119	0.127	34,012	0.574	6,347

3233.5	3249.5	16	115.2	-55	0.221	0.035	0.055	100,876	0.278	13,763
3620.5	3632	11.5	122.9	-47	0.207	0.044	0.060	81,418	0.738	4,554
3636	3655.5	19.5	123.3	-34	0.207	0.064	0.077	58,709	0.531	6,408
3746.5	3787	40.5	125.7	-19	0.203	0.099	0.108	37,181	0.503	6,648
3802	3817	15	126.6	-23	0.202	0.086	0.097	42,496	0.559	5,905
3852.5	3882.5	30	127.8	-16	0.200	0.106	0.115	33,807	0.500	6,588
3889.5	3931.5	42	128.6	-21	0.199	0.091	0.101	39,513	0.526	6,204
4031	4072.5	41.5	131.5	-21	0.195	0.089	0.098	39,798	0.377	8,618
4117.5	4136.5	19	133.0	-33	0.192	0.061	0.074	56,494	0.806	3,848
4318.5	4324	5.5	136.9	-22	0.187	0.083	0.093	40,925	0.812	3,713
4335	4346	11	137.3	-24	0.187	0.078	0.088	43,196	0.550	5,545
4365	4390	25	138.0	-30	0.186	0.066	0.078	50,565	0.441	6,961
4548	4591.5	43.5	141.9	-21	0.181	0.084	0.094	38,656	0.431	6,933
4670	4696	26	144.1	-30	0.178	0.063	0.074	50,943	0.407	7,236
4732.5	4753	20.5	145.3	-19	0.177	0.087	0.096	36,330	0.457	6,352
4762	4784	22	146.0	-34	0.176	0.056	0.068	56,319	0.493	5,851

05045222650000 C&C Energy GM 23-13

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
17	73	56	50.8		0.387					
100.5	126.5	26	52.0		0.379					
146.5	199.5	53	53.1		0.372					
204	220.5	16.5	53.8		0.368					
224.5	237.5	13	54.1		0.366					
244	253.5	9.5	54.5		0.364					
259	277.5	18.5	54.8		0.362					
307.5	352	44.5	55.9		0.356					
365.5	386	20.5	56.7		0.351					
435.5	445.5	10	57.9		0.345					
454.5	485	30.5	58.4		0.342					
525	531.5	6.5	59.5		0.337					
618	661.5	43.5	61.5		0.327					
724	746.5	22.5	63.2		0.319					
756	846.5	90.5	64.4		0.314					
857	878.5	21.5	65.6		0.308					
917	994.5	77.5	67.1		0.302					
1031	1046	15	68.6		0.296					
1050	1139	89	69.6		0.292					
1156	1189.5	33.5	71.0		0.287					
1193	1206	13	71.5		0.285					
1210	1231.5	21.5	71.9		0.284					
1236	1247.5	11.5	72.3		0.282					

1404	1408.5	4.5	75.2	-55	0.272	0.039	0.064	139,261	1.314	4,030
1461	1467	6	76.2	-43	0.269	0.057	0.078	105,076	0.628	8,623
1642.5	1648.5	6	79.5	-38	0.259	0.065	0.084	90,631	1.124	4,493
2078.5	2084.5	6	87.3	-13	0.237	0.134	0.140	41,386	0.623	7,612
2230	2237	7	90.0	-9	0.230	0.146	0.152	36,091	0.598	7,716
2485.5	2494	8.5	94.6	-7	0.220	0.151	0.157	32,719	0.495	8,985
2619	2625	6	97.0	-5	0.215	0.156	0.163	30,499	0.422	10,391
2681	2699.5	18.5	98.2	-9	0.212	0.134	0.142	35,622	0.340	12,997
2796.5	2829.5	33	100.4	-21	0.208	0.091	0.103	51,897	0.420	10,097
2955.5	2962.5	7	103.0	-4	0.203	0.152	0.160	29,188	0.348	12,064
2993	2998.5	5.5	103.7	-12	0.202	0.118	0.126	38,562	0.343	12,155
3029	3040	11	104.4	-6	0.201	0.140	0.148	31,632	0.356	11,604
3074.5	3083.5	9	105.2	-10	0.199	0.124	0.132	35,810	0.277	15,167
3284	3289	5	108.9	-16	0.193	0.101	0.111	42,735	0.632	6,032
3301.5	3316.5	15	109.3	-21	0.192	0.085	0.096	50,788	0.454	8,523
3343	3351	8	110.0	-21	0.191	0.086	0.097	49,998	0.720	5,215
3355	3397	42	110.5	-31	0.190	0.063	0.078	65,857	0.432	8,896
3456	3487.5	31.5	112.2	-24	0.187	0.075	0.088	55,278	0.449	8,401
3493	3509	16	112.7	-11	0.187	0.115	0.124	35,893	0.408	9,256
3529.5	3552.5	23	113.5	-23	0.185	0.078	0.090	52,920	0.517	7,154
3611	3621	10	114.8	-13	0.183	0.104	0.113	39,078	0.615	5,889
3637	3650.5	13.5	115.3	-30	0.183	0.063	0.077	63,193	0.421	8,759
3675	3680.5	5.5	115.9	-23	0.182	0.076	0.089	52,773	0.454	8,040
3690.5	3697.5	7	116.2	-41	0.181	0.044	0.062	84,485	0.641	5,569
3747	3773	26	117.4	-19	0.180	0.087	0.098	45,954	0.210	18,484
3830	3860	30	118.9	-30	0.177	0.061	0.075	62,979	0.567	6,191
3887.5	3896	8.5	119.7	-29	0.176	0.062	0.076	62,231	1.181	2,879
3986	4011	25	121.7	-14	0.174	0.098	0.108	38,851	0.368	9,589
4061.5	4071	9.5	122.9	-21	0.172	0.078	0.090	48,494	0.358	9,776
4170	4183	13	124.8	-16	0.169	0.089	0.099	41,933	0.626	5,326
4276	4309.5	33.5	126.9	-21	0.167	0.076	0.088	47,933	0.663	4,928
4410	4419	9	129.1	-18	0.164	0.082	0.093	43,794	0.621	5,192
4437.5	4450	12.5	129.6	-14	0.163	0.092	0.102	38,677	0.320	10,436
4510.5	4526	15.5	131.0	-19	0.162	0.079	0.090	44,746	0.230	14,790
4571.5	4580	8.5	132.0	-13	0.161	0.093	0.103	37,390	0.329	9,944
4652	4707	55	133.9	-20	0.159	0.075	0.086	45,907	0.115	32,260
4738	4780.5	42.5	135.3	-21	0.157	0.072	0.083	47,741	0.418	7,502
4871.5	4897.5	26	137.5	-21	0.155	0.070	0.081	48,012	0.478	6,408
4914	4928.5	14.5	138.2	-28	0.154	0.058	0.070	57,436	0.399	7,723
5019	5042.5	23.5	140.2	-15	0.152	0.084	0.094	39,270	0.343	8,928
5091.5	5098	6.5	141.3	-21	0.151	0.070	0.081	46,893	0.613	4,814
5186.5	5202	15.5	143.1	-15	0.149	0.081	0.091	39,598	0.216	14,501
5226.5	5233	6.5	143.7	-21	0.148	0.068	0.078	47,609	0.424	6,957

5444	5459	15	147.7	-15	0.144	0.080	0.089	39,165	0.464	6,159
5479	5493	14	148.3	-11	0.144	0.088	0.097	35,130	0.272	10,840
5547	5566	19	149.6	-18	0.143	0.072	0.082	42,952	0.439	6,436
5725	5732.5	7.5	152.7	-14	0.140	0.081	0.090	37,346	0.250	11,529
5869.5	5878.5	9	155.3	-25	0.138	0.058	0.069	51,151	0.246	11,517
5885	5894	9	155.5	-18	0.137	0.071	0.080	42,152	0.453	5,990
5977	5991	14	157.2	-32	0.136	0.046	0.058	62,418	0.394	6,869
6019.5	6037	17.5	158.0	-16	0.135	0.074	0.083	39,538	0.347	7,805
6040.5	6047	6.5	158.3	-8	0.135	0.091	0.100	31,454	9.804	260
6165.5	6179.5	14	160.6	-30	0.133	0.048	0.060	58,960	0.364	7,307
6189.5	6194.5	5	161.0	-16	0.133	0.073	0.082	39,307	0.166	17,071
6219	6229	10	161.5	-10	0.132	0.084	0.093	33,701	0.510	5,099
6259	6271.5	12.5	162.3	-15	0.132	0.073	0.082	39,026	21.965	113
6309	6322	13	163.2	-13	0.131	0.077	0.086	36,475	0.552	4,653
6334.5	6381	46.5	163.9	-11	0.131	0.082	0.091	33,885	0.217	12,444
6384.5	6393.5	9	164.5	-6	0.130	0.094	0.103	28,964	0.191	14,319

05045224090000 Hicks PA 44-6

Top F	Bottom F	Thickness F	Temp DEGF	SP mv	Rmf ohmm	Rweq ohmm	Rw ohmm	TDS ppm	Archie Rw ohmm	Archie TDS ppm
69	180.5	111.5	51.3		1.958					
191.5	202.5	11	52.1		1.933					
219	330	111	52.9		1.906					
334	482	148	54.3		1.862					
487.5	541	53.5	55.4		1.829					
548	603	55	56.1		1.810					
606.5	675.5	69	56.8		1.790					
728	776	48	57.9		1.758					
817	848.5	31.5	58.8		1.735					
903	915	12	59.6		1.714					
928.5	950	21.5	59.9	-7	1.706	1.134	2.379	2,707		
965.5	999.5	34	60.4	-11	1.694	0.979	1.786	3,607		
1167	1175.5	8.5	62.4	-22	1.645	0.678	0.942	6,807	0.527	12,711
1223	1232	9	63.0	-39	1.631	0.377	0.399	17,159	0.433	15,622
1241	1247.5	6.5	63.1	-26	1.627	0.588	0.752	8,544	0.558	11,788
1273.5	1288	14.5	63.5	-22	1.618	0.668	0.928	6,800	0.447	14,961
1384.5	1393	8.5	64.7	-27	1.592	0.543	0.672	9,424	0.606	10,533
1468	1500.5	32.5	65.7	-40	1.570	0.356	0.374	17,644	0.592	10,647
1588	1596.5	8.5	66.8	-26	1.546	0.549	0.692	8,839	0.600	10,306
2323	2330	7	74.6	-37	1.398	0.352	0.385	15,036	0.594	9,354
2427	2433	6	75.6	-25	1.380	0.520	0.674	8,056	0.560	9,835
2670	2686	16	78.3	-24	1.337	0.523	0.693	7,570	0.472	11,437
2697	2707.5	10.5	78.5	-22	1.333	0.548	0.747	6,974	0.473	11,371

2813.5	2828	14.5	79.8	-19	1.314	0.600	0.875	5,816	0.522	10,060
2853	2869	16	80.2	-21	1.308	0.570	0.804	6,318	0.496	10,564
2938.5	2947.5	9	81.1	-5	1.295	0.945	2.040	2,390	0.390	13,608
3083.5	3088	4.5	82.6	-29	1.273	0.418	0.507	10,029	0.396	13,110
3097	3114	17	82.8	-82	1.270	0.076	0.092	75,913	0.376	13,855
3308	3318	10	85.0	-37	1.240	0.318	0.353	14,485	0.359	14,213
3506	3514	8	87.0	-34	1.212	0.349	0.401	12,265	0.810	5,794
3518	3543	25	87.3	-62	1.209	0.142	0.148	38,720	0.292	17,410
3599	3603.5	4.5	88.0	-40	1.200	0.287	0.313	15,973	0.577	8,193
3653.5	3699	45.5	88.8	-47	1.190	0.228	0.238	21,501	0.585	7,998
3740.5	3763.5	23	89.6	-37	1.180	0.305	0.340	14,267	0.325	15,019
3896	3941	45	91.4	-37	1.159	0.303	0.339	14,045	0.518	8,854
4023	4033.5	10.5	92.5	-35	1.145	0.320	0.366	12,729	0.459	9,963
4074.5	4084	9.5	93.1	-27	1.139	0.416	0.532	8,459	0.528	8,524
4110.5	4122.5	12	93.4	-27	1.135	0.406	0.513	8,751	0.361	12,797
4128.5	4140	11.5	93.6	-35	1.133	0.316	0.361	12,781	0.579	7,681
4177.5	4186.5	9	94.1	-58	1.127	0.153	0.160	32,318	0.413	10,983
4325.5	4353	27.5	95.8	-35	1.109	0.310	0.355	12,703	0.445	9,937
4416.5	4450	33.5	96.8	-39	1.098	0.272	0.301	15,089	0.421	10,452
4465.5	4493	27.5	97.3	-33	1.093	0.329	0.388	11,353	0.374	11,832
4579.5	4599	19.5	98.4	-39	1.081	0.271	0.302	14,766	0.348	12,653
4604.5	4609.5	5	98.6	-20	1.079	0.486	0.699	5,980	0.332	13,301
4633.5	4638.5	5	98.9	-35	1.076	0.307	0.356	12,269	0.277	16,211
4643.5	4684	40.5	99.2	-74	1.073	0.092	0.103	52,439	0.215	21,494
4688.5	4701.5	13	99.6	-64	1.070	0.125	0.133	37,965	0.565	7,411
4740	4759	19	100.1	-30	1.064	0.360	0.445	9,501	0.332	13,056
4785	4801	16	100.6	-41	1.059	0.252	0.277	15,893	0.399	10,661
4816	4842	26	101.0	-47	1.056	0.209	0.223	20,219	0.284	15,417
4931	4962	31	102.2	-44	1.044	0.228	0.247	17,753	0.448	9,243
4976.5	4989	12.5	102.6	-31	1.040	0.336	0.407	10,205	0.390	10,710
5018	5046	28	103.1	-40	1.035	0.257	0.286	14,932	0.333	12,629
5052.5	5091.5	39	103.5	-32	1.031	0.325	0.392	10,542	0.281	15,194
5107.5	5126.5	19	104.0	-25	1.027	0.400	0.532	7,575	0.325	12,872
5167	5180	13	104.6	-45	1.021	0.216	0.233	18,493	0.322	12,930
5194	5208.5	14.5	104.9	-40	1.018	0.252	0.281	14,995	0.275	15,316
5215.5	5232	16.5	105.1	-41	1.016	0.246	0.273	15,408	0.238	18,009
5265.5	5277	11.5	105.6	-33	1.012	0.311	0.371	10,950	0.279	14,980
5281	5293	12	105.8	-40	1.010	0.246	0.274	15,255	0.347	11,769
5301	5314.5	13.5	106.0	-19	1.008	0.479	0.715	5,444	0.314	13,126
5407.5	5414	6.5	107.1	-27	0.999	0.368	0.475	8,284	0.350	11,517
5434	5452.5	18.5	107.5	-28	0.996	0.352	0.447	8,822	0.335	12,055
5468	5478.5	10.5	107.8	-60	0.993	0.134	0.142	31,880	0.564	6,867
5527.5	5536.5	9	108.4	-42	0.988	0.234	0.259	15,830	0.274	14,914

5586.5	5598	11.5	109.0	-23	0.982	0.408	0.561	6,830	0.409	9,561
5710.5	5734.5	24	110.4	-70	0.971	0.096	0.106	44,516	0.161	26,763
5918.5	5928	9.5	112.5	-153	0.953	0.008	0.027	240,433	0.359	10,651
6178	6182.5	4.5	115.2	-83	0.932	0.064	0.078	62,671	5.904	586
6211	6216	5	115.6	-145	0.930	0.010	0.030	213,203	7.865	438
6221	6248	27	115.8	-65	0.928	0.110	0.119	36,526	0.400	9,215
6289.5	6294	4.5	116.4	-140	0.923	0.011	0.032	197,772	0.160	25,449
6337.5	6352.5	15	117.0	-71	0.919	0.090	0.100	44,618	8.611	395
6389.5	6402	12.5	117.5	-39	0.915	0.240	0.275	13,627	0.206	18,866
6471.5	6490	18.5	118.4	-116	0.909	0.023	0.044	131,007	0.327	11,193
6497.5	6624	126.5	119.2	-144	0.903	0.010	0.030	209,155	0.161	24,622

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File: 05045066230000 Union GV 10-34.lbs | Well Name: GV 10-34

Plot: Salinity by Depth

Gross Interval: 300 to 3720 by 0.5 F

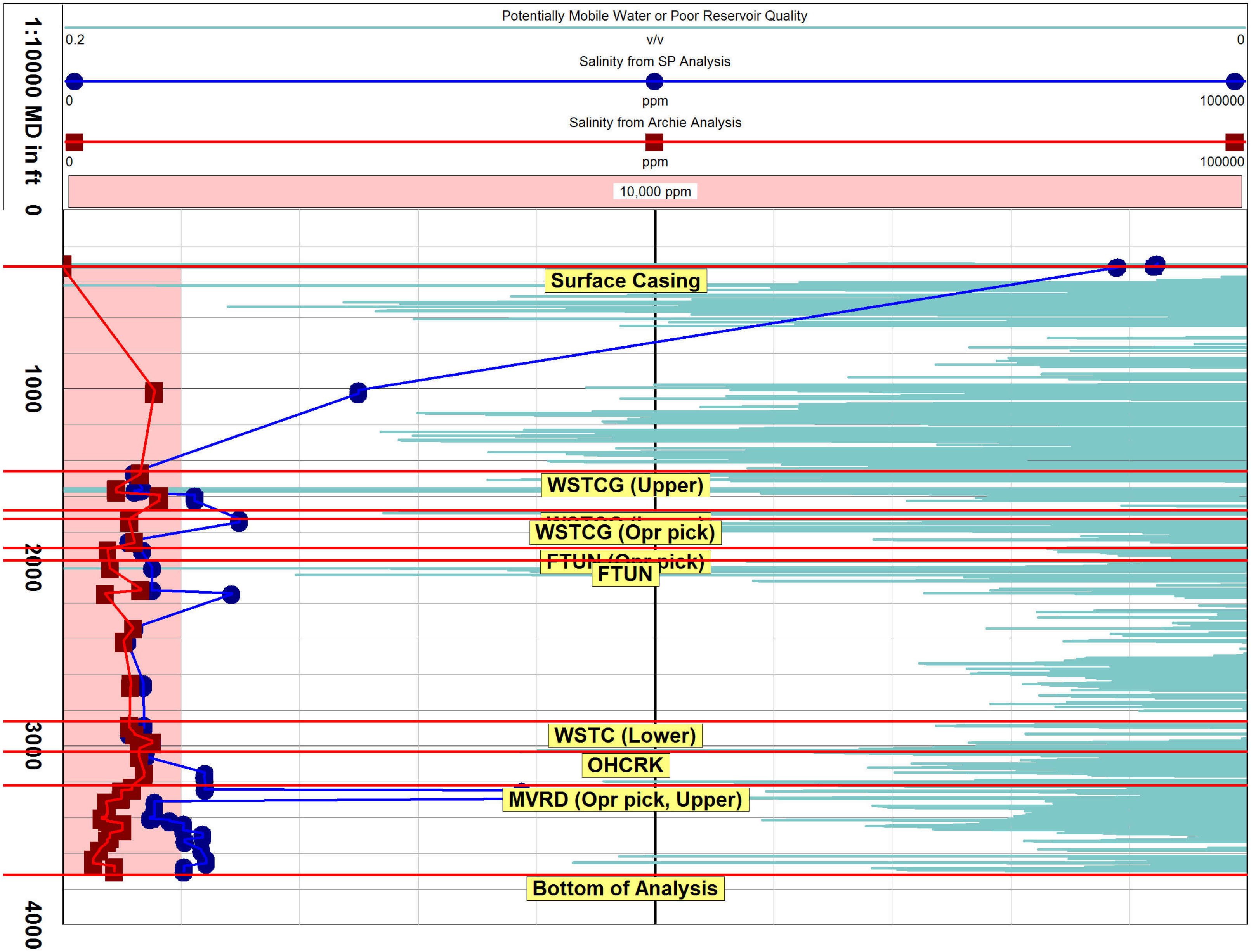
Ranges: User Ranges
300-3720

Time: 08:56 AM | Date: Thu, Jun 16, 2016

Section: SECTION | Township: TOWNSHIP | API #: 05045066230000

Location: LOCATION | Range: RANGE | UWI: 05045066230000

Comments:



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File: 05045066230000 Union GV 10-34.lbs   Well Name: GV 10-34

Plot: SP Shift Deflection

Gross Interval: 300 to 3720 by 0.5 F

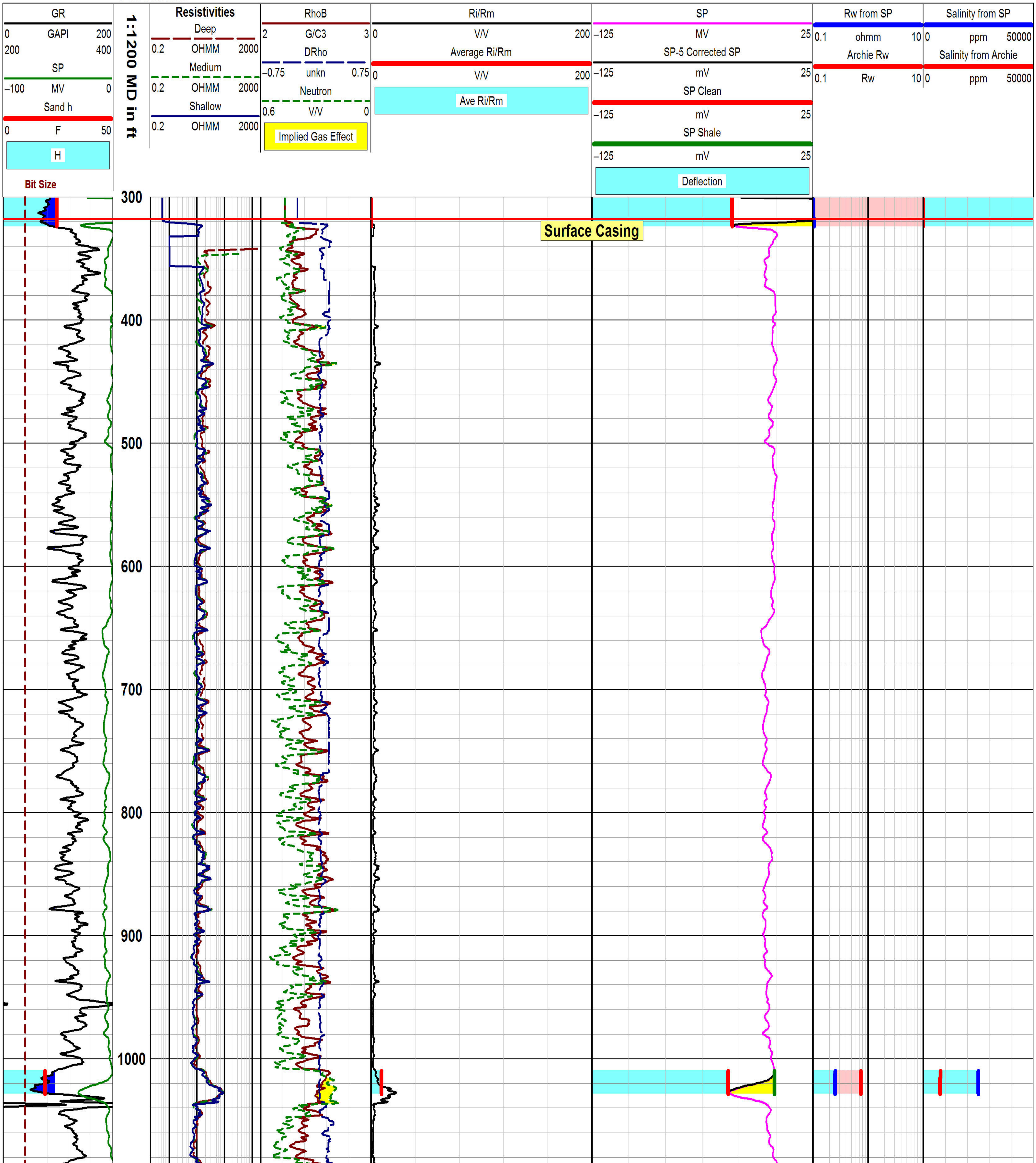
Ranges: User Ranges
300-3720

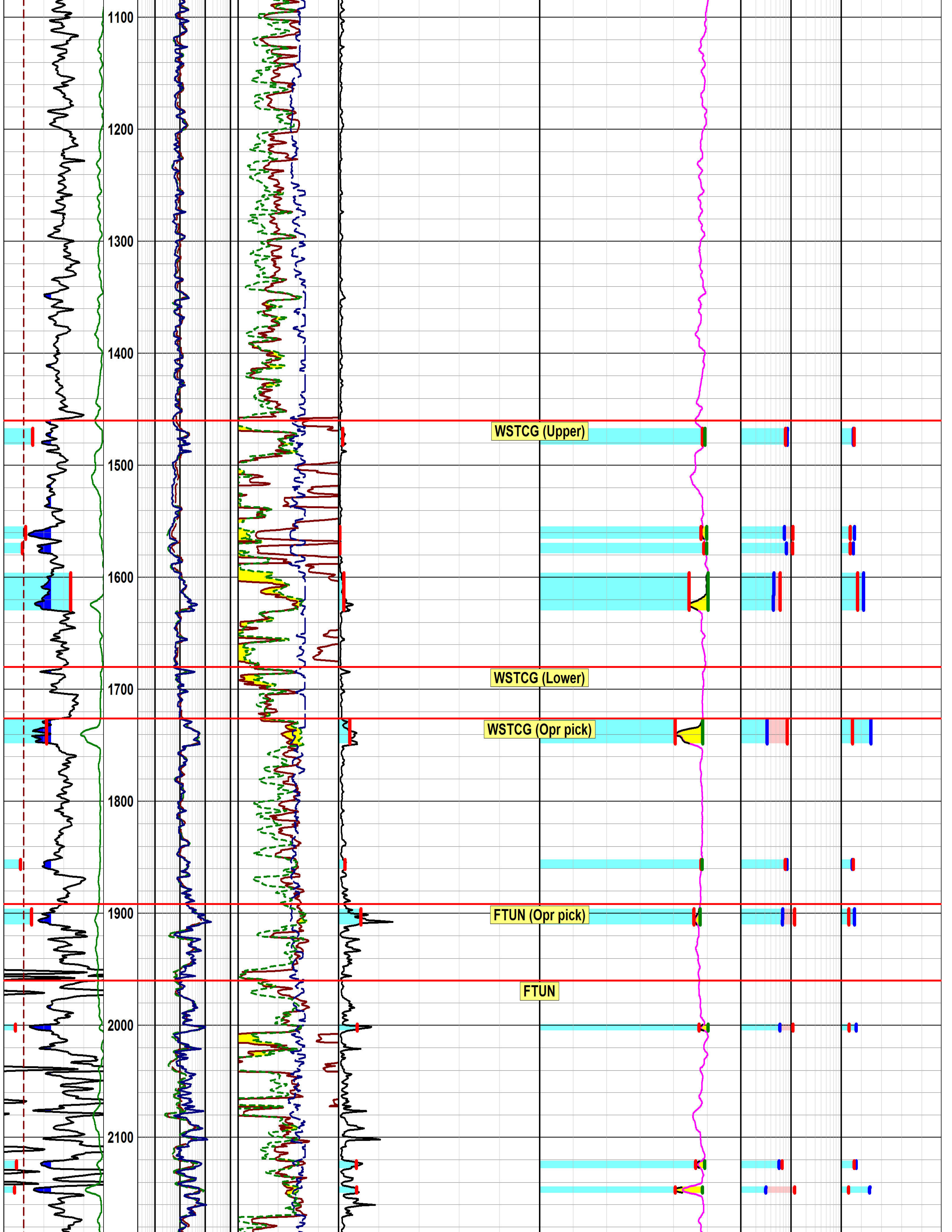
Time: 08:47 AM   Date: Thu, Jun 16, 2016

Section: SECTION   Township: TOWNSHIP   API #:05045066230000

Location: LOCATION   Range: RANGE   UWI: 05045066230000

Comments:

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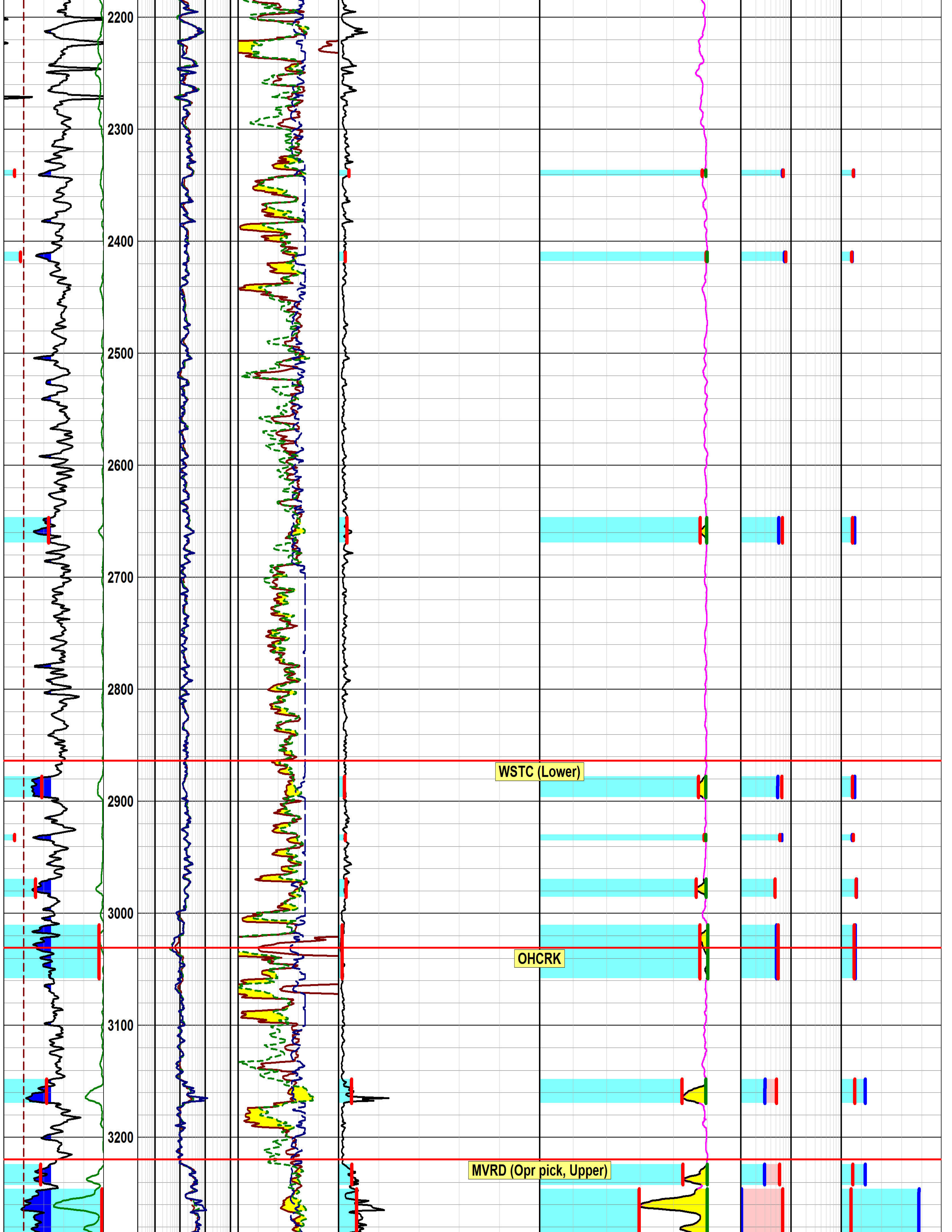
1200
1300
1400
WSTCG (Upper)
1500
1600
WSTCG (Lower)
1700
WSTCG (Opr pick)
1800
1900
FTUN (Opr pick)
FTUN
2000
2100



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2800
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OHCRK
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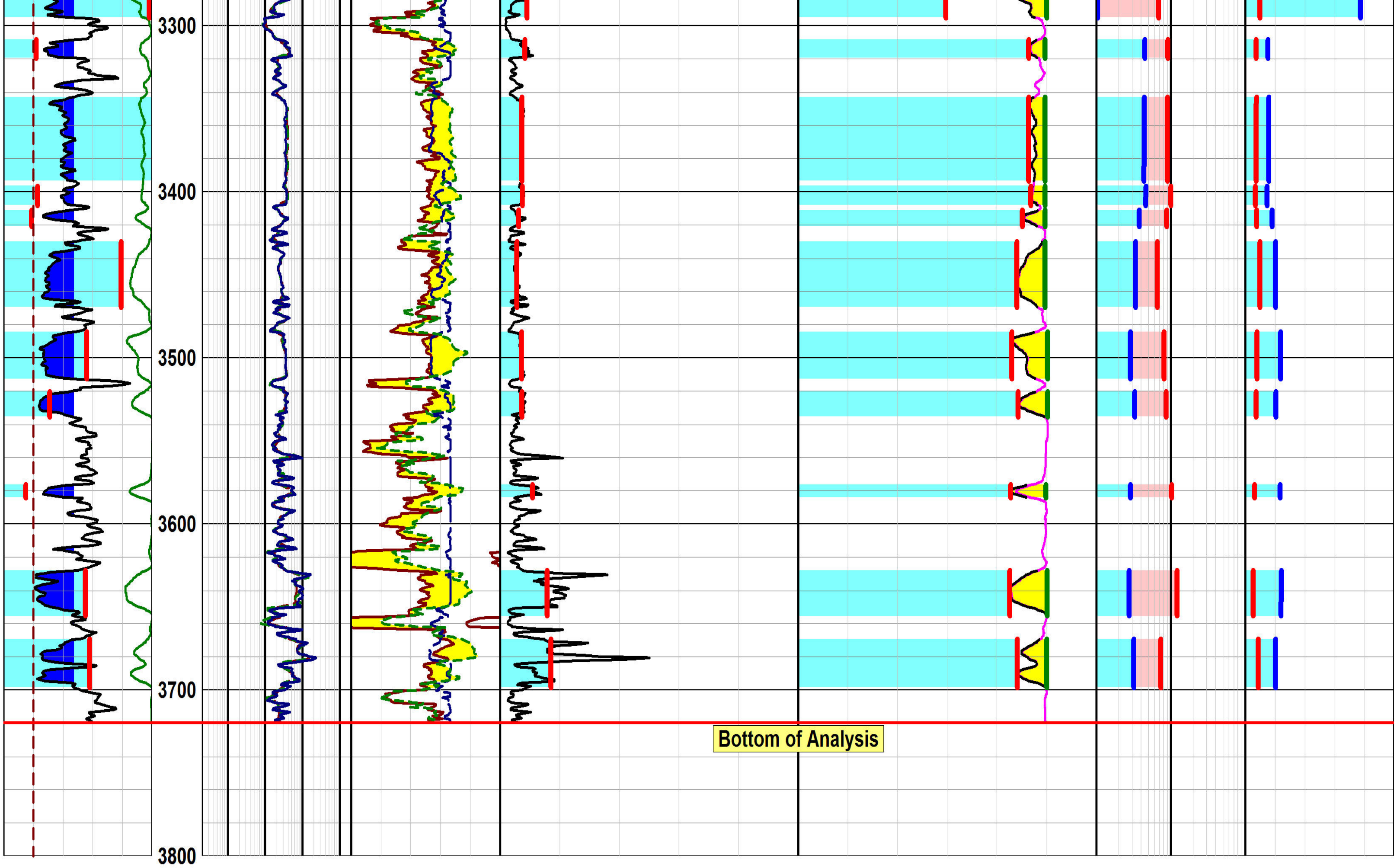
MVRD (Opr pick, Upper)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3600
3700
3800
Bottom of Analysis

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File: 05045068420000 Unocal GR 31-2.lbs

Well Name: GR 31-2

Plot: Salinity by Depth

Gross Interval: 300 to 3915 by 0.5 F

Ranges: User Ranges
300-3915

Time: 08:56 AM

Date: Thu, Jun 16, 2016

Section: SECTION

Township: TOWNSHIP

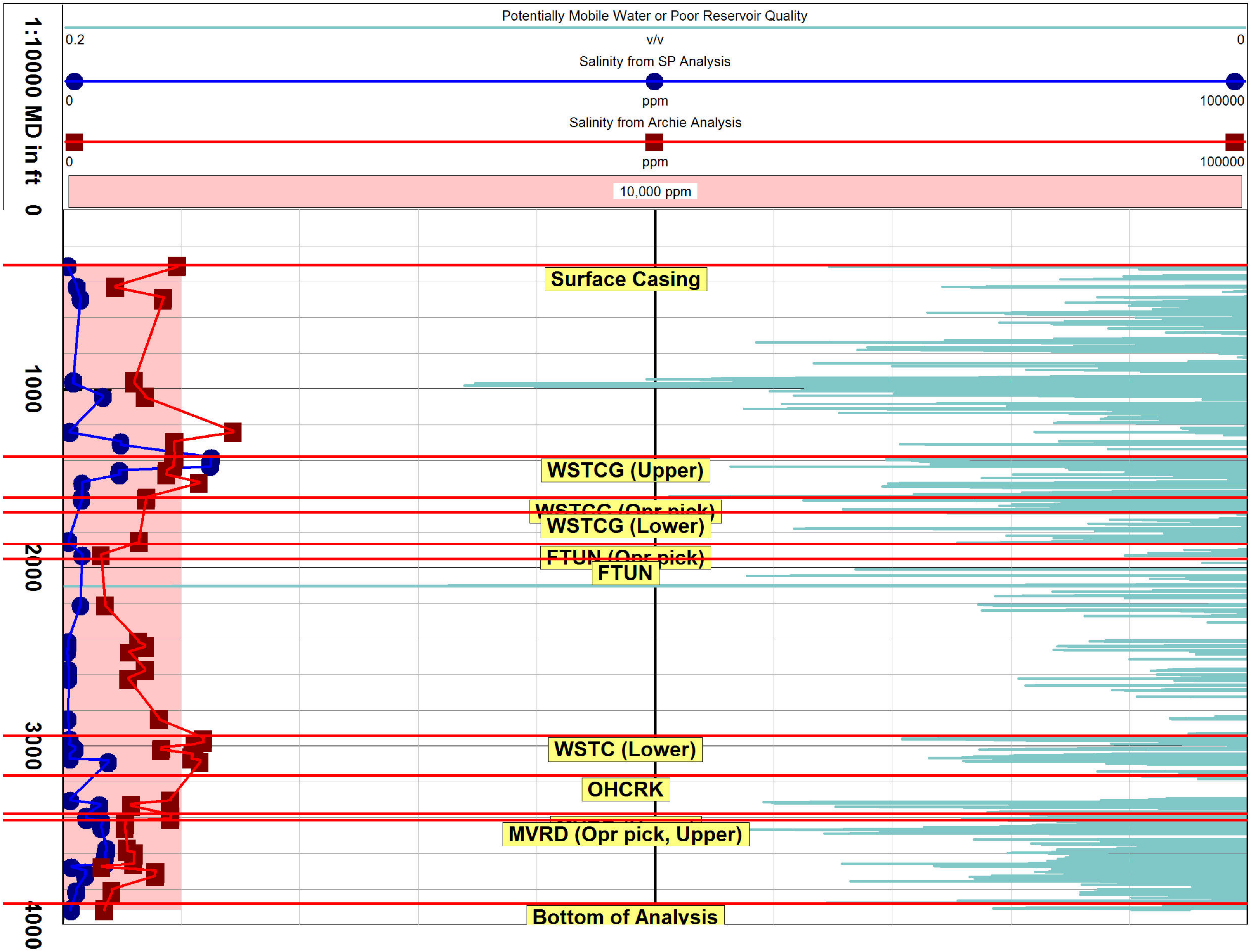
API #: 05045068420000

Location: LOCATION

Range: RANGE

UWI: 05045068420000

Comments:



LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045068420000 Unocal GR 31-2.lbs   Well Name: GR 31-2

Plot: SP Shift Deflection

Gross Interval: 300 to 3915 by 0.5 F

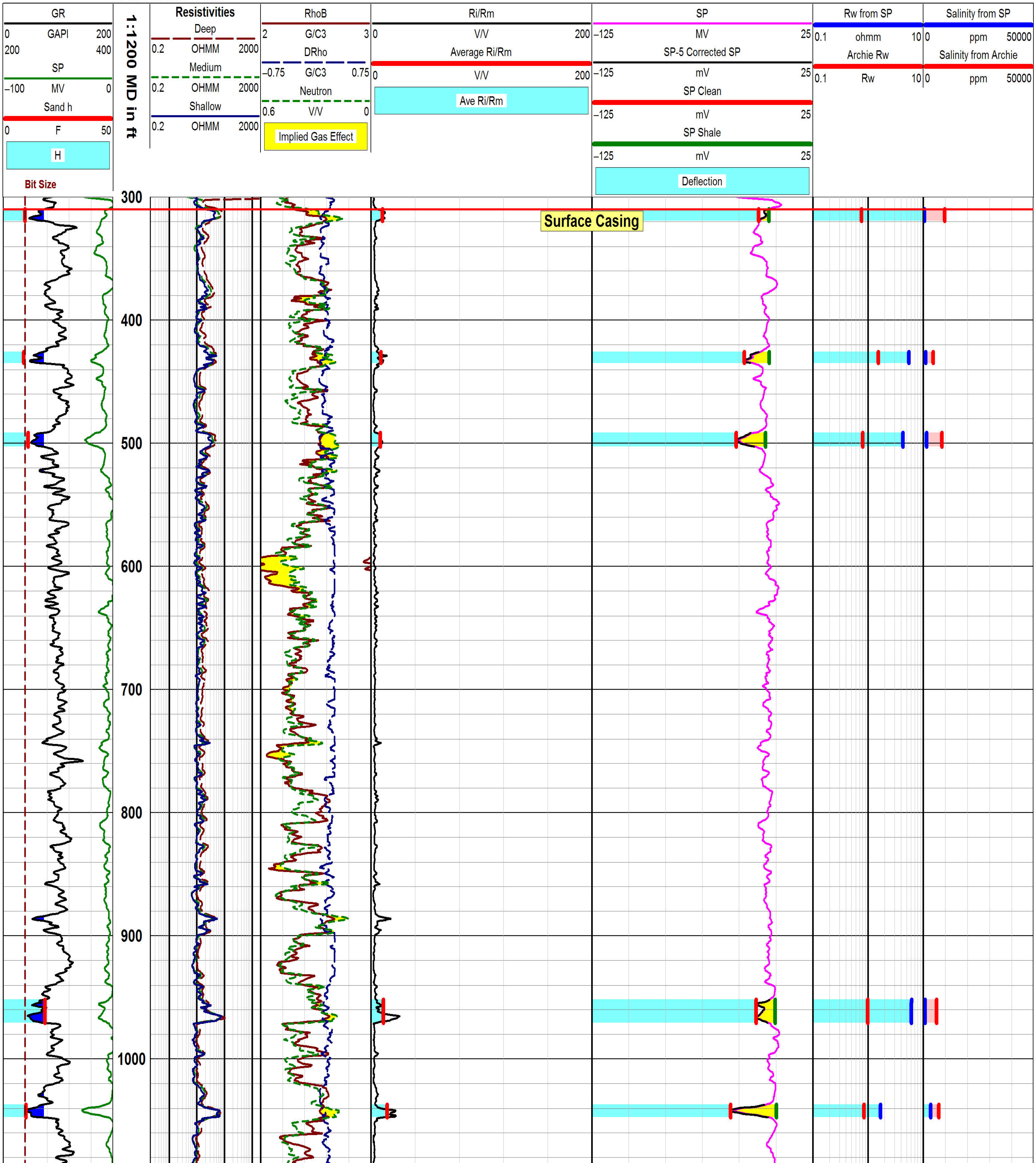
Ranges: User Ranges
300-3915

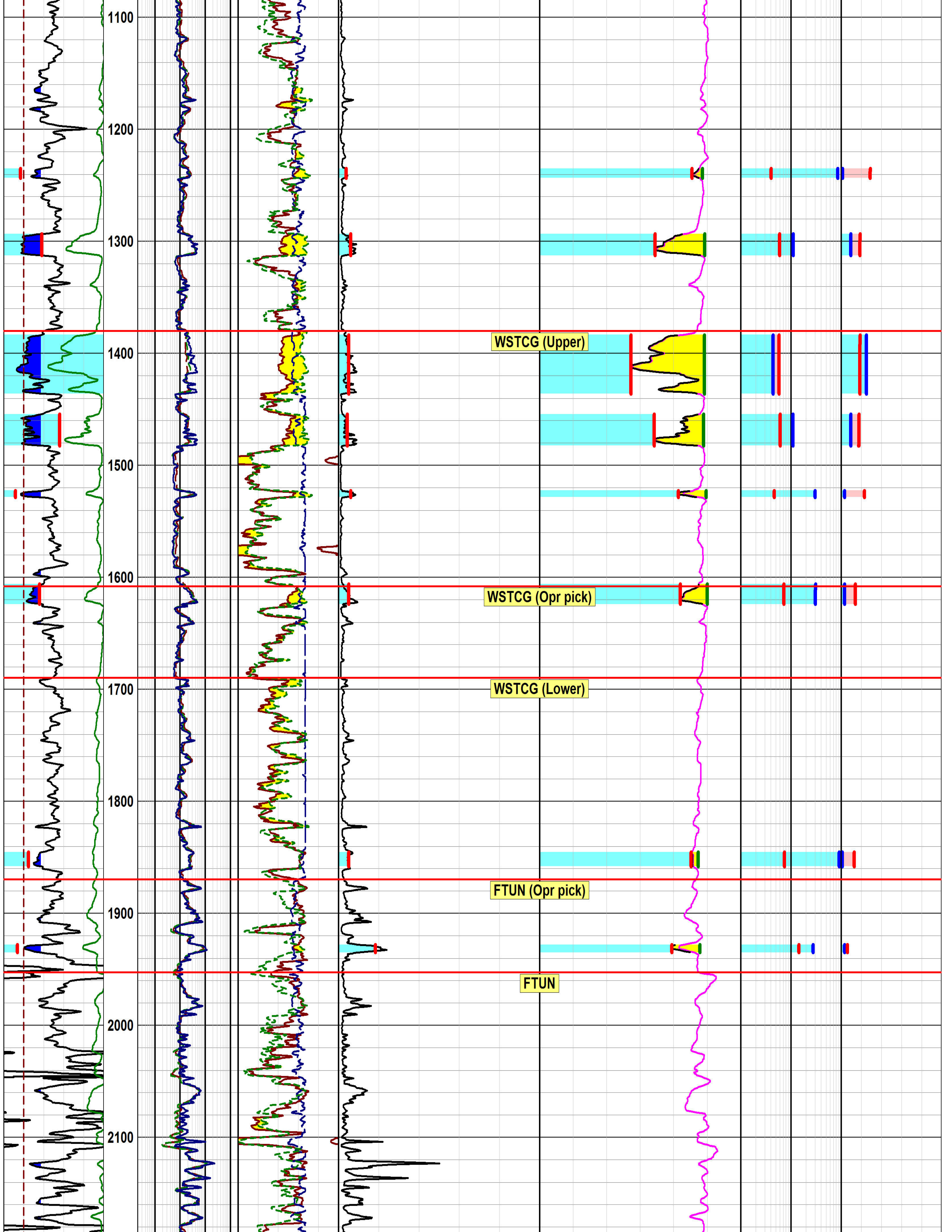
Time: 08:48 AM   Date: Thu, Jun 16, 2016

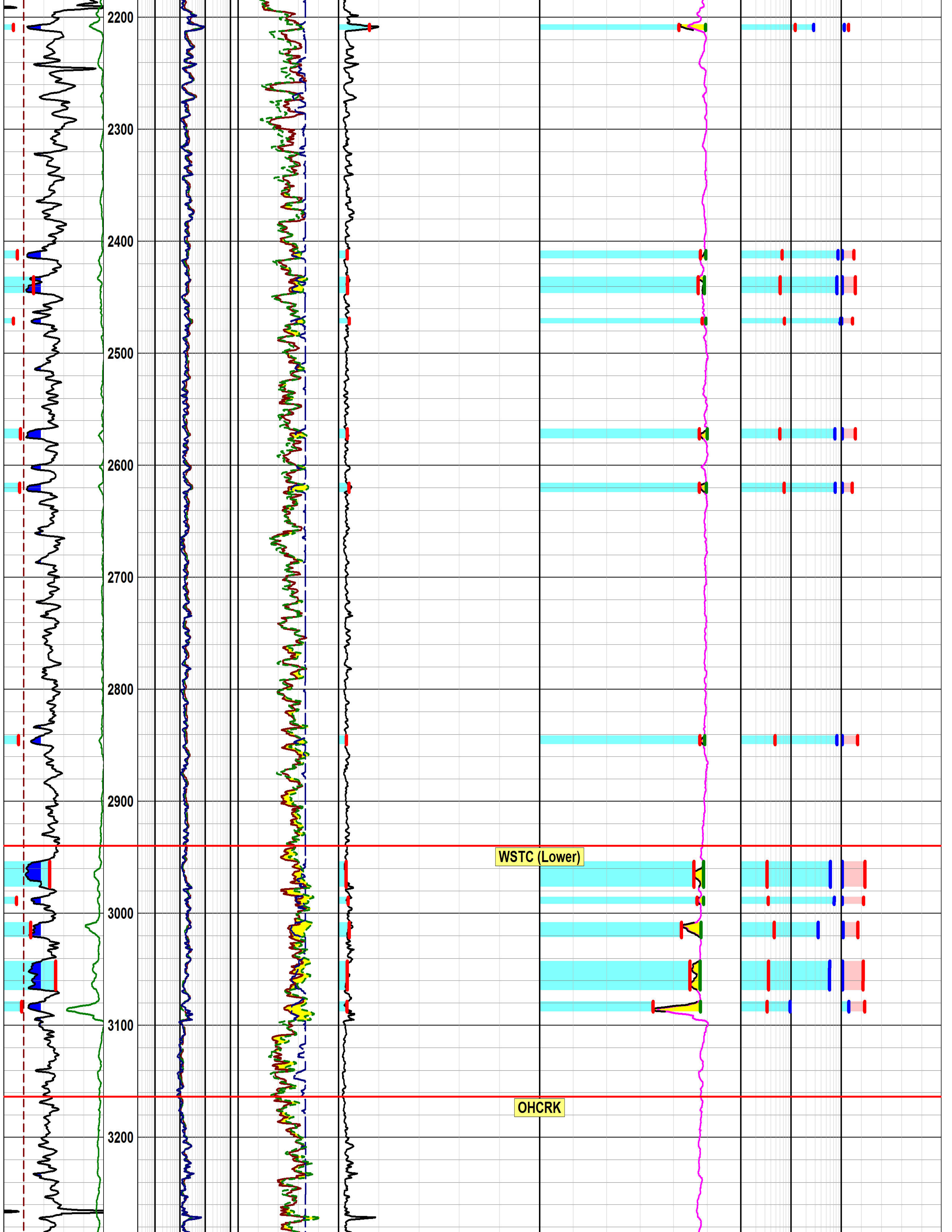
Section: SECTION   Township: TOWNSHIP   API #:05045068420000

Location: LOCATION   Range: RANGE   UWI: 05045068420000

Comments:




1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
WSTCG (Upper)
WSTCG (Opr pick)
WSTCG (Lower)
FTUN (Opr pick)
FTUN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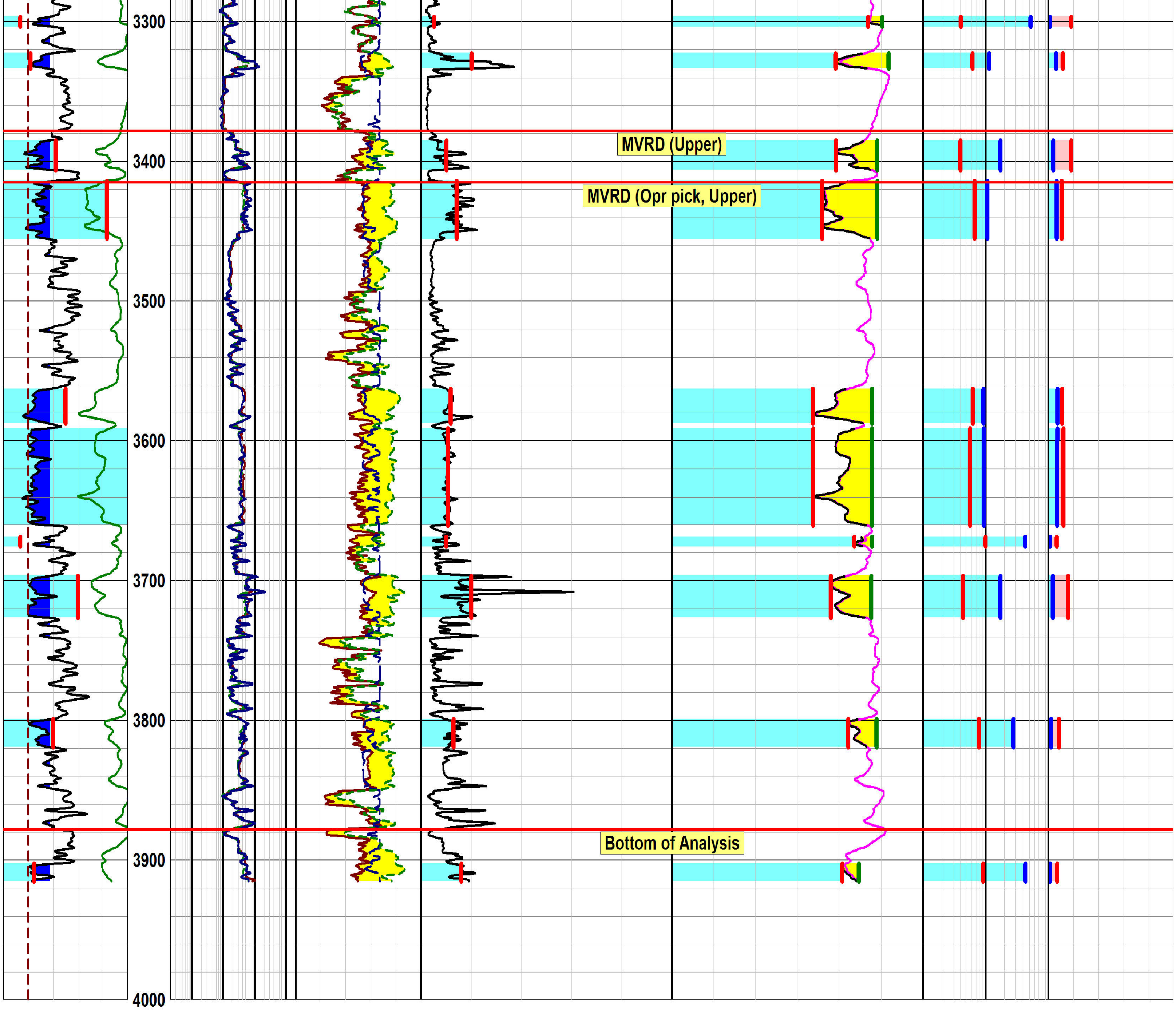
2300
2400
2500
2600
2700
2800
2900
WSTC (Lower)
3000
3100
OHCRK
3200



3300
MVRD (Upper)
3400
MVRD (Opr pick, Upper)
3500
3600
3700
3800
Bottom of Analysis
3900
4000

DIGITAL FORMATION

LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045071900000 Federal GM 34-3.lbs

Well Name: GM 34-3

Plot: Salinity by Depth

Gross Interval: 330 to 4000 by 0.5 F

Ranges: User Ranges
330-4000

Time: 08:56 AM

Date: Thu, Jun 16, 2016

Section: SECTION

Township: TOWNSHIP

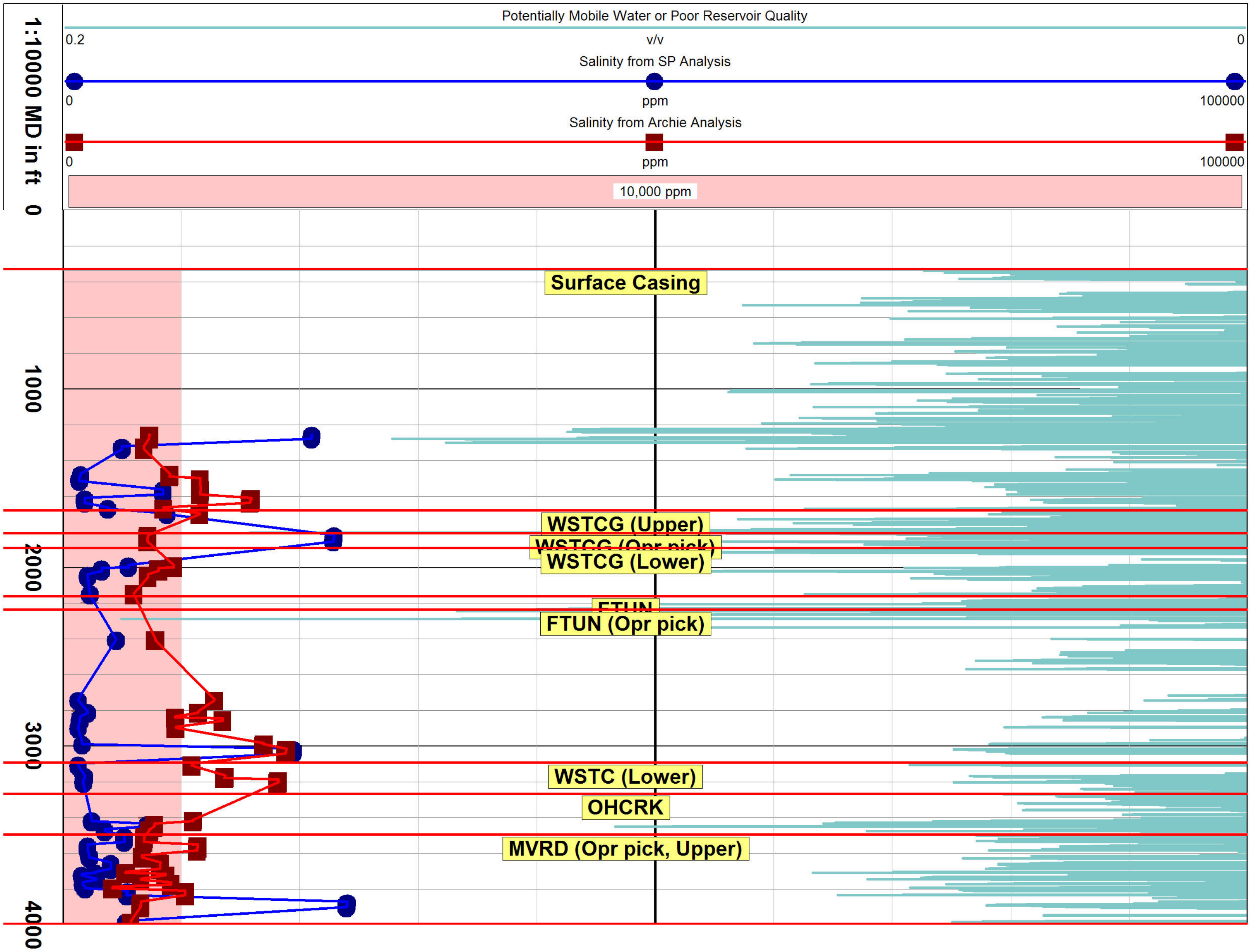
API #: 05045071900000

Location: LOCATION

Range: RANGE

UWI: 05045071900000

Comments:



DIGITAL FORMATION

LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045071900000 Federal GM 34-3.lbs Well Name: GM 34-3

Plot: SP Shift Deflection

Gross Interval: 330 to 4000 by 0.5 F

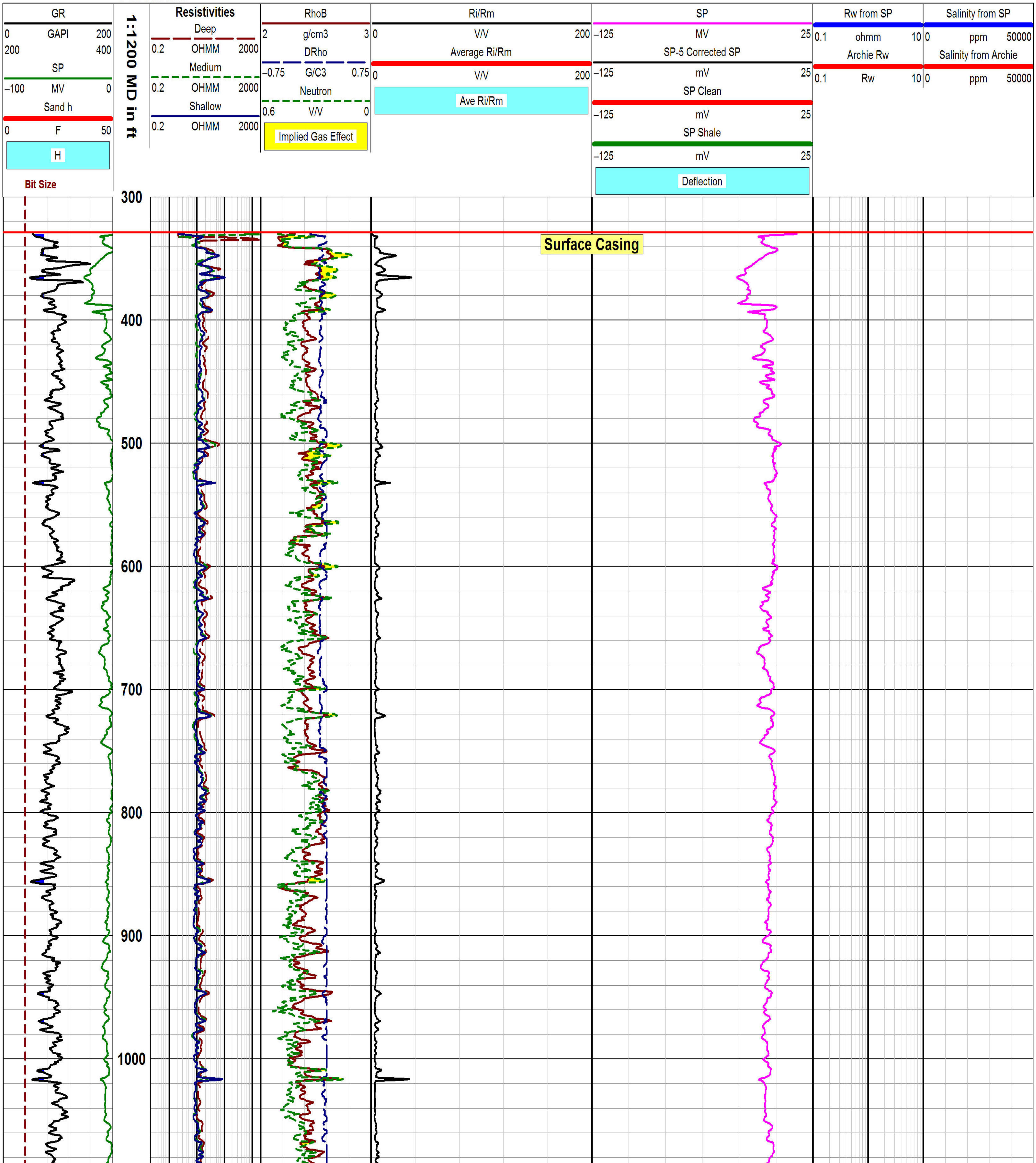
Ranges: User Ranges
330-4000

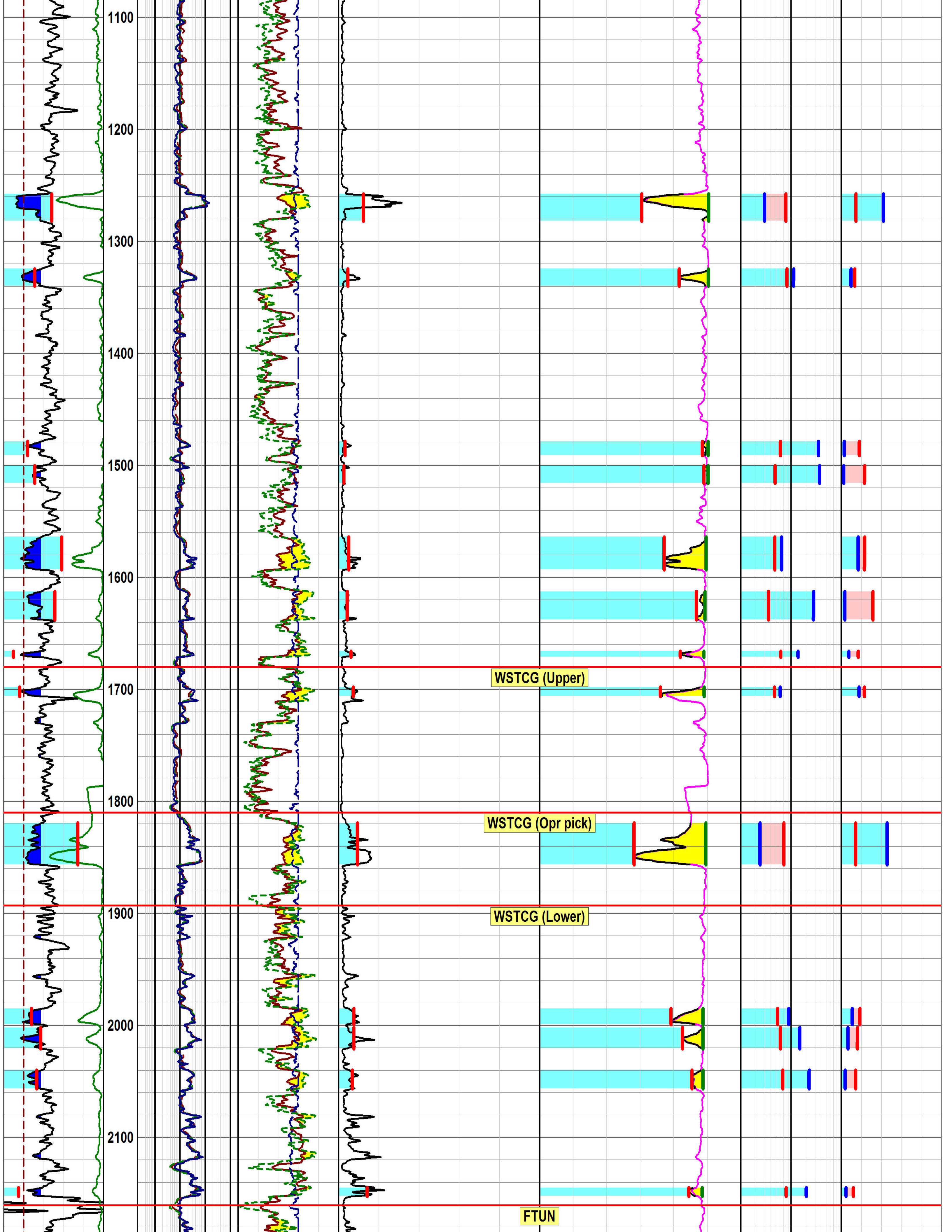
Time: 08:48 AM Date: Thu, Jun 16, 2016

Section: SECTION Township: TOWNSHIP API #:05045071900000

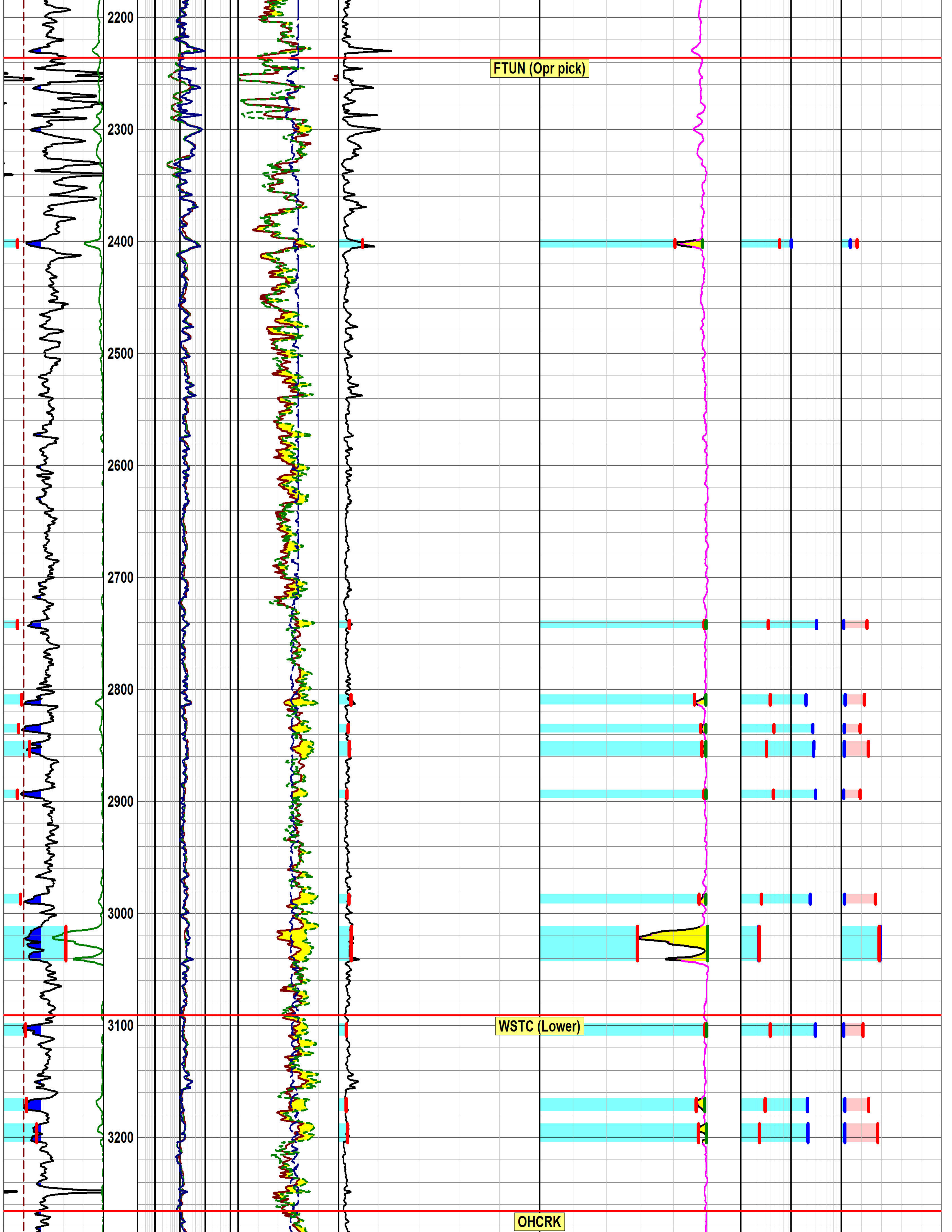
Location: LOCATION Range: RANGE UWI: 05045071900000

Comments:





1100
1200
1300
1400
1500
1600
WSTCG (Upper)
1700
1800
WSTCG (Opr pick)
WSTCG (Lower)
1900
2000
2100
FTUN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2400
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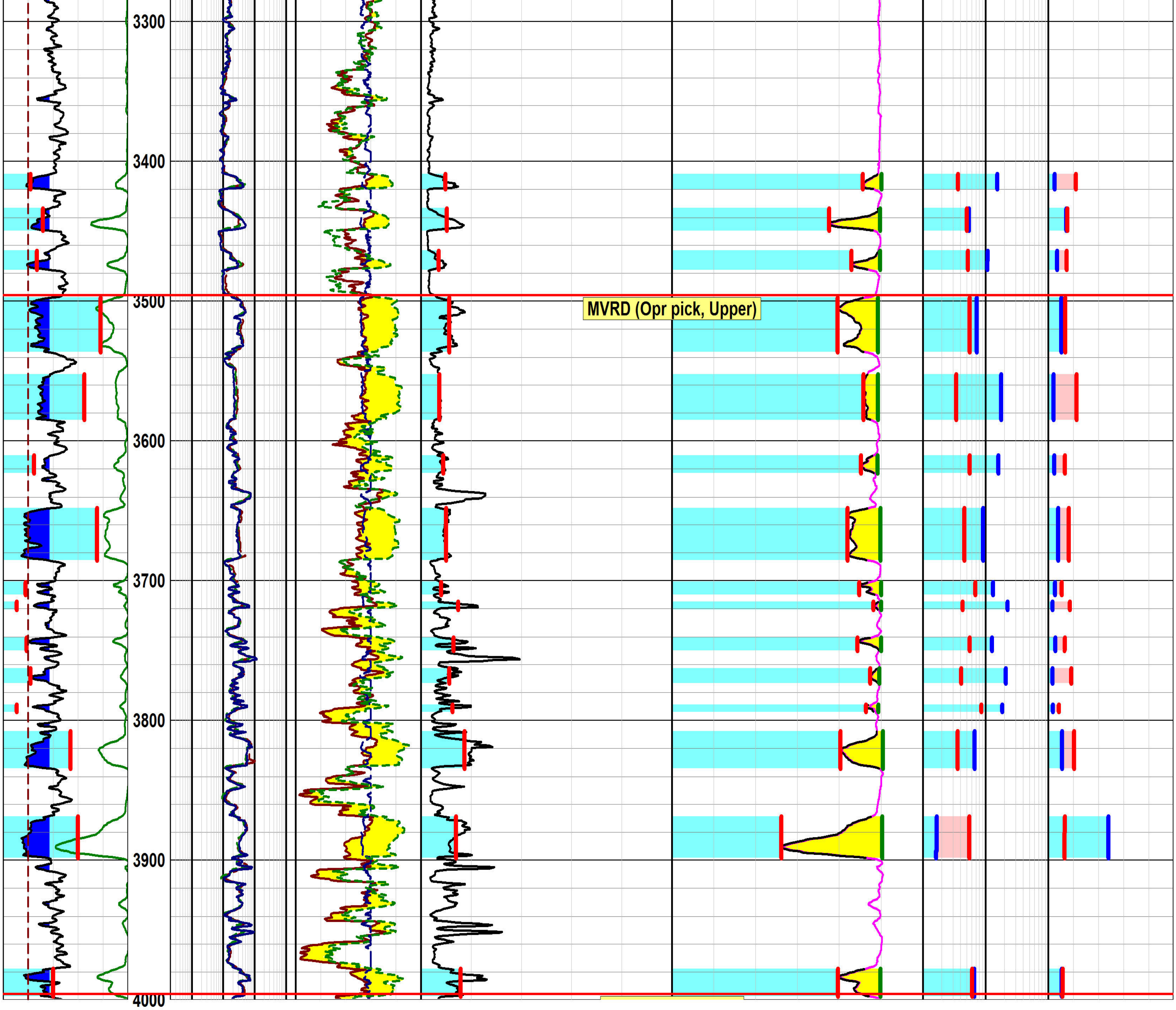
2900
3000
3100
WSTC (Lower)
3200
OHCRK


3300
3400
3500
MVRD (Opr pick, Upper)
3600
3700
3800
3900
4000

LESA 2016, © 1992-2016 Digital Formation, Inc.

File: **05045074160000 PA 14-32.lbs**

Well Name: **PA 14-32**

Plot: **Salinity by Depth**

Gross Interval: **700** to **3900** by **0.5** **F**

Ranges: **User Ranges**
700-3900

Time: **08:56 AM**

Date: **Thu, Jun 16, 2016**

Section: **SECTION**

Township: **TOWNSHIP**

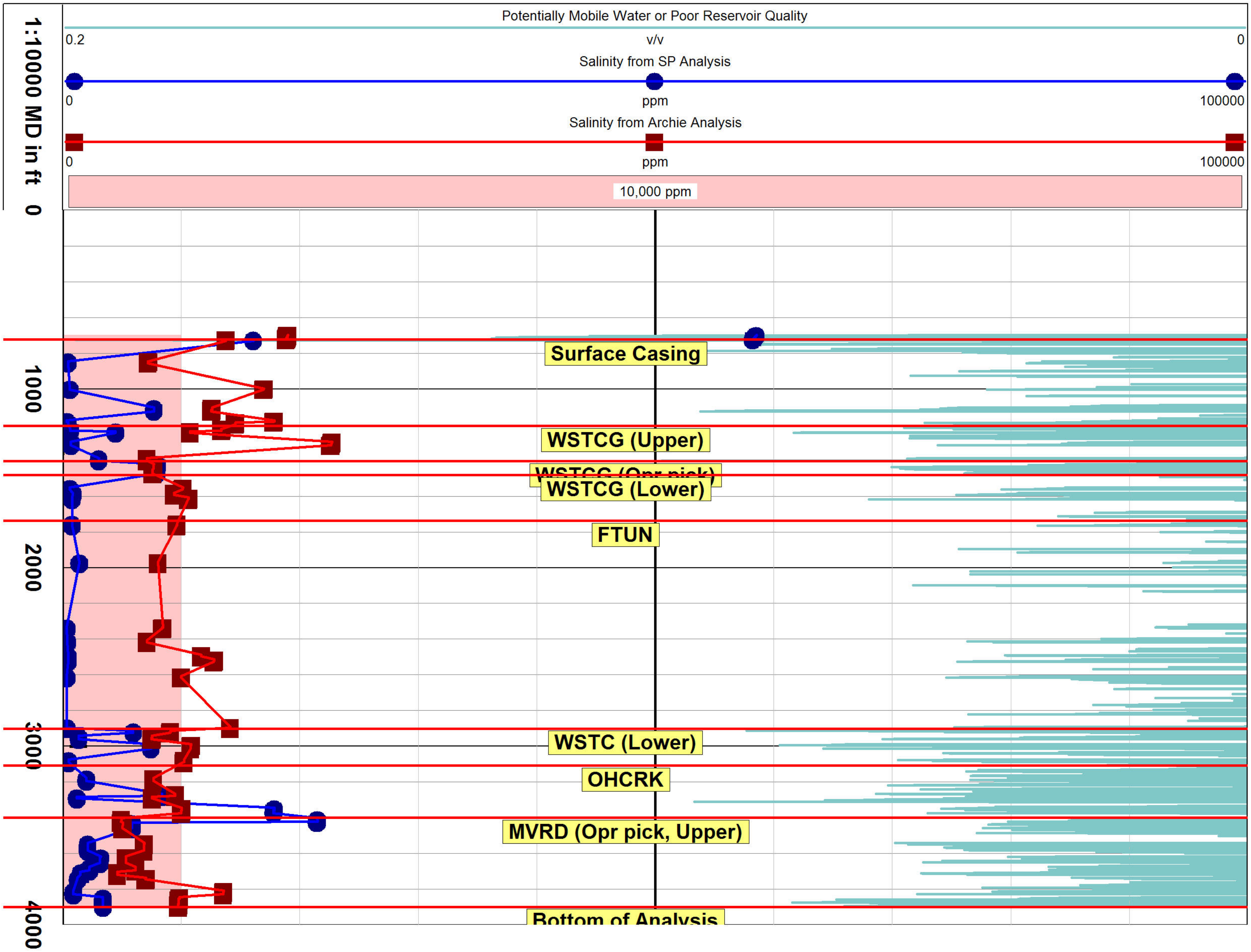
API #: **05045074160000**

Location: **LOCATION**

Range: **RANGE**

UWI: **05045074160000**

Comments:



LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045074160000 PA 14-32.lbs Well Name: PA 14-32

Plot: SP Shift Deflection

Gross Interval: 700 to 3900 by 0.5 F

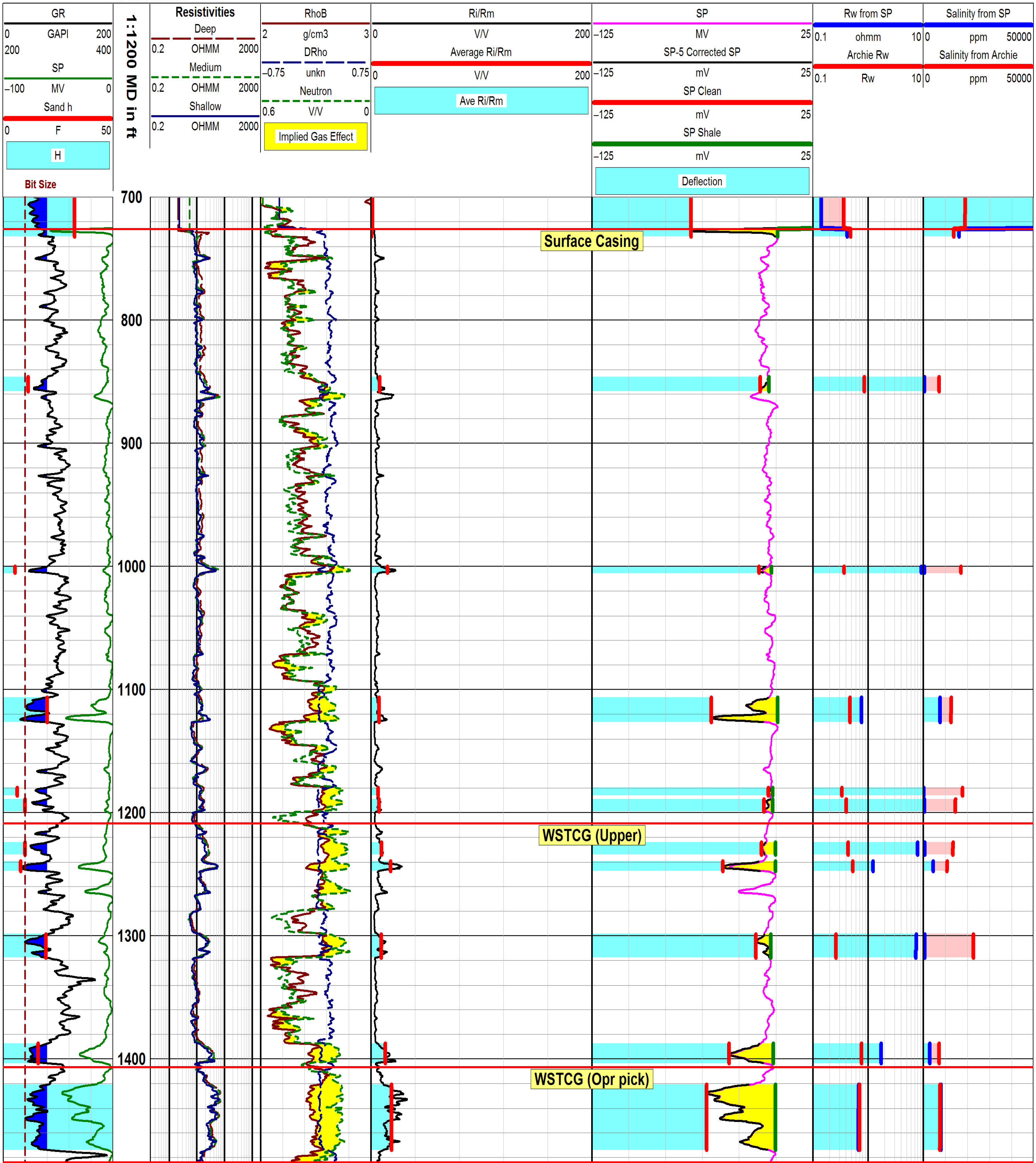
Ranges: User Ranges
700-3900

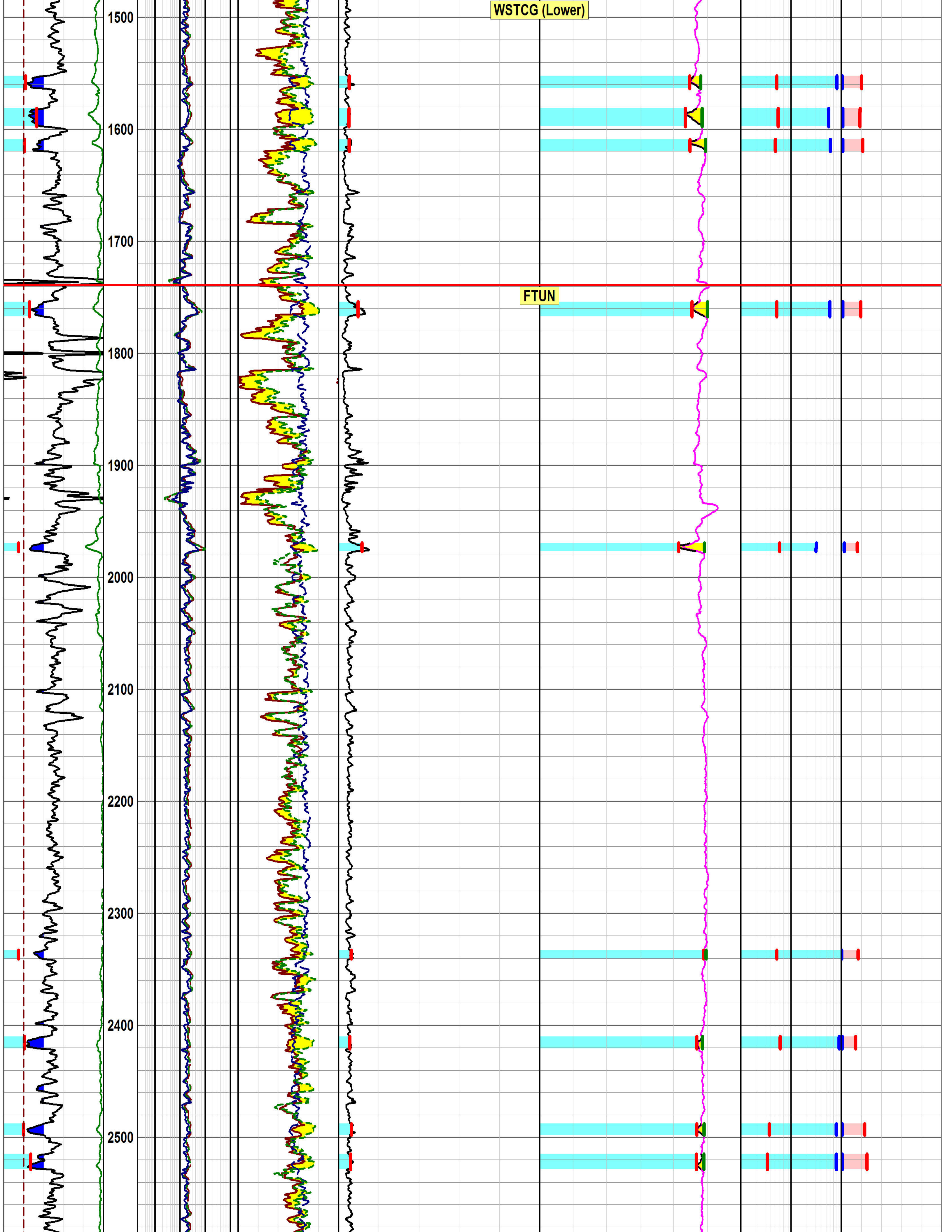
Time: 08:49 AM Date: Thu, Jun 16, 2016

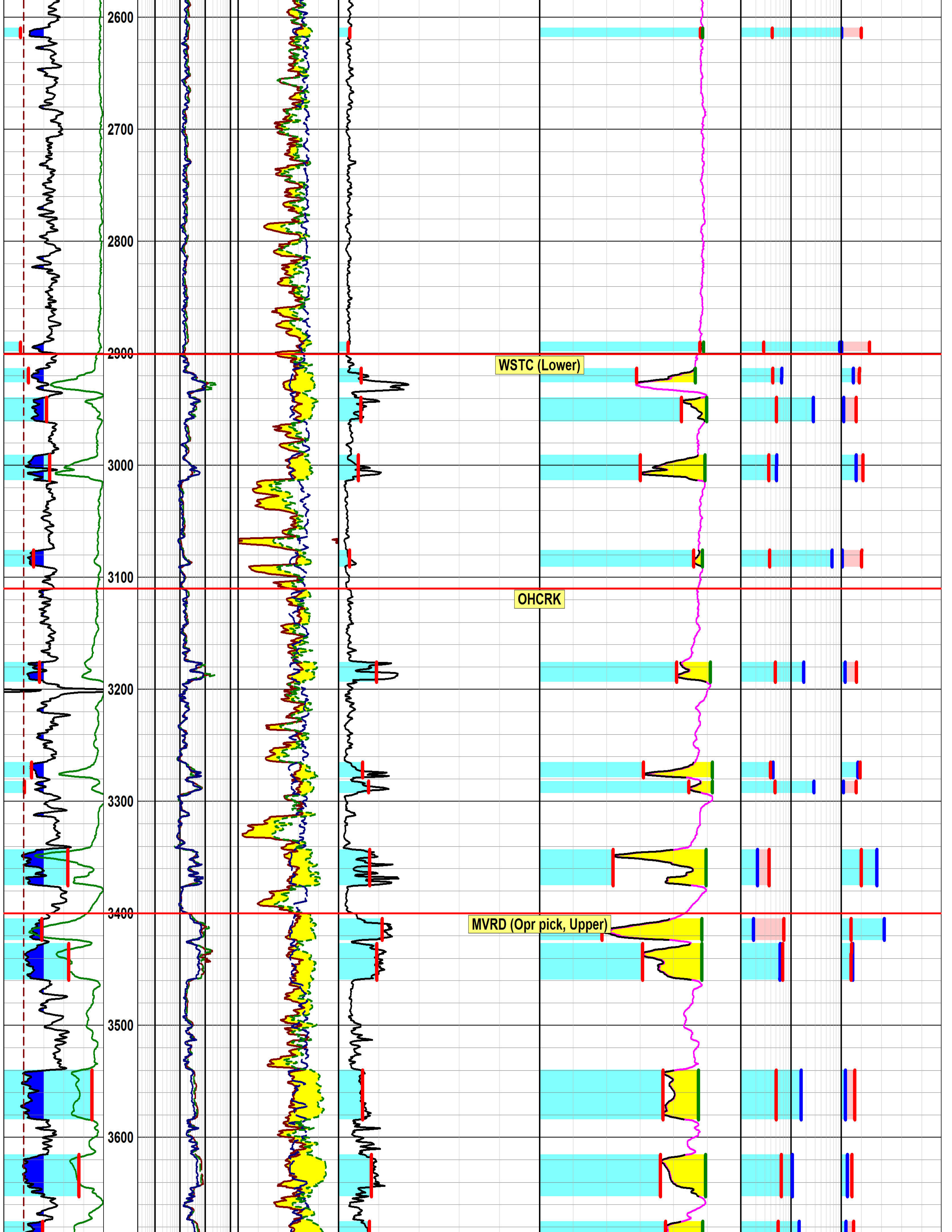
Section: SECTION Township: TOWNSHIP API #: 05045074160000

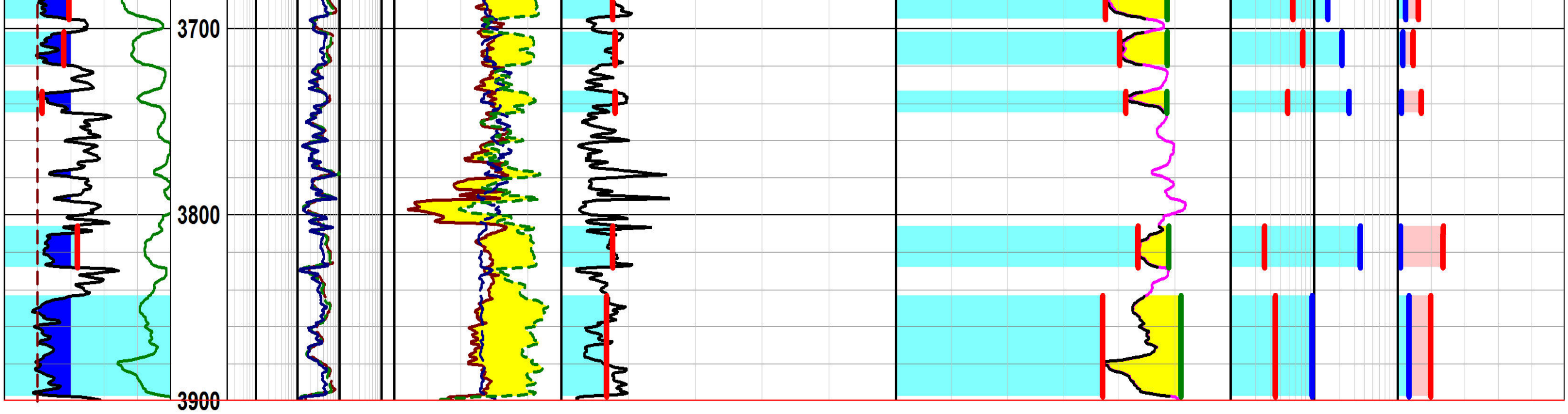
Location: LOCATION Range: RANGE UWI: 05045074160000

Comments:




WSTCG (Lower)
1500
1600
1700
FTUN
1800
1900
2000
2100
2200
2300
2400
2500


2600
2700
2800
2900
WSTC (Lower)
3000
3100
OHCRK
3200
3300
3400
MVRD (Opr pick, Upper)
3500
3600


3700
3800
3900

LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045089740000 Brouch GM 314-12.lbs

Well Name: GM 314-12

Plot: Salinity by Depth

Gross Interval: 626 to 3447 by 0.5 F

Ranges: User Ranges 626-3447

Time: 08:56 AM

Date: Thu, Jun 16, 2016

Section: SECTION

Township: TOWNSHIP

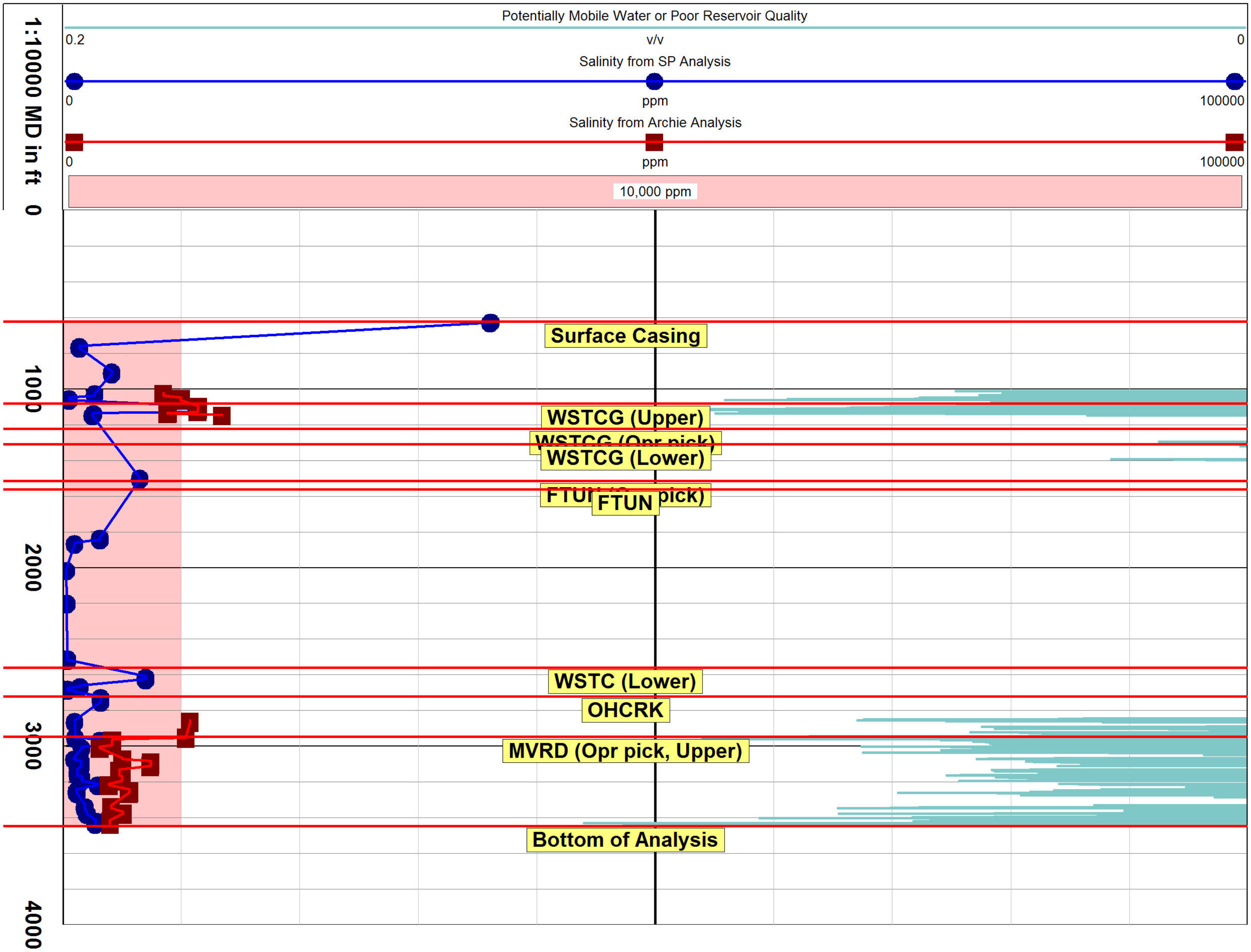
API #: 05045089740000

Location: LOCATION

Range: RANGE

UWI: 05045089740000

Comments:



LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045089740000 Brouch GM 314-12.lbs   Well Name: GM 314-12

Plot: SP Shift Deflection

Gross Interval: 626 to 3447 by 0.5 F

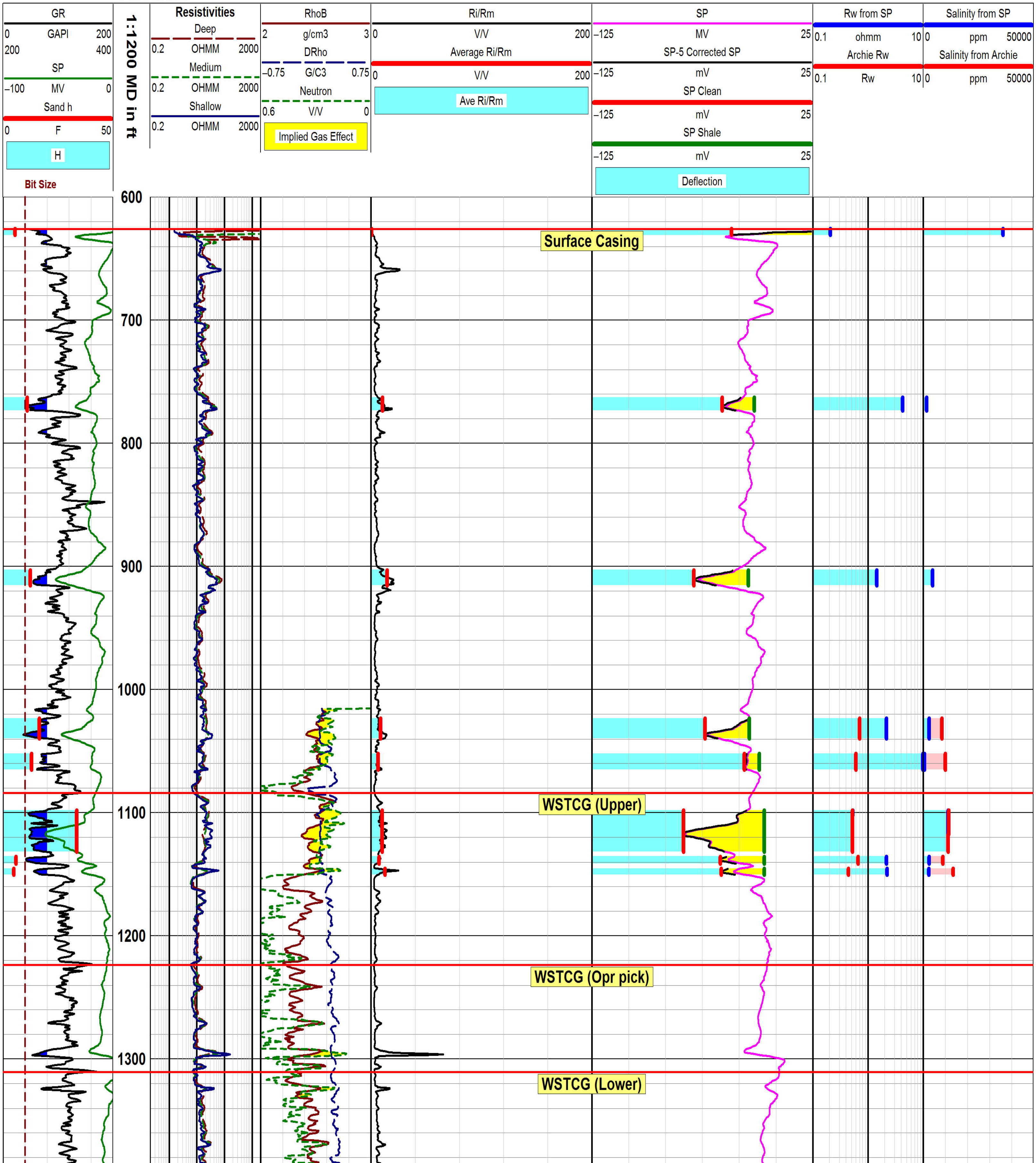
Ranges: User Ranges
626-3447

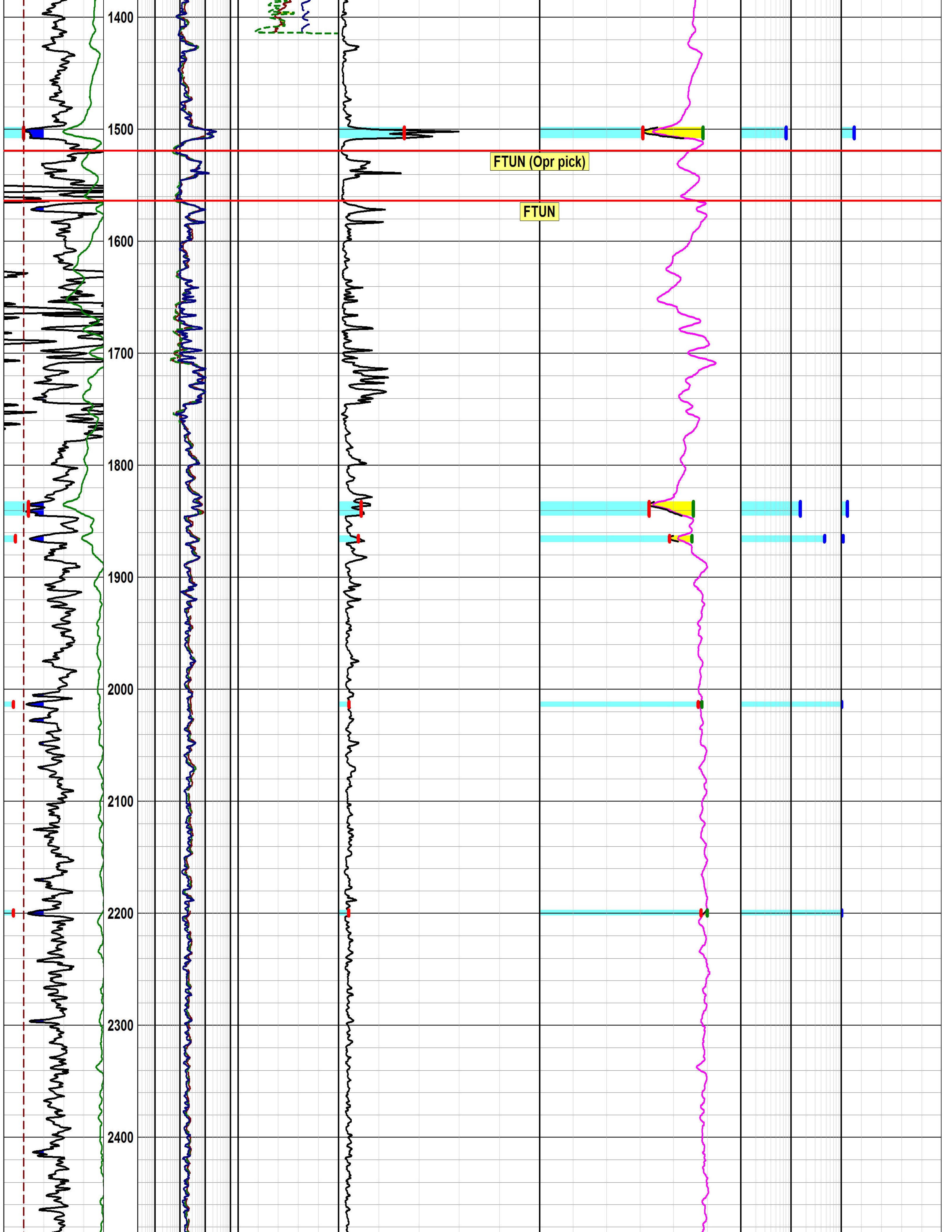
Time: 08:50 AM   Date: Thu, Jun 16, 2016

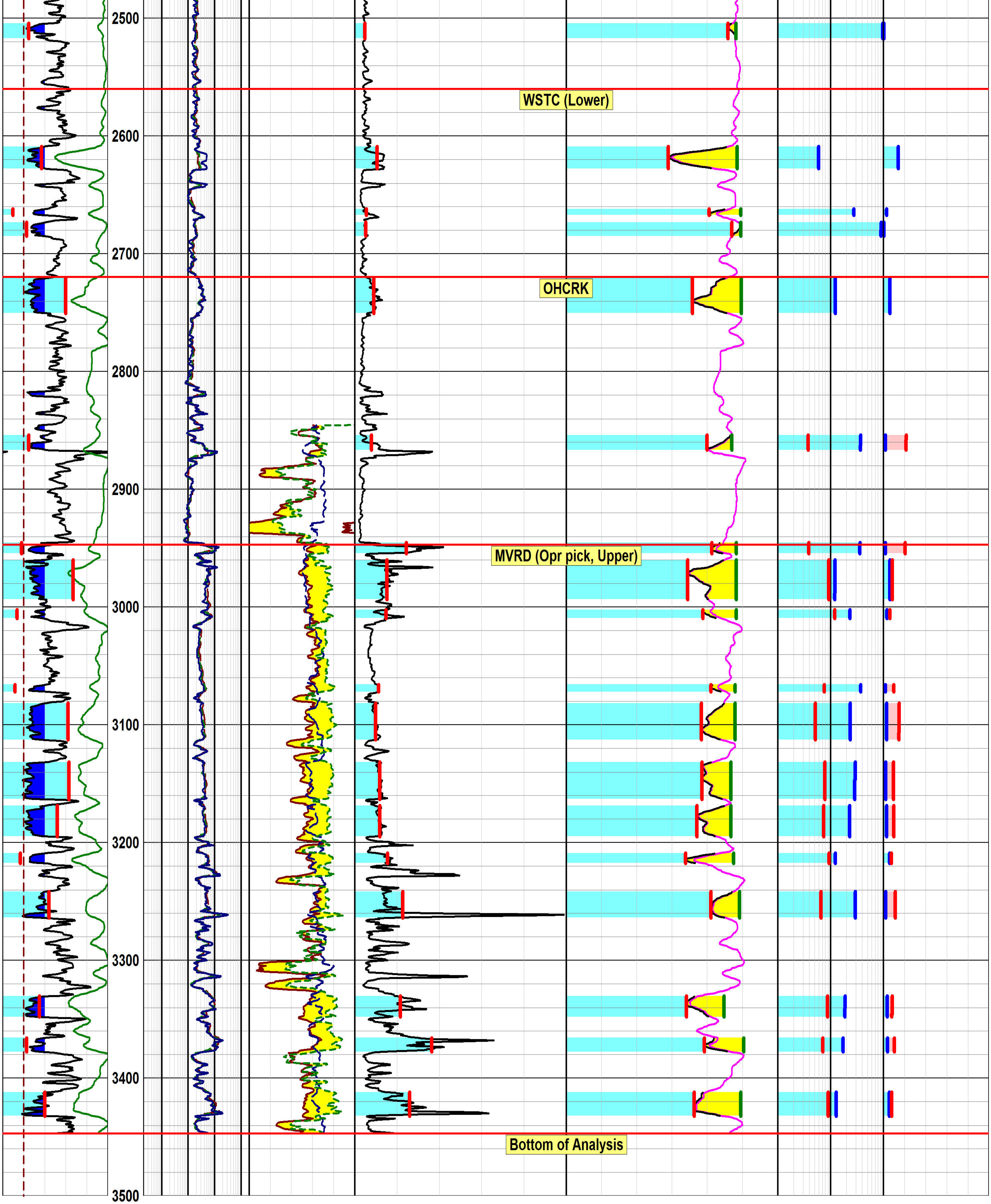
Section: SECTION   Township: TOWNSHIP   API #:05045089740000

Location: LOCATION   Range: RANGE   UWI: 05045089740000

Comments:




1400
1500
FTUN (Opr pick)
FTUN
1600
1700
1800
1900
2000
2100
2200
2300
2400



2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
WSTC (Lower)
OHCRK
MVRD (Opr pick, Upper)
Bottom of Analysis

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File: 05045126040000 Enyeart 16-4 (PD16).lbs

Well Name: Enyeart 16-4 (PD16)

Plot: Salinity by Depth

Gross Interval: 7722 to 289 by -0.5 F

Ranges: User Ranges
289-7722

Time: 08:56 AM

Date: Thu, Jun 16, 2016

Section: 16

Township: 7 S

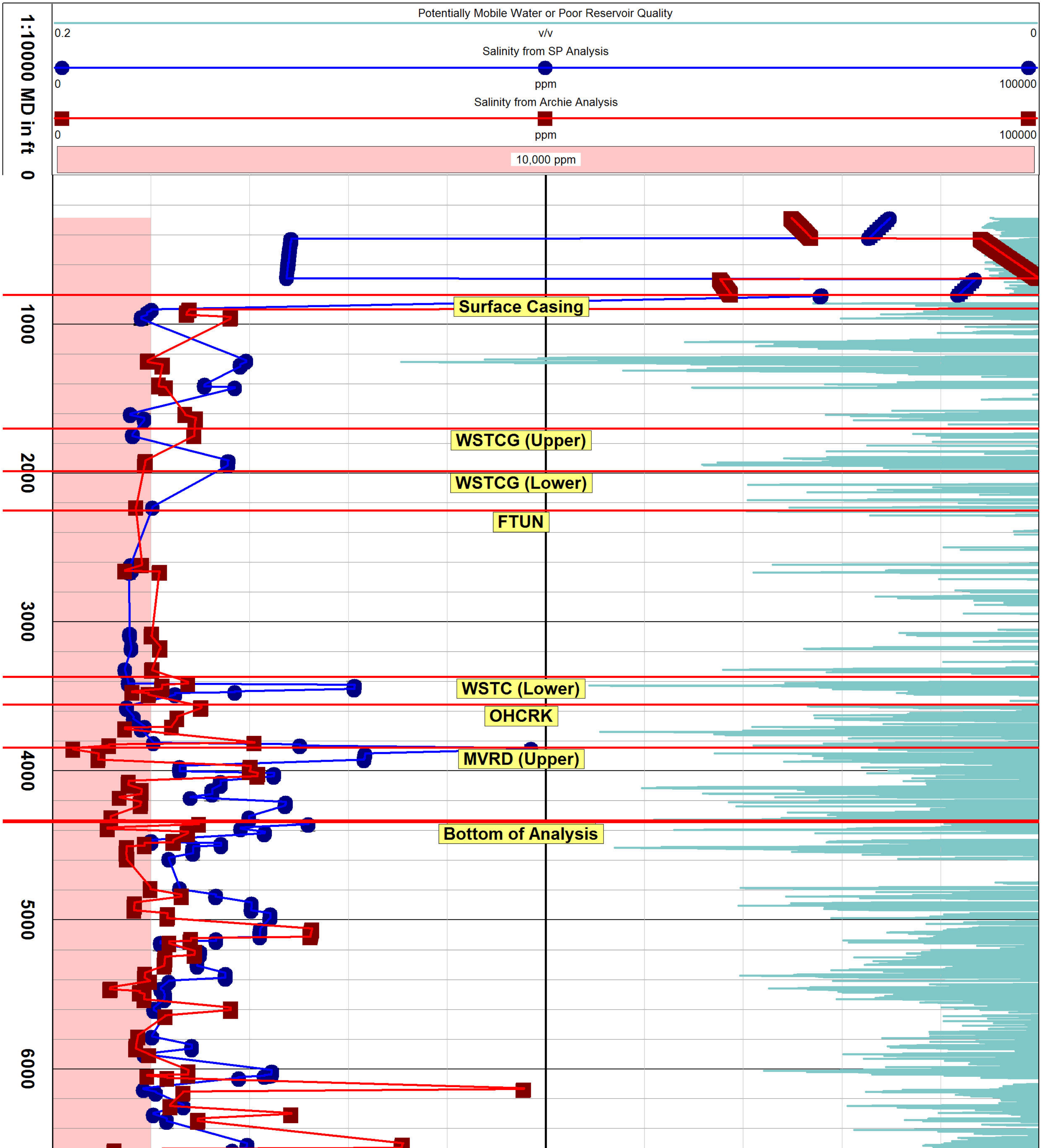
API #: 05-045-126040000

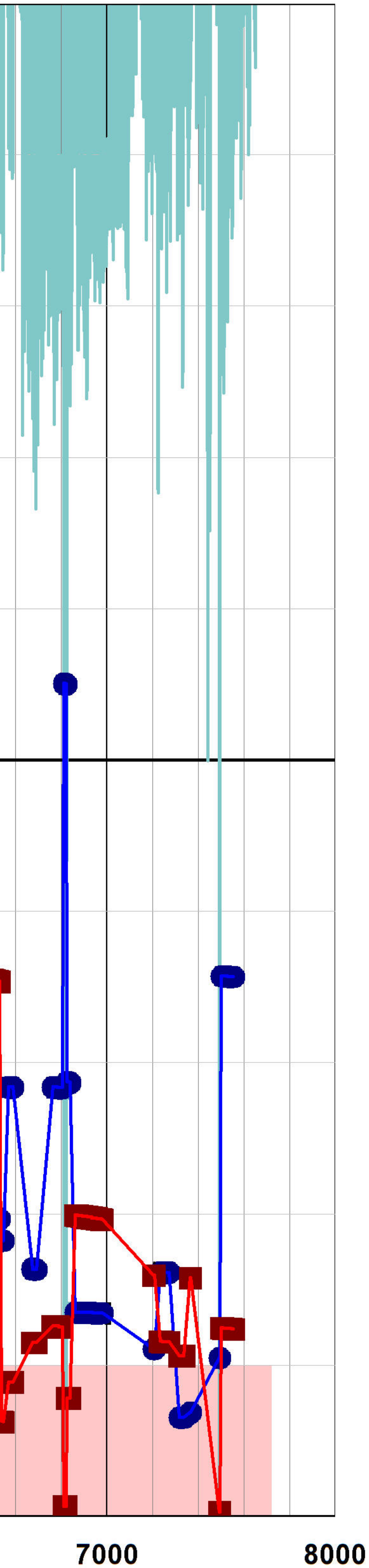
Location: LOCATION

Range: 95 W

UWI: 05045126040000

Comments:




7000
8000

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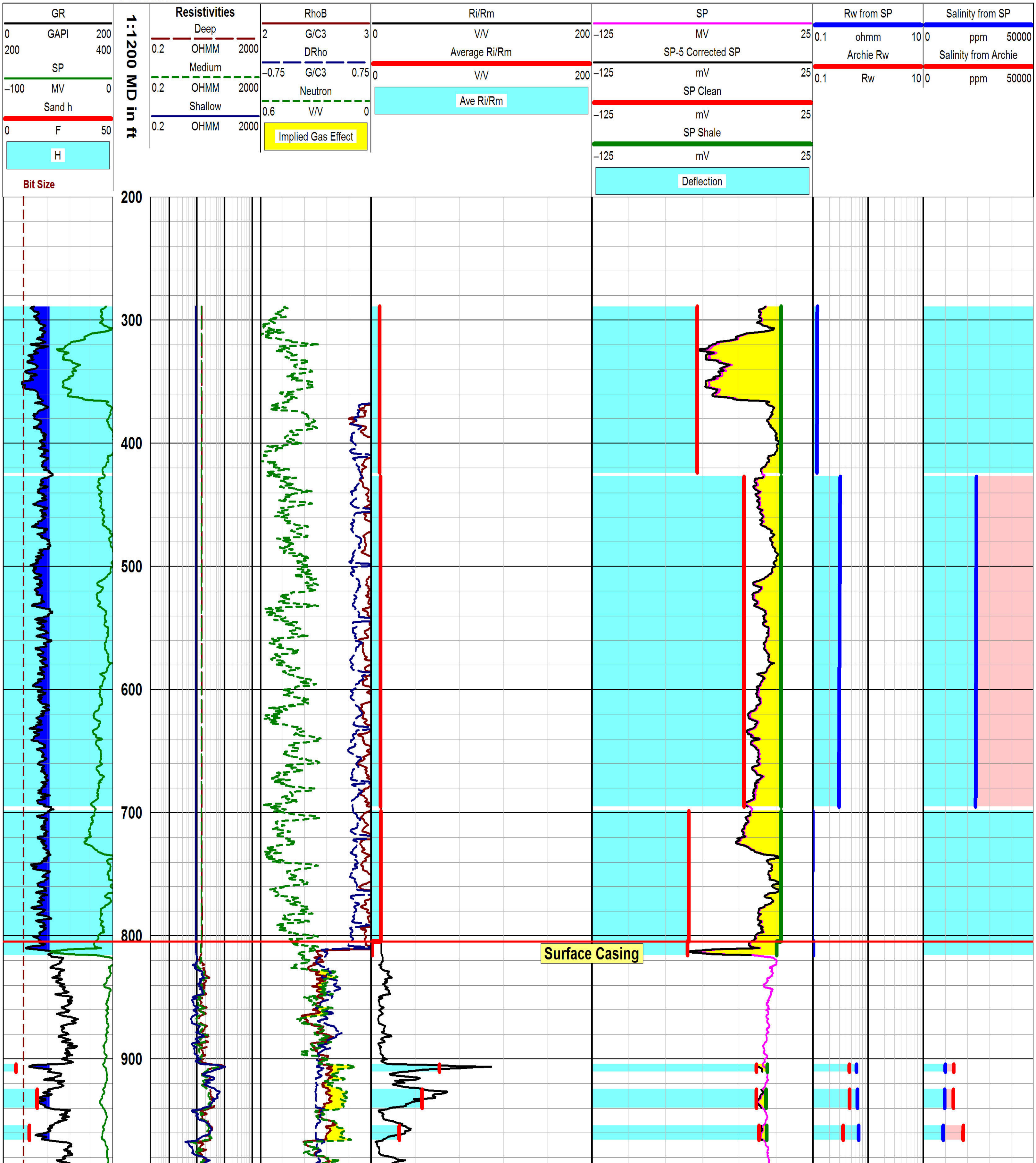
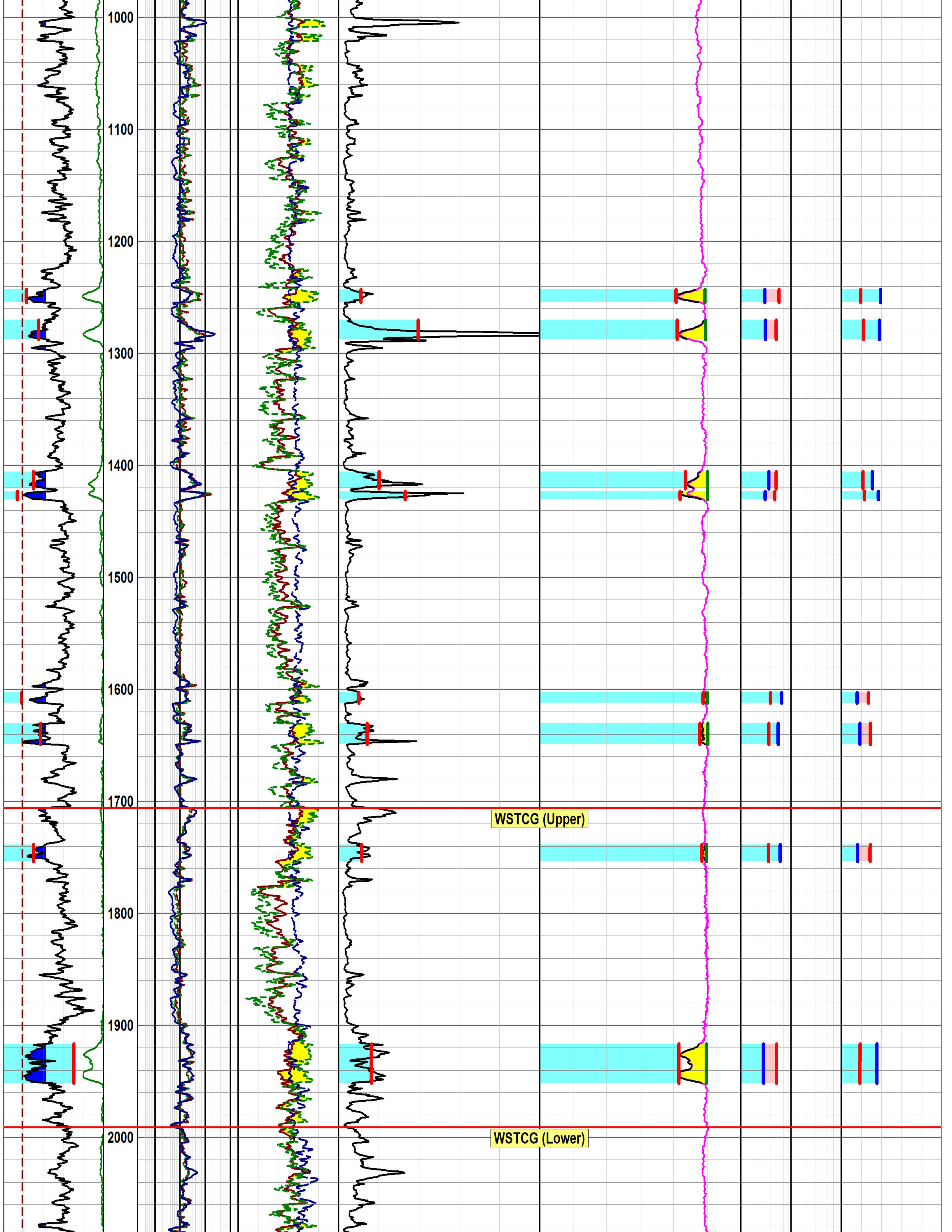
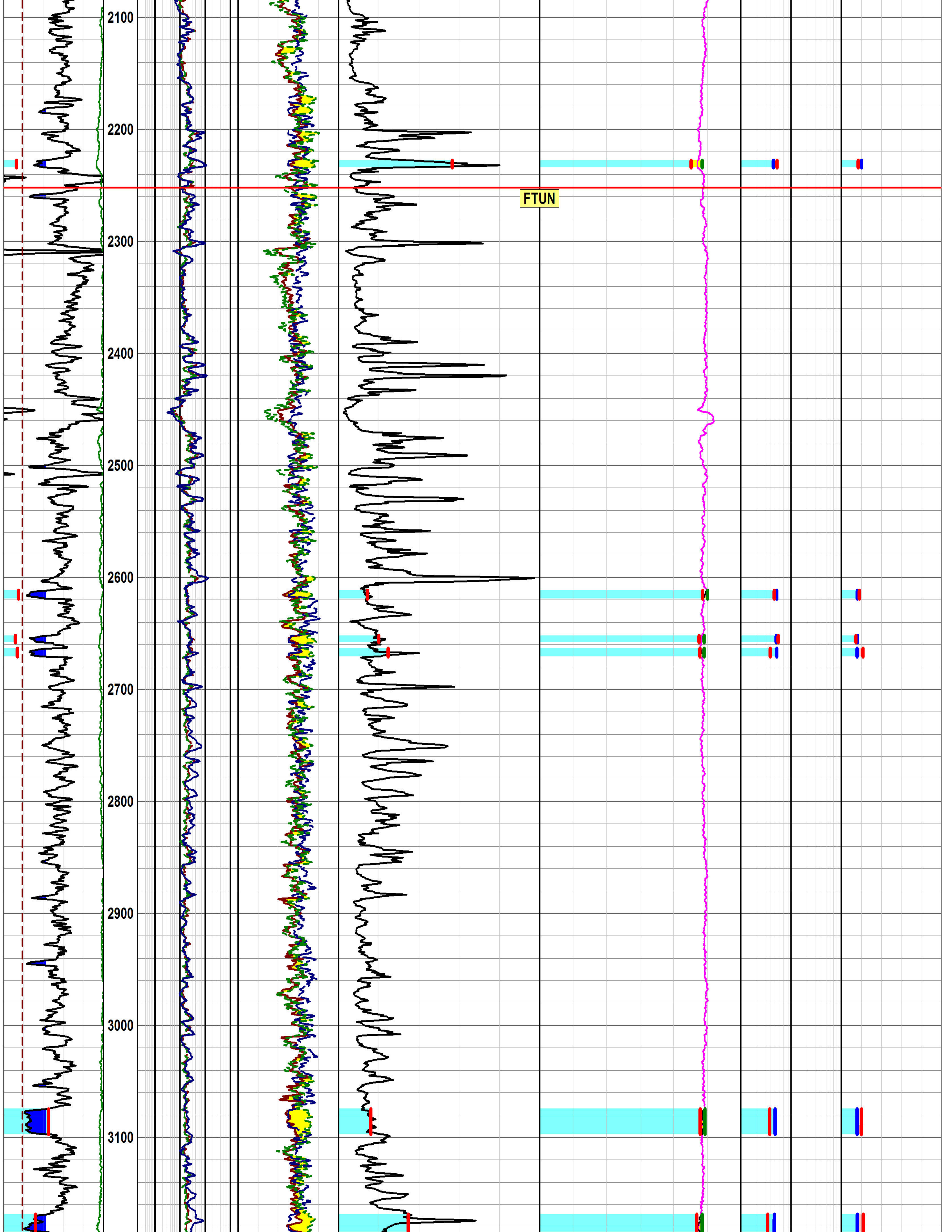
DIGITAL FORMATION

File:	05045126040000 Enyeart 16-4 (PD16).lbs		Well Name:	Enyeart 16-4 (PD16)	
Plot:	SP Shift Deflection				
Gross Interval:	7722	to 289	by -0.5	F	
Ranges:	User Ranges 289-7722				
Time:	08:50 AM		Date:	Thu, Jun 16, 2016	
Section:	16		Township:	7 S	API #: 05-045-126040000
Location:	LOCATION		Range:	95 W	UWI: 05045126040000
Comments:					





1000
1100
1200
1300
1400
1500
1600
1700
WSTCG (Upper)
1800
1900
WSTCG (Lower)
2000


2100
2200
FTUN
2300
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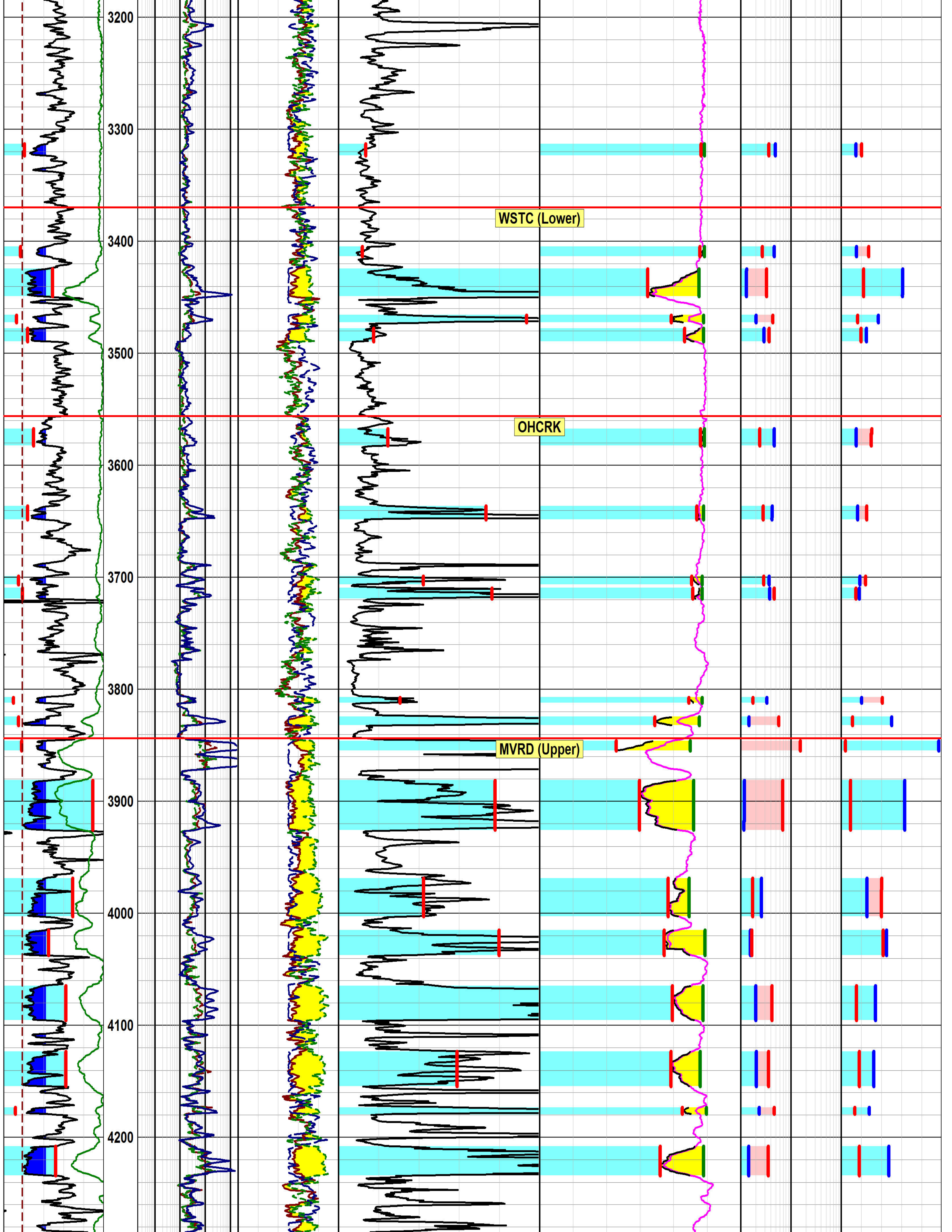
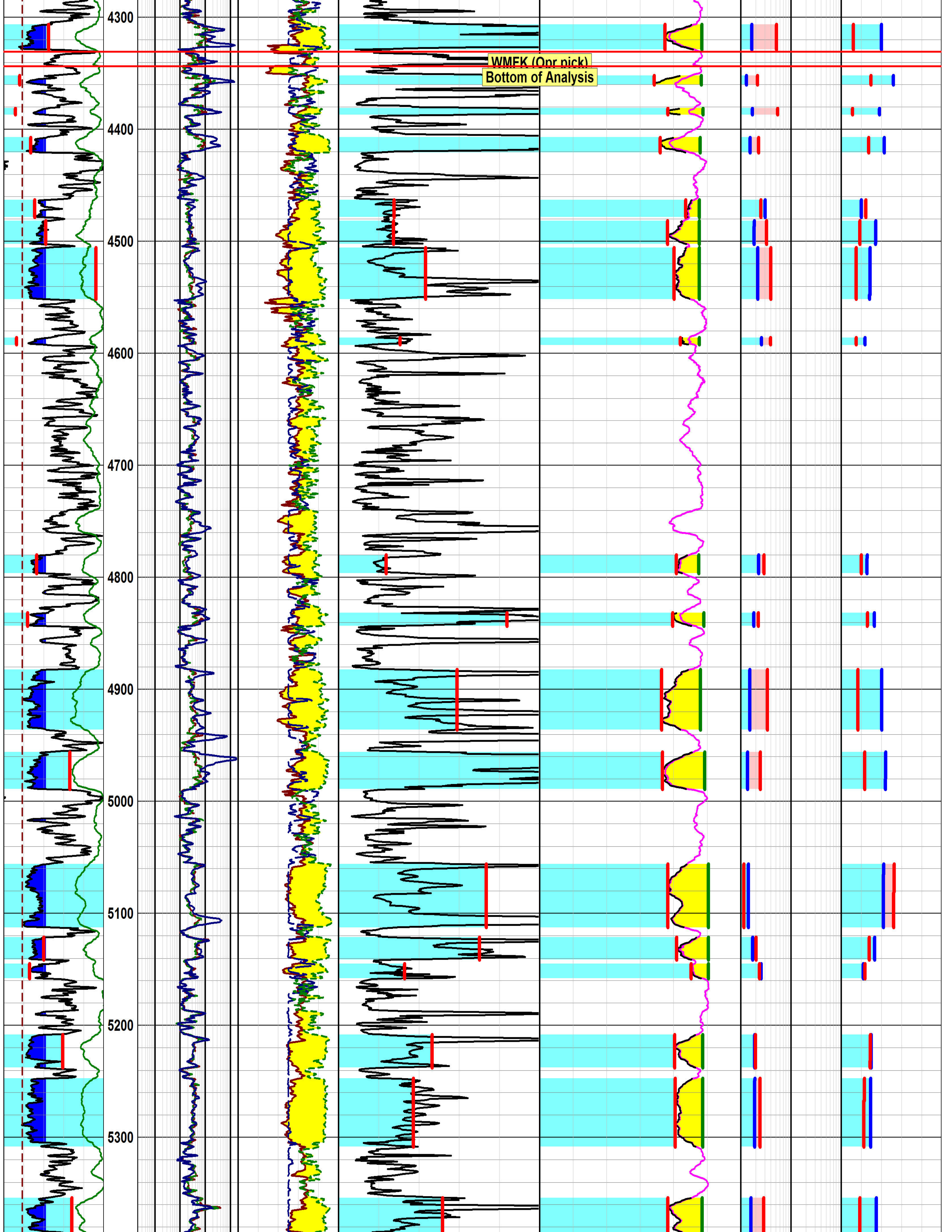
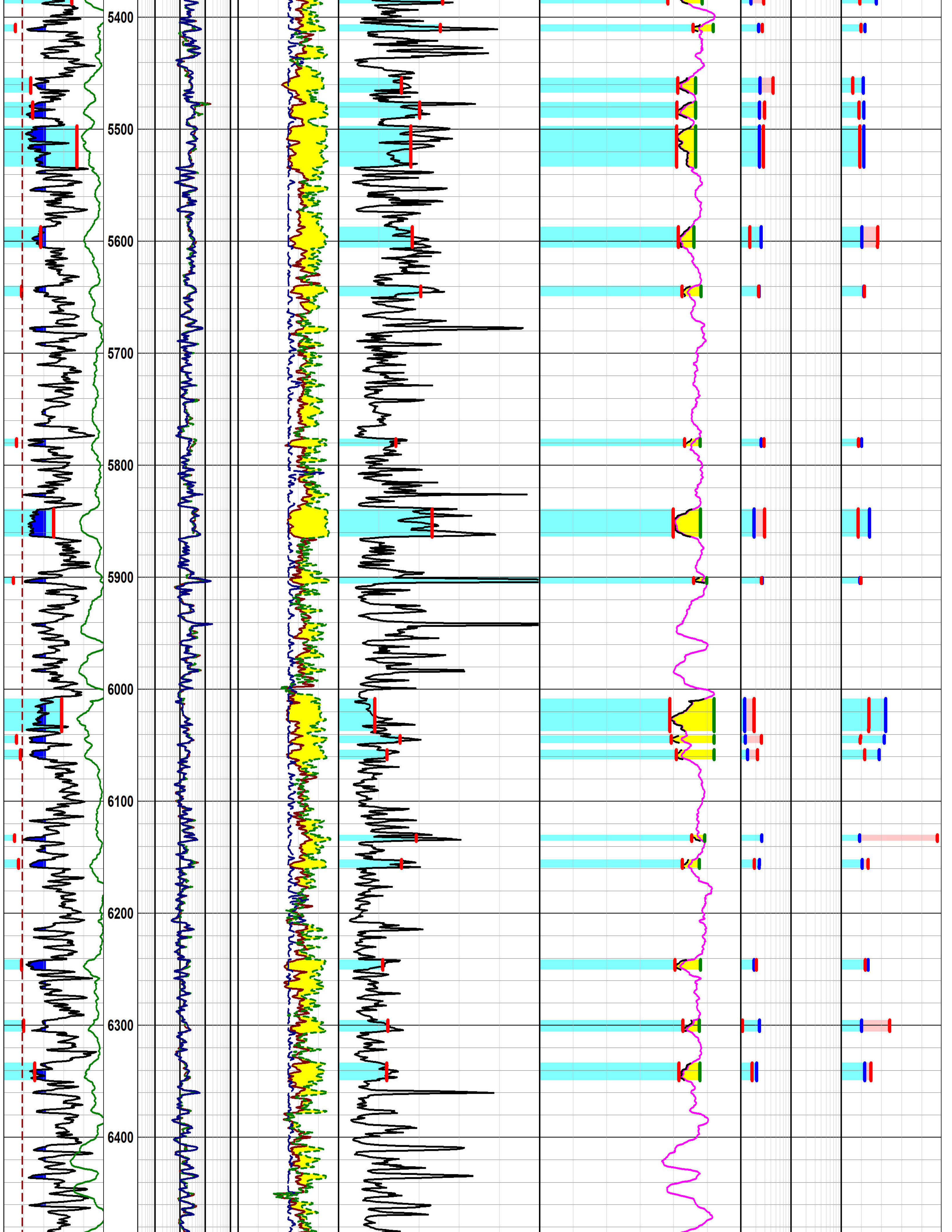
2500
2600
2700
2800
2900
3000
3100



3200
3300
WSTC (Lower)
3400
3500
OHCRK
3600
3700
3800
MVRD (Upper)
3900
4000
4100
4200



4300
WMFK (Opr pick)
Bottom of Analysis
4400
4500
4600
4700
4800
4900
5000
5100
5200
5300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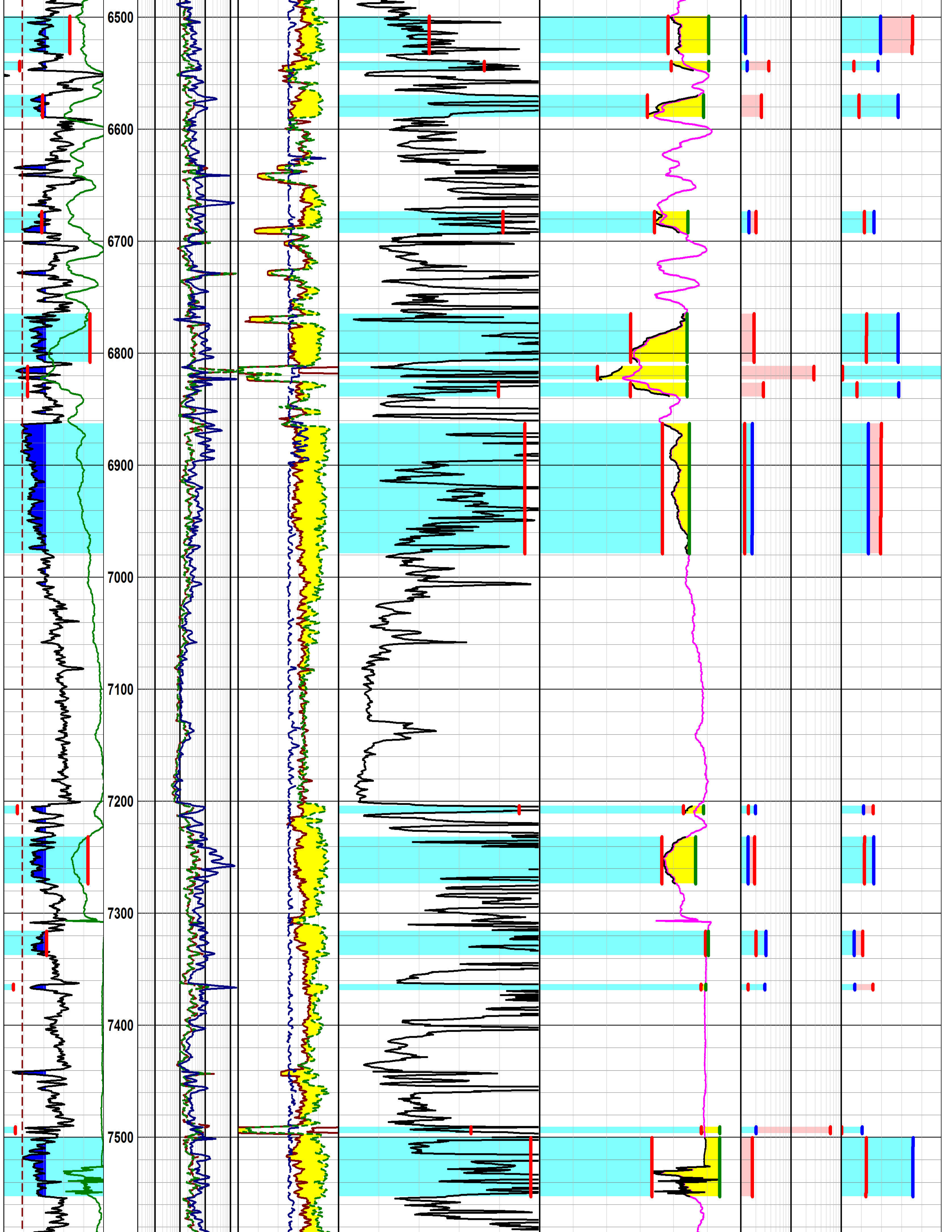
6400



6500
6600
6700
6800
6900
7000
7100
7200
7300
7400
7500


7600
7700
7800

DIGITAL FORMATION

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File: **05045184250000 Williams GM 931-1D.lbs** Well Name: **GM 931-1D**

Plot: **Salinity by Depth**

Gross Interval: **7** to **4849** by **0.5** **FT**

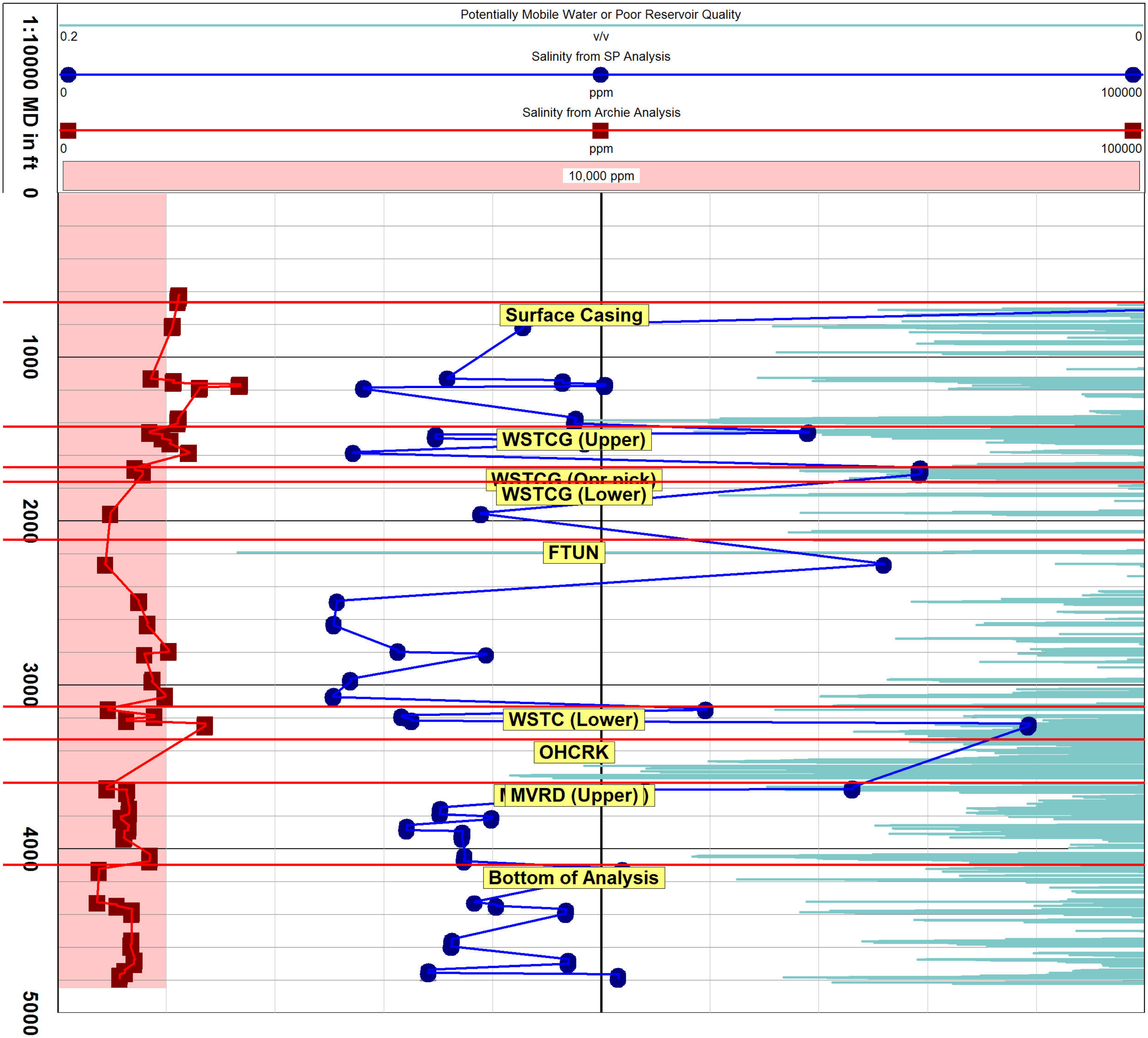
Ranges: **User Ranges**
7-4849

Time: **08:57 AM** Date: **Thu, Jun 16, 2016**

Section: **1** Township: **6S** API #: **05045184250000**

Location: **SHL** Range: **96W** UWI: **050451842500**

Comments:



DIGITAL FORMATION

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File: 05045184250000 Williams GM 931-1D.lbs   Well Name: GM 931-1D

Plot: SP Shift Deflection

Gross Interval: 7 to 4849 by 0.5 FT

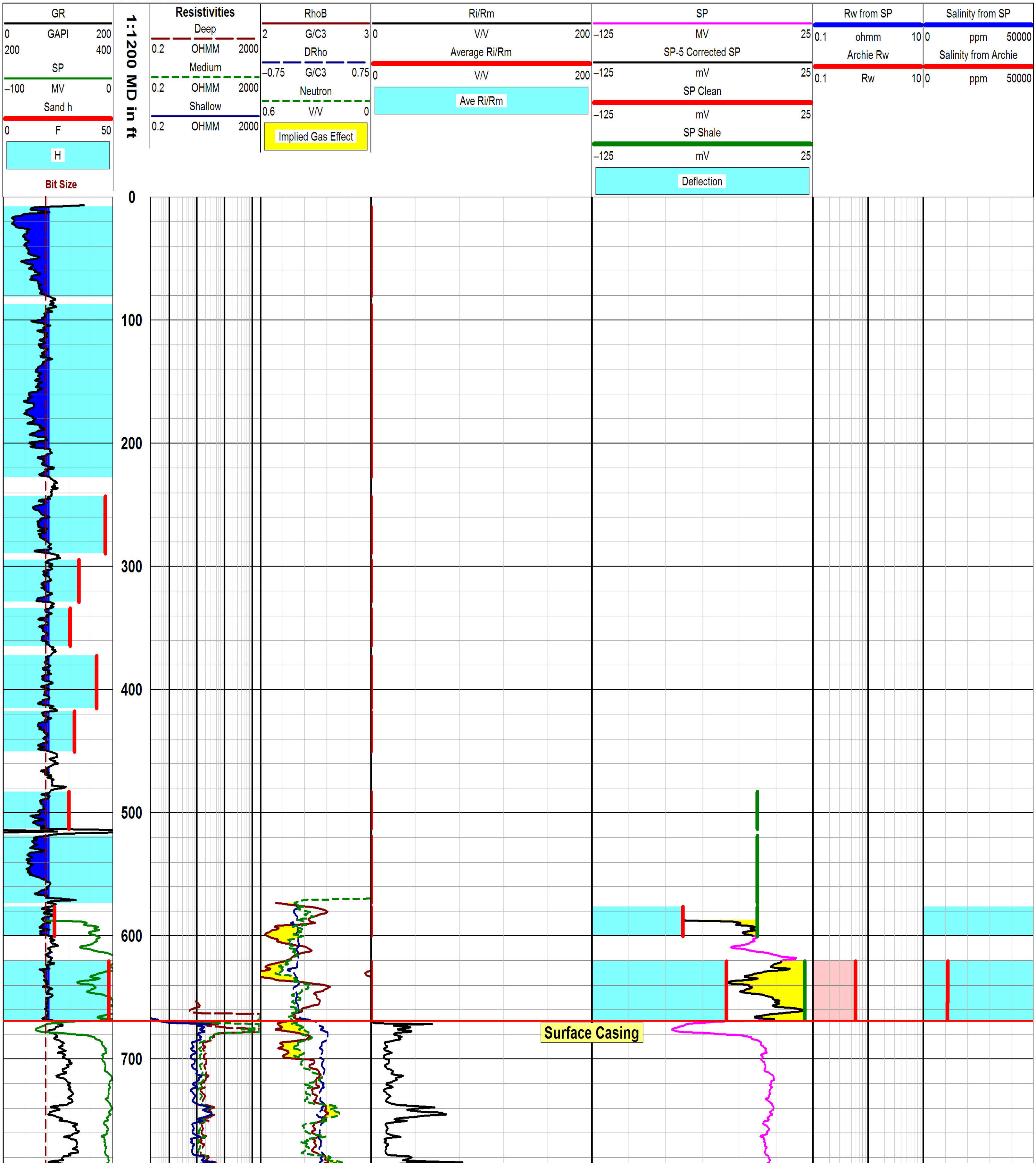
Ranges: User Ranges
7-4849

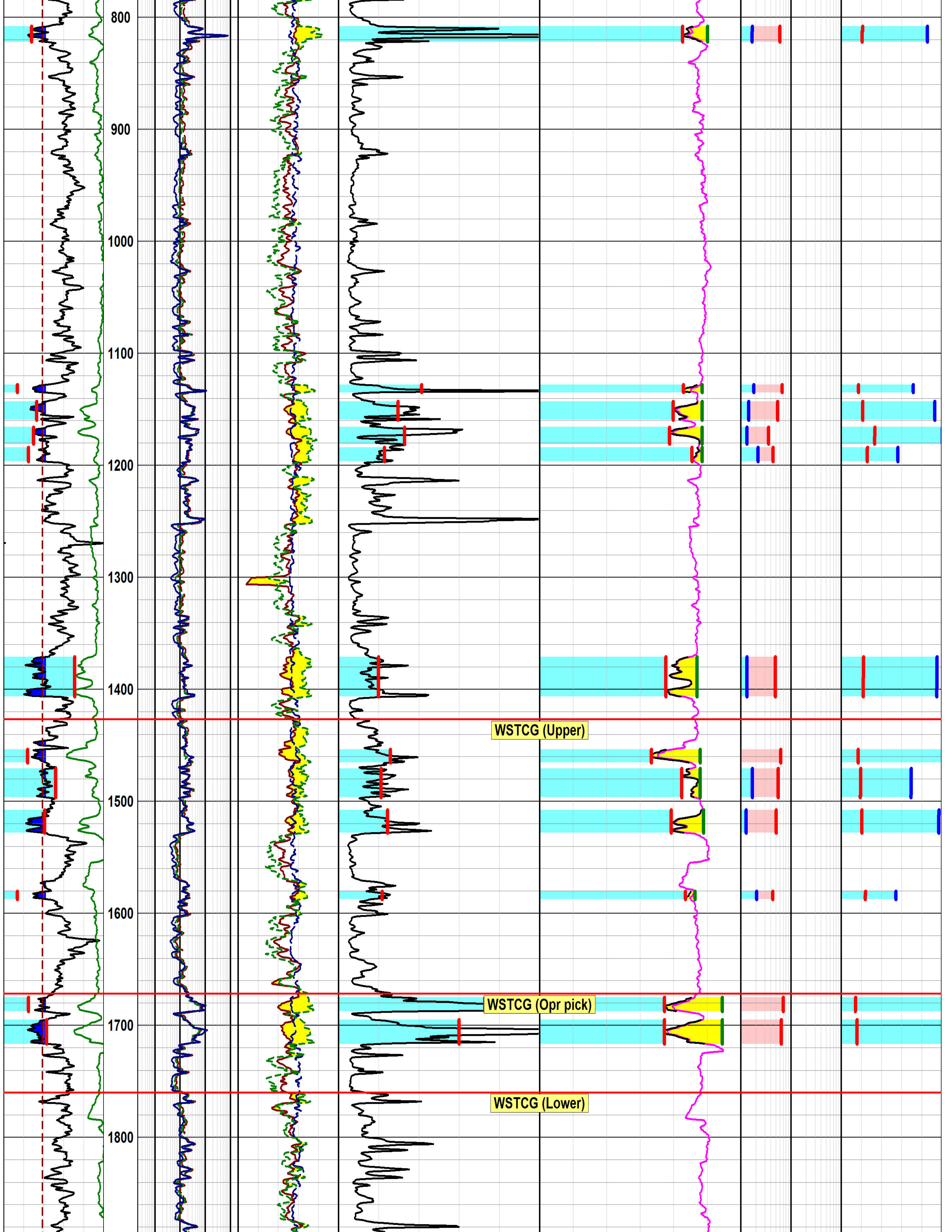
Time: 08:51 AM   Date: Thu, Jun 16, 2016

Section: 1   Township: 6S   API #:05045184250000

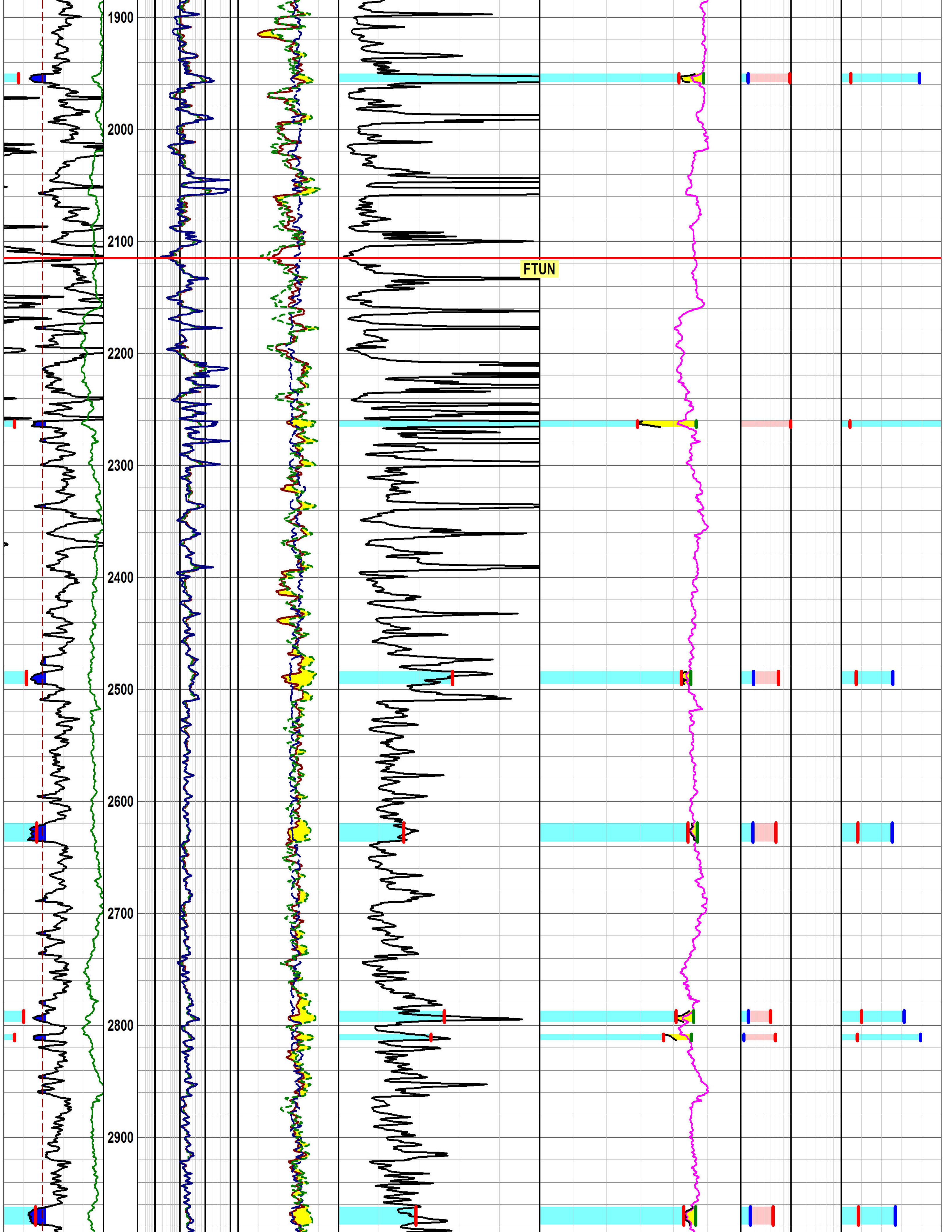
Location: SHL   Range: 96W   UWI: 050451842500

Comments:





800
900
1000
1100
1200
1300
1400
WSTCG (Upper)
1500
1600
WSTCG (Opr pick)
1700
WSTCG (Lower)
1800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2000
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FTUN
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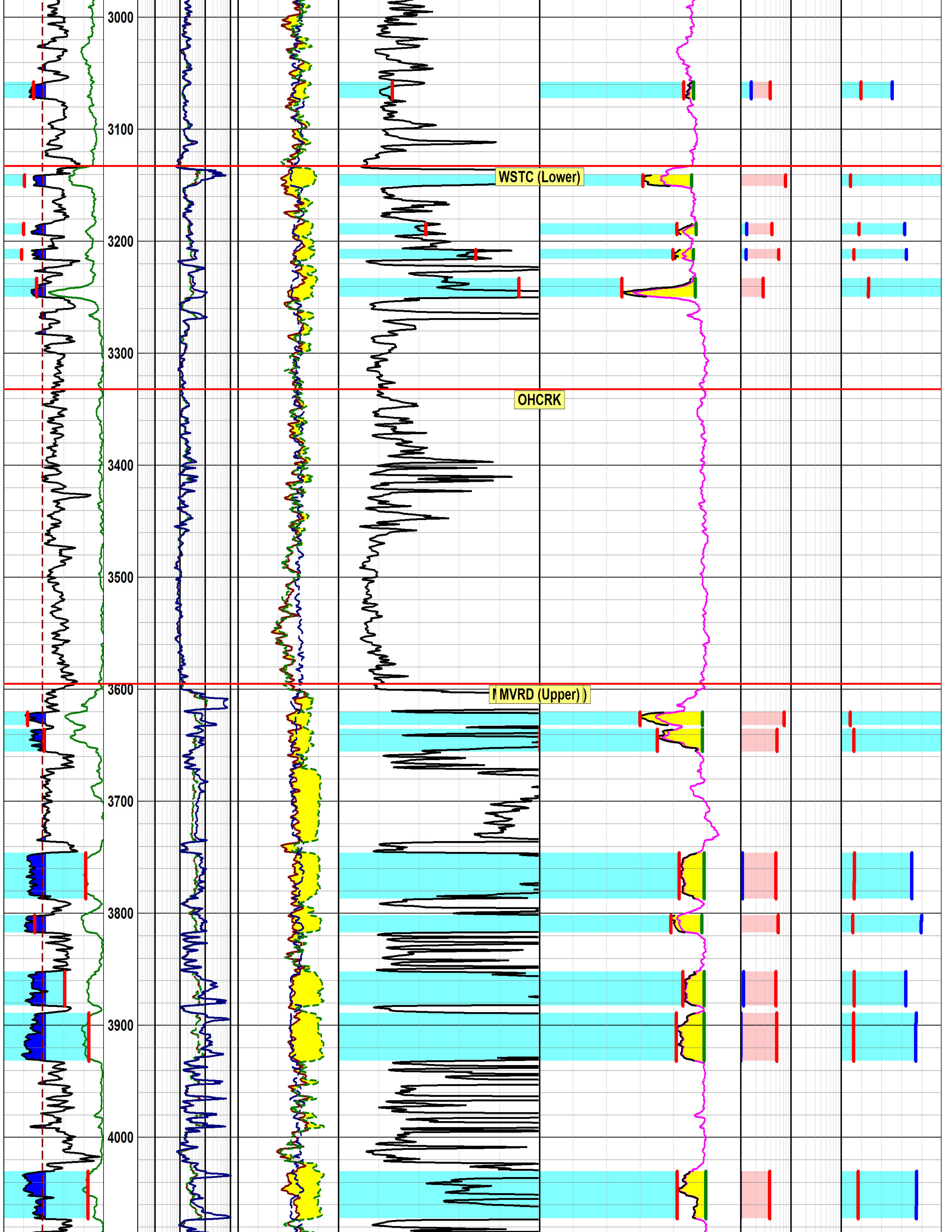
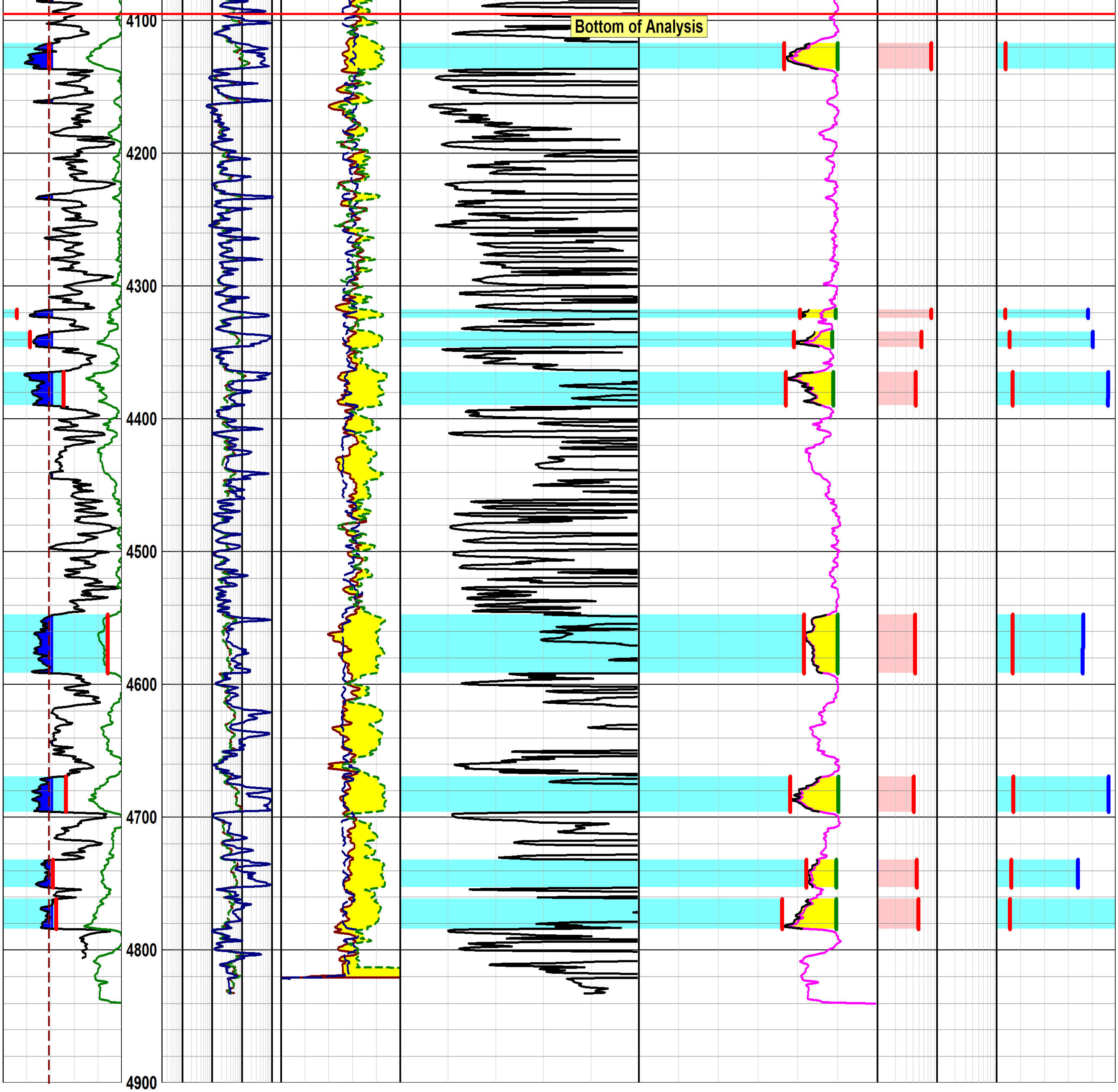
2800
2900


3000
3100
WSTC (Lower)
3200
3300
OHCRK
3400
3500
3600
MVRD (Upper)
3700
3800
3900
4000


Bottom of Analysis
4100
4200
4300
4400
4500
4600
4700
4800
4900

LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045222650000 C&C Energy GM 23-13.lbs

Well Name: C&C ENERGY GM 23-13

Plot: Salinity by Depth

Gross Interval: -3.5 to 6479.5 by 0.5 FT

Ranges: User Ranges -3.5-6479.5

Time: 08:57 AM

Date: Thu, Jun 16, 2016

Section: 13

Township: 7S

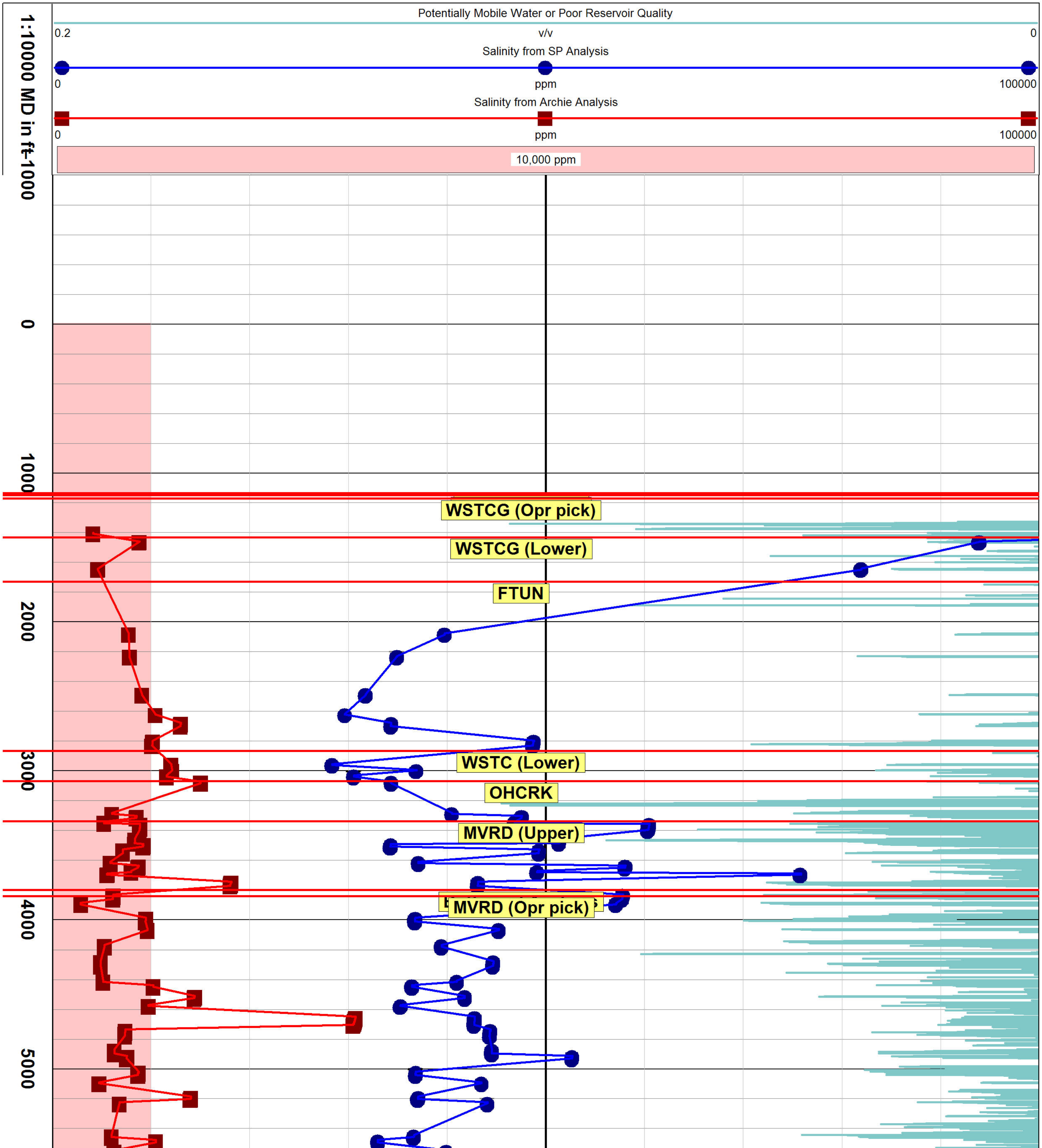
API #: 05045222650000

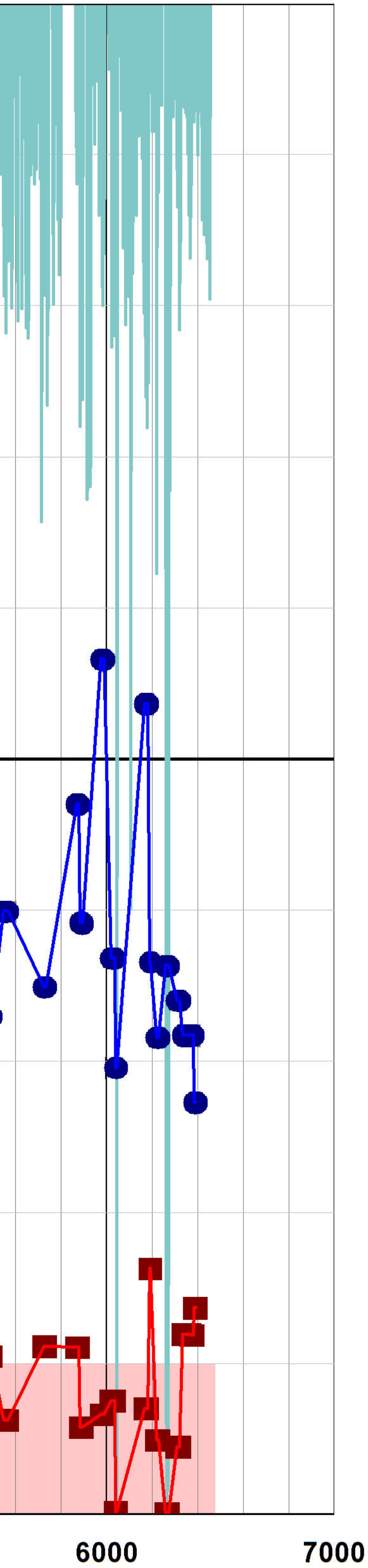
Location: SHL

Range: 96W

UWI: 05045222650000

Comments:





6000
7000

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File: 05045222650000 C&C Energy GM 23-13.lbs   Well Name: C&C ENERGY GM 23-13

Plot: SP Shift Deflection

Gross Interval: -3.5 to 6479.5 by 0.5 FT

Ranges: User Ranges
-3.5-6479.5

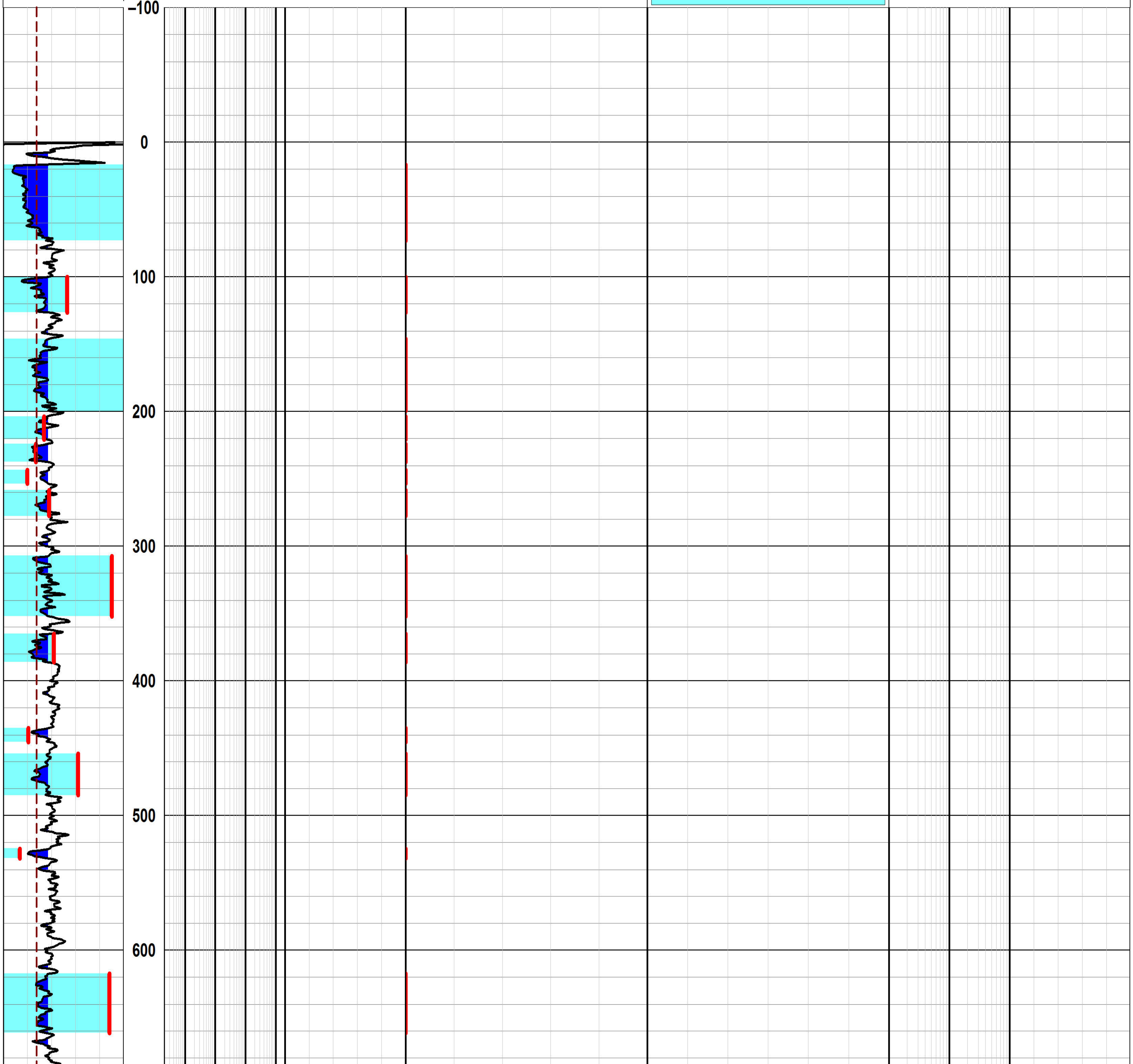
Time: 08:52 AM   Date: Thu, Jun 16, 2016

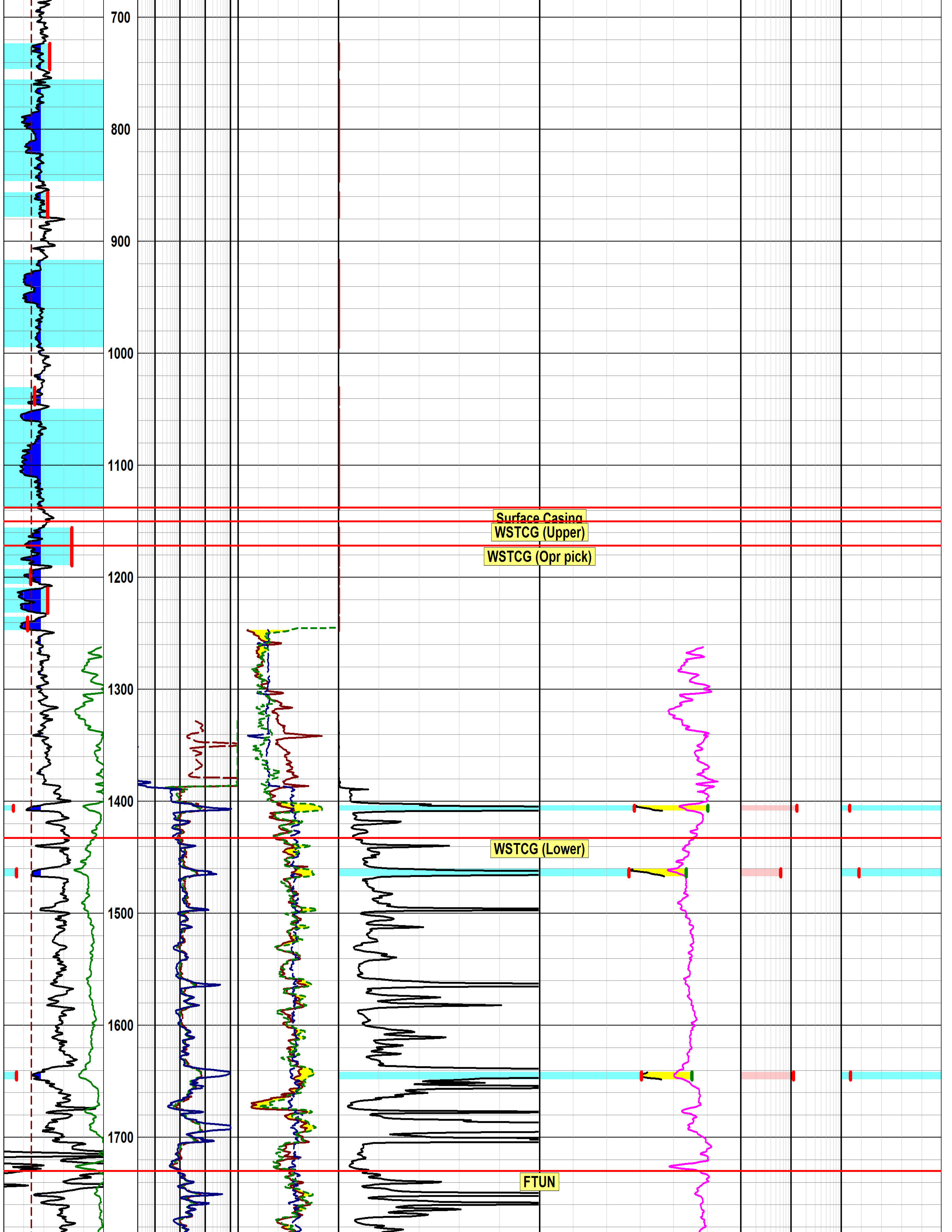
Section: 13   Township: 7S   API #:05045222650000

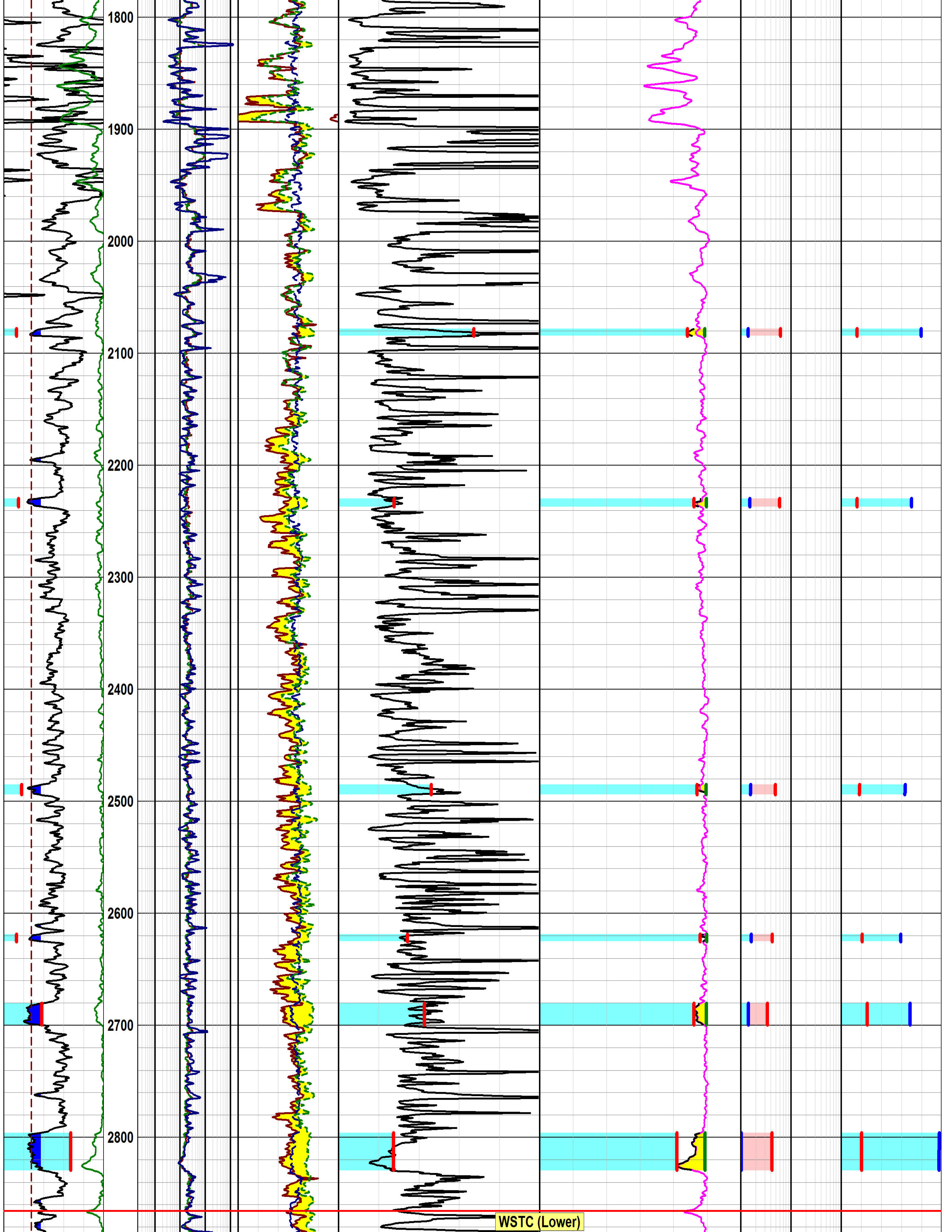
Location: SHL   Range: 96W   UWI: 05045222650000

Comments:

GR	1:1200 MD in ft	Resistivities	RhoB	Ri/Rm	SP	Rw from SP	Salinity from SP
0 GAPI 200 200 400 SP -100 MV 0 Sand h 0 F 50 H Bit Size		Deep 0.2 OHMM 2000 Medium 0.2 OHMM 2000 Shallow 0.2 OHMM 2000	2 G/C3 3 DRho -0.75 G/C3 0.75 Neutron 0.6 V/V 0 Implied Gas Effect	0 V/V 200 Average Ri/Rm 0 V/V 200 Ave Ri/Rm	-125 MV 25 SP-5 Corrected SP -125 mV 25 SP Clean -125 mV 25 SP Shale -125 mV 25 Deflection	0.1 ohmm 10 Archie Rw 0.1 Rw 10	0 ppm 50000 Salinity from Archie 0 ppm 50000




700
800
900
1000
1100
Surface Casing
WSTCG (Upper)
WSTCG (Opr pick)
1200
1300
1400
WSTCG (Lower)
1500
1600
1700
FTUN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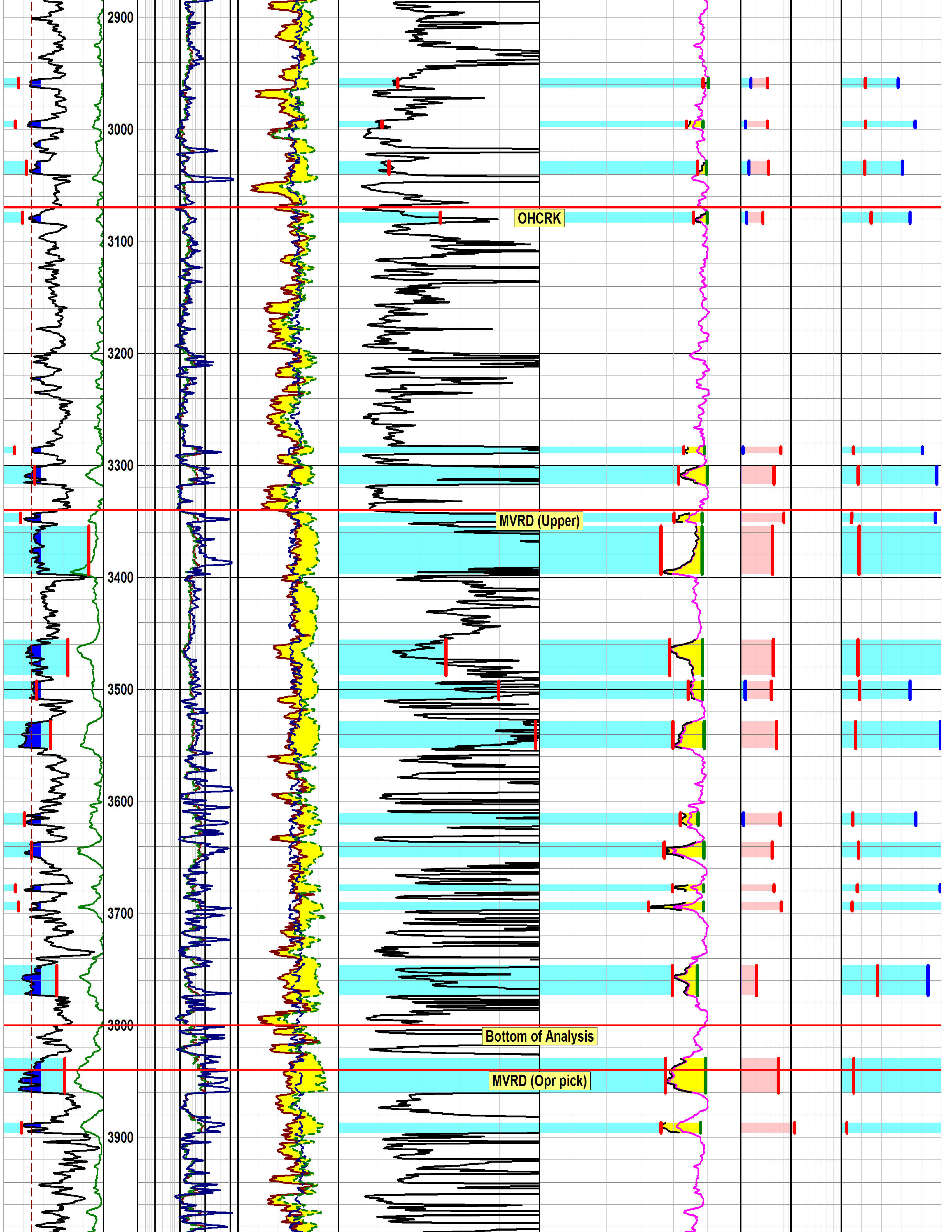
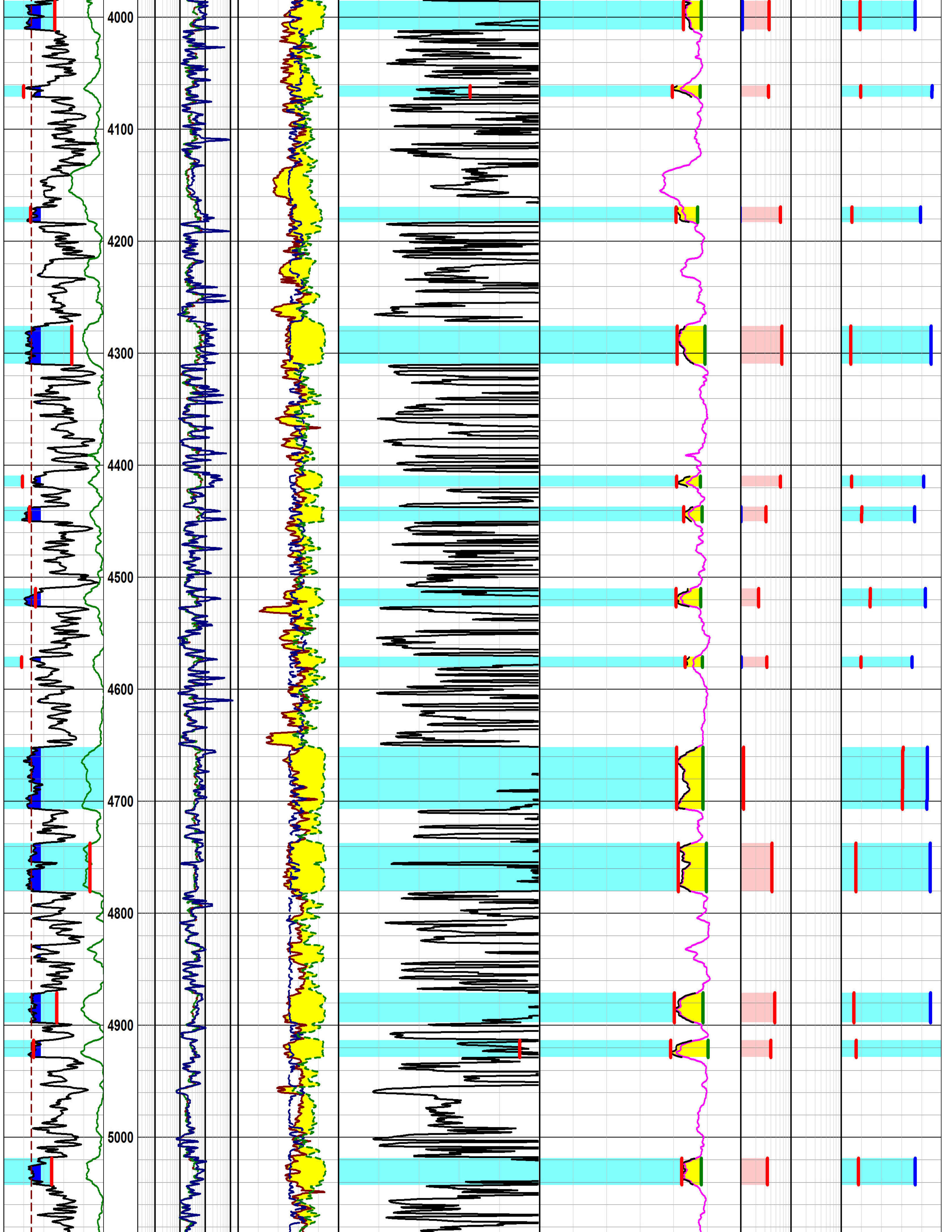
2400
2500
2600
2700
2800
WSTC (Lower)


2900
3000
OHCRK
3100
3200
3300
MVRD (Upper)
3400
3500
3600
3700
3800
Bottom of Analysis
MVRD (Opr pick)
3900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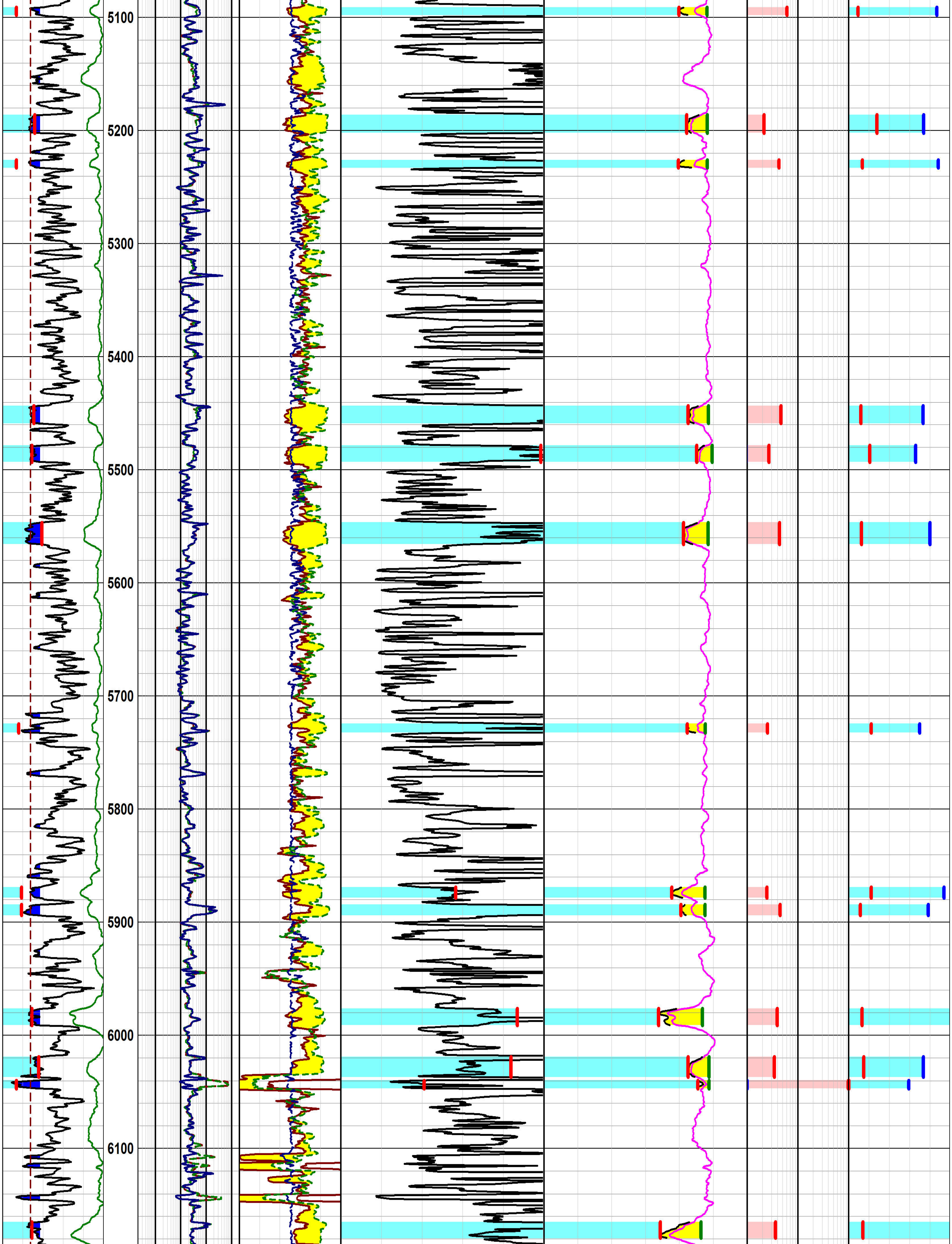
4900
5000


5100
5200
5300
5400
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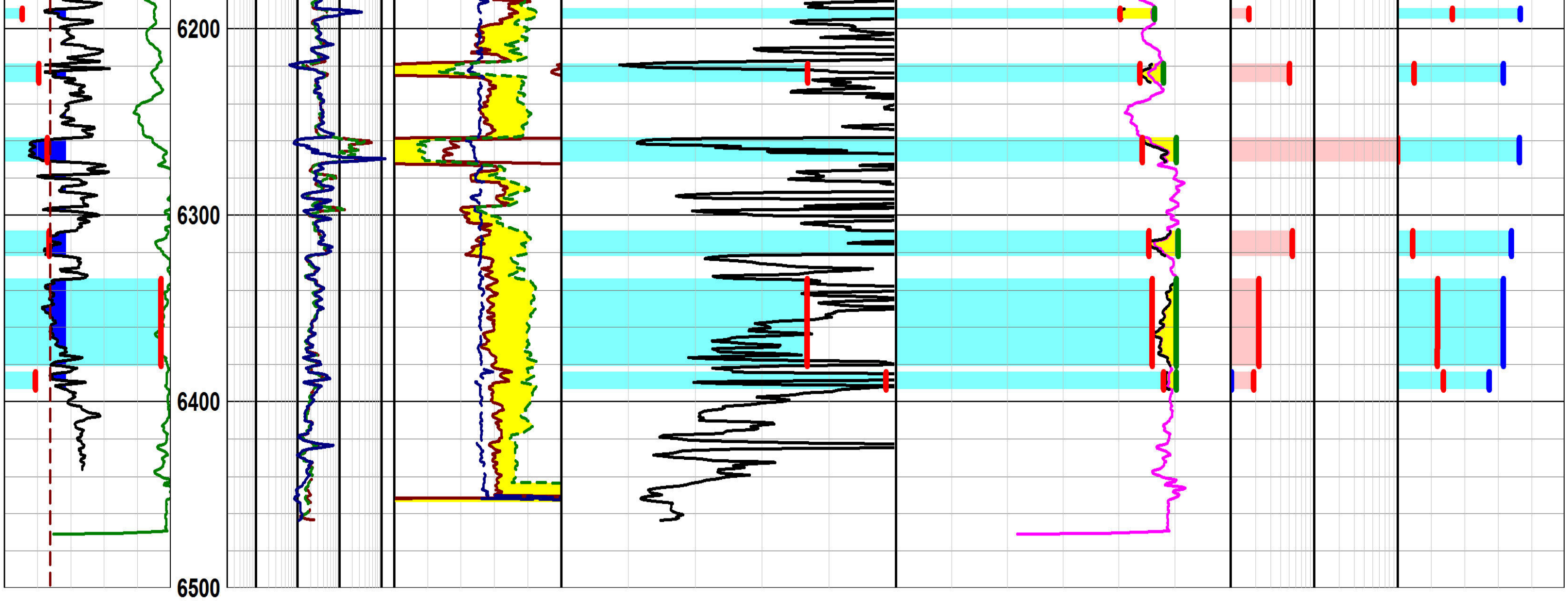
5600
5700
5800
5900
6000
6100



6200
6300
6400
6500

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File: 05045224090000 Hicks PA 44-6.lbs

Well Name: HICKS PA 44-6

Plot: Salinity by Depth

Gross Interval: 69 to 6687.5 by 0.5 FT

Ranges: User Ranges 69-6687.5

Time: 08:57 AM

Date: Thu, Jun 16, 2016

Section: 6

Township: 7S

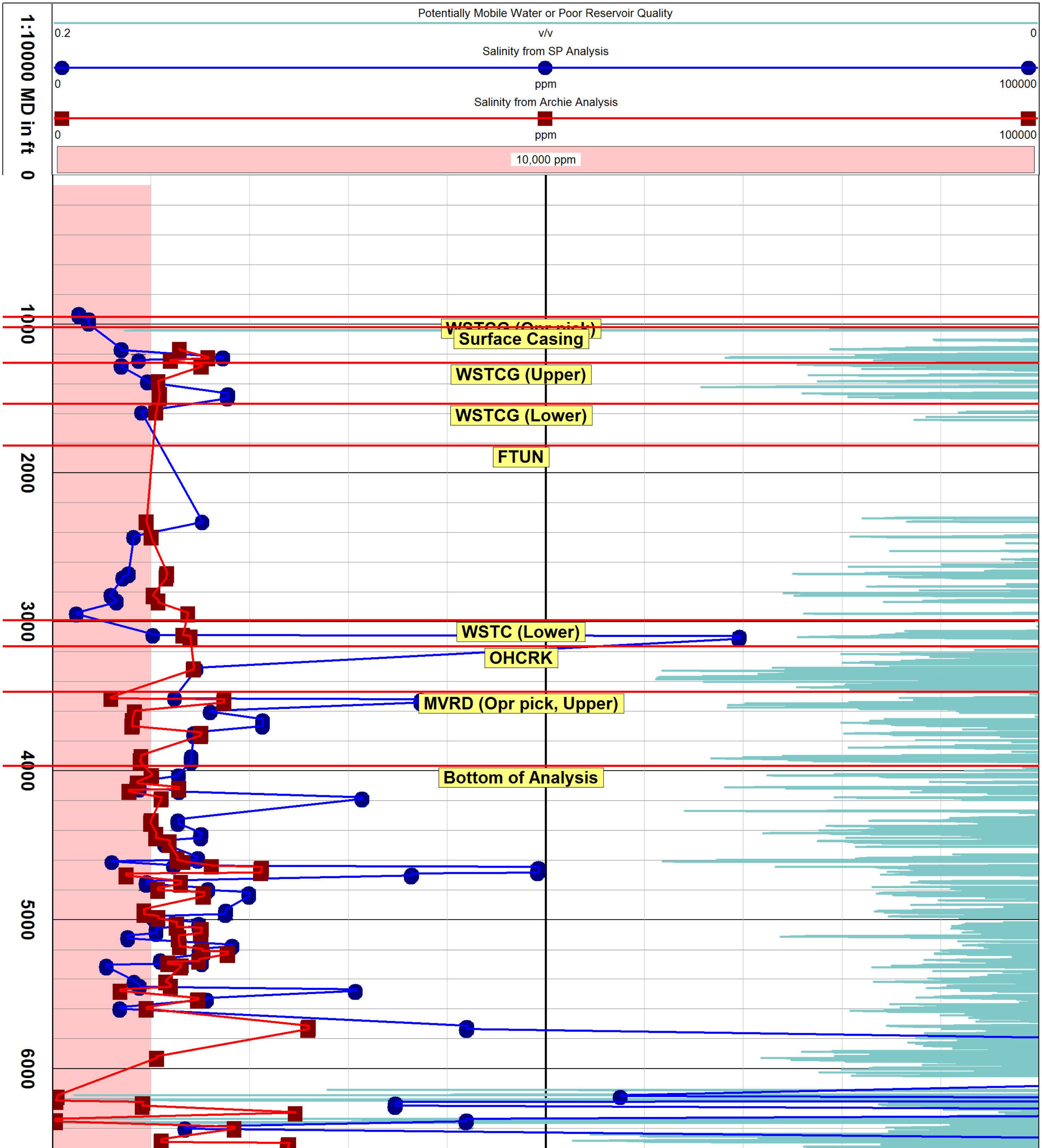
API #: 05045224090000

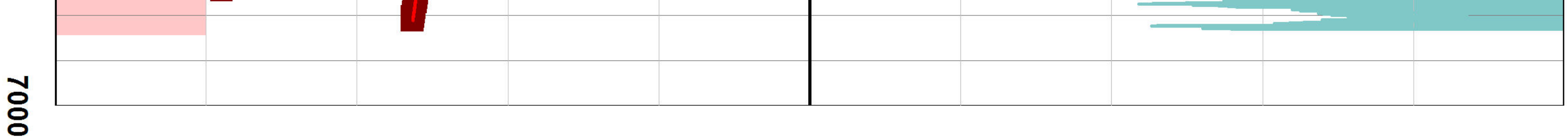
Location: SHL

Range: 95W

UWI: 05045224090000

Comments:




7000

LESA 2016, © 1992-2016 Digital Formation, Inc.

File: 05045224090000 Hicks PA 44-6.lbs   Well Name: HICKS PA 44-6

Plot: SP Shift Deflection

Gross Interval: 69 to 6687.5 by 0.5 FT

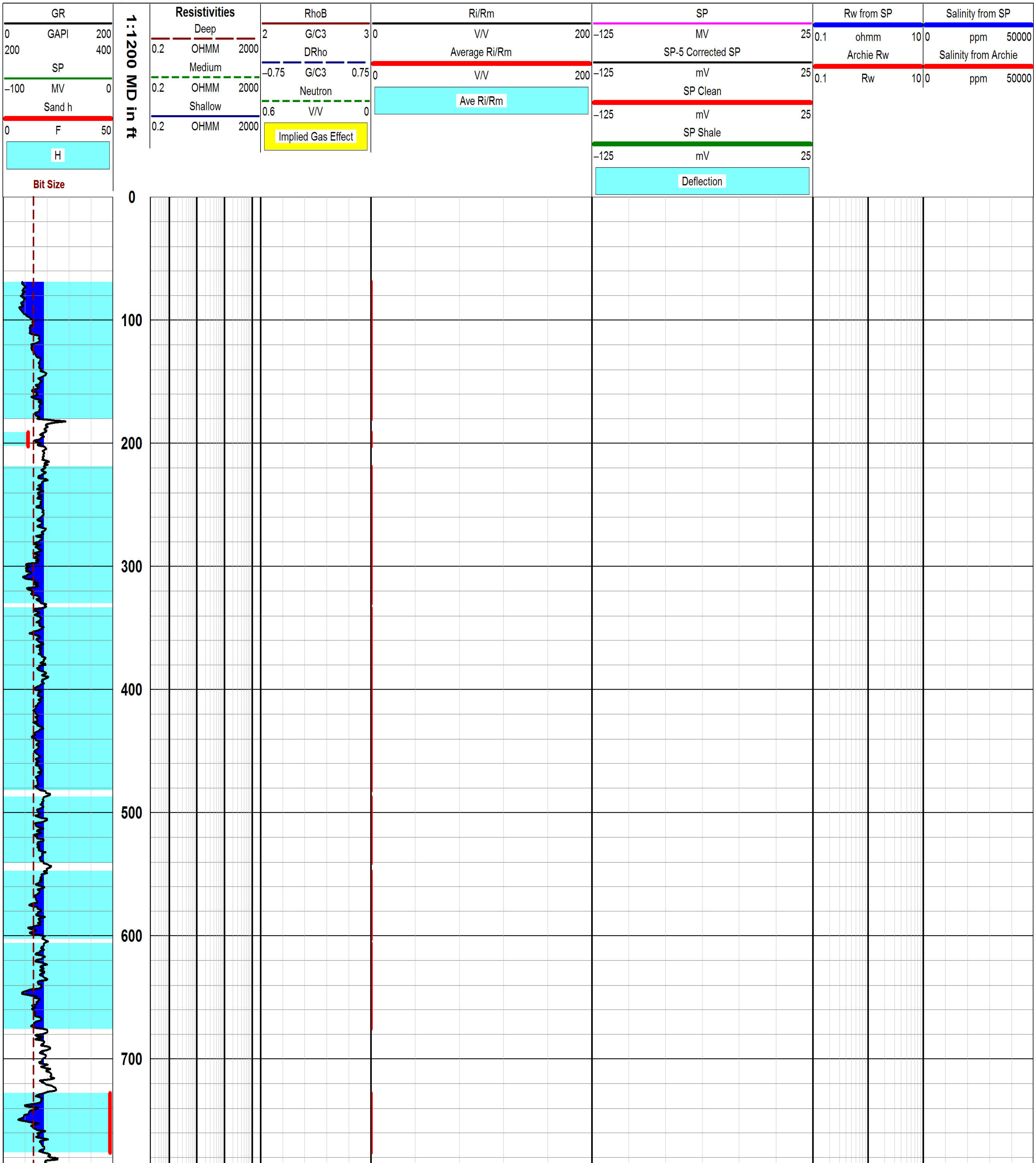
Ranges: User Ranges 69-6687.5

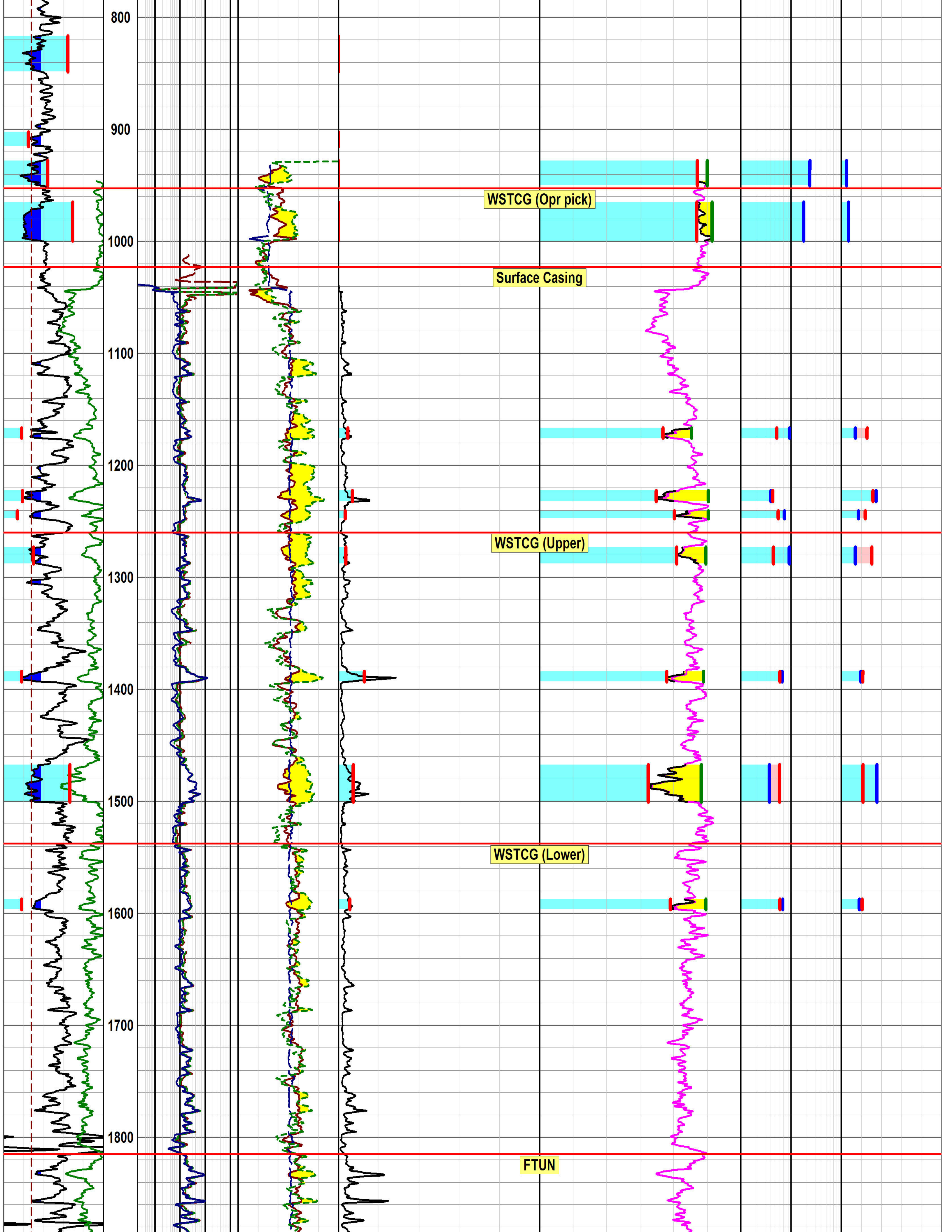
Time: 08:53 AM   Date: Thu, Jun 16, 2016

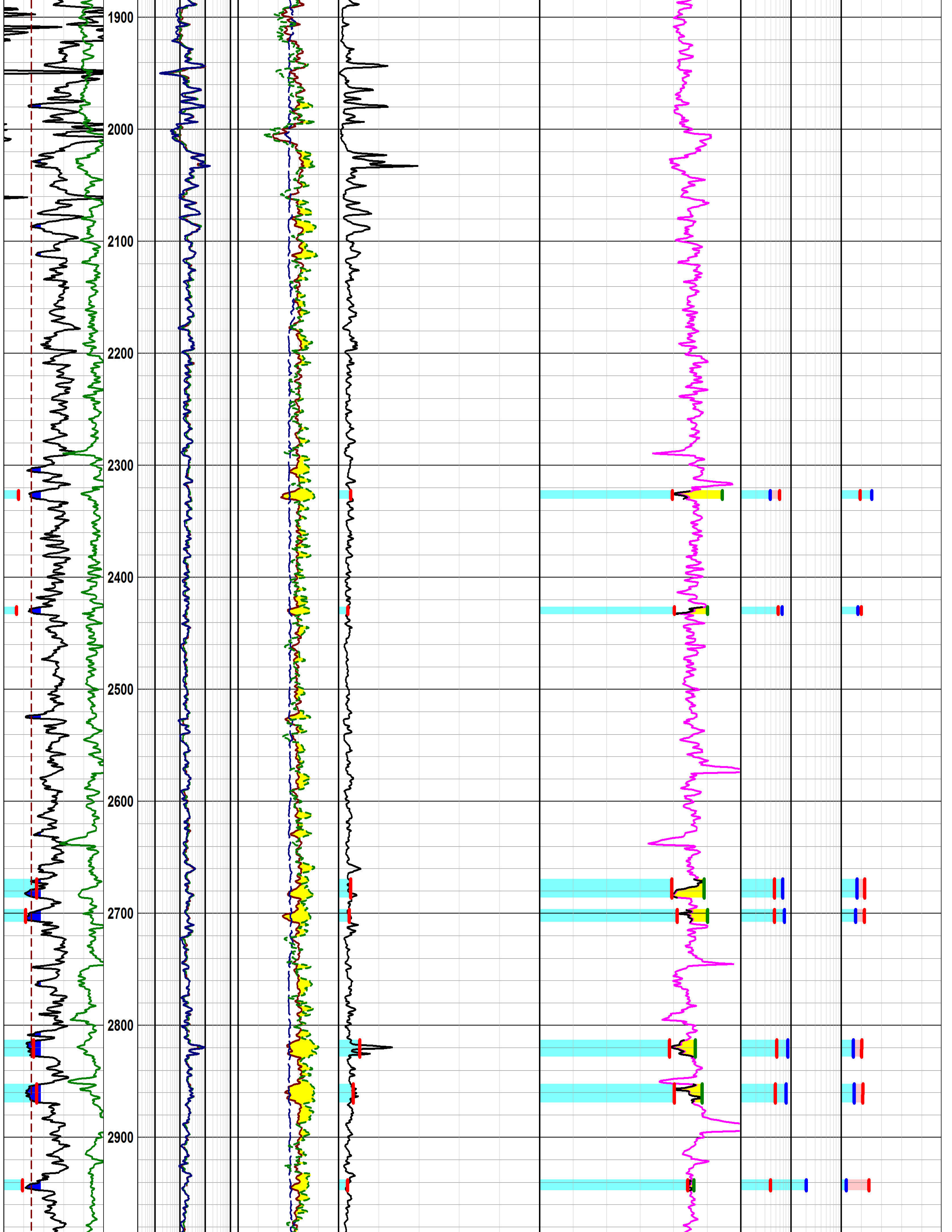
Section: 6   Township: 7S   API #: 05045224090000

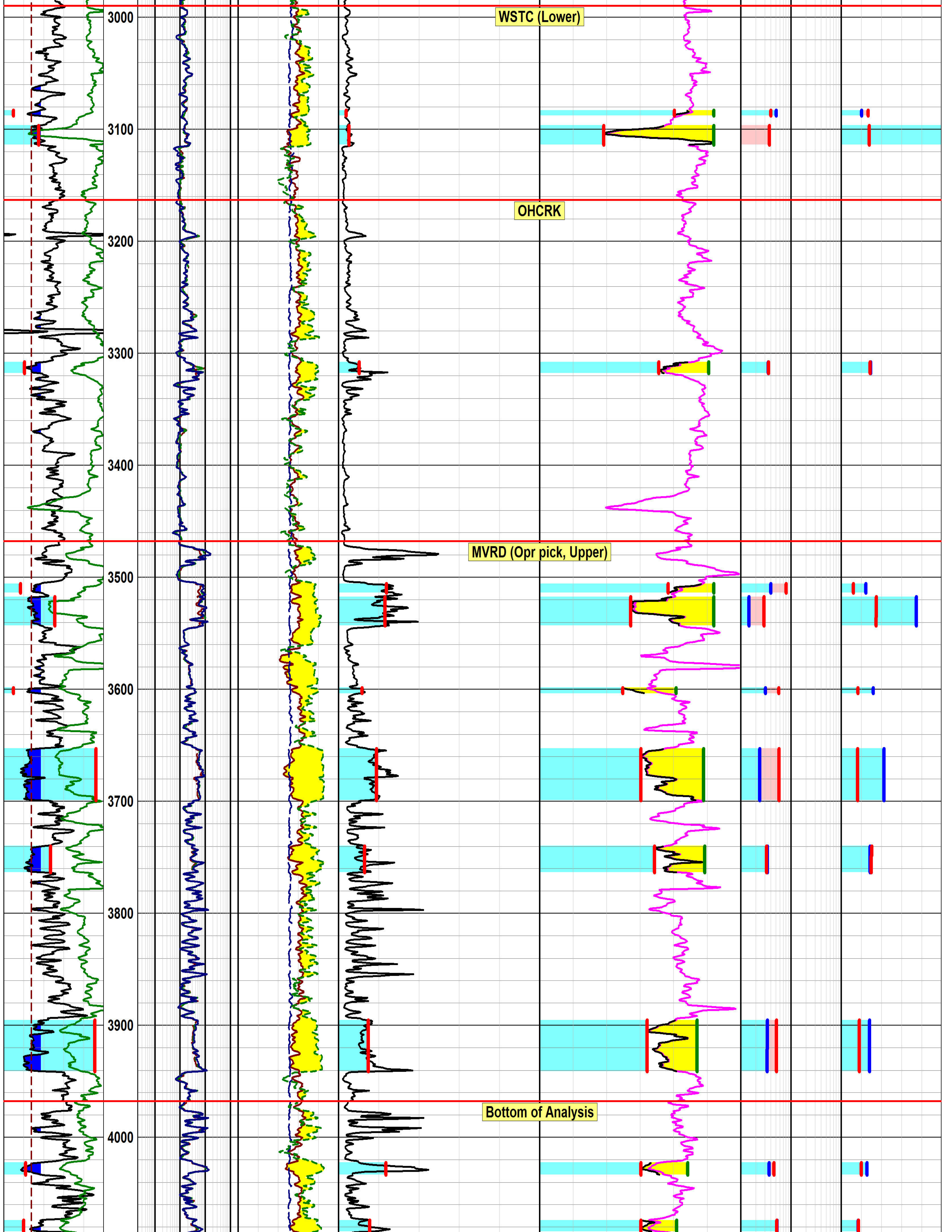
Location: SHL   Range: 95W   UWI: 05045224090000

Comments:

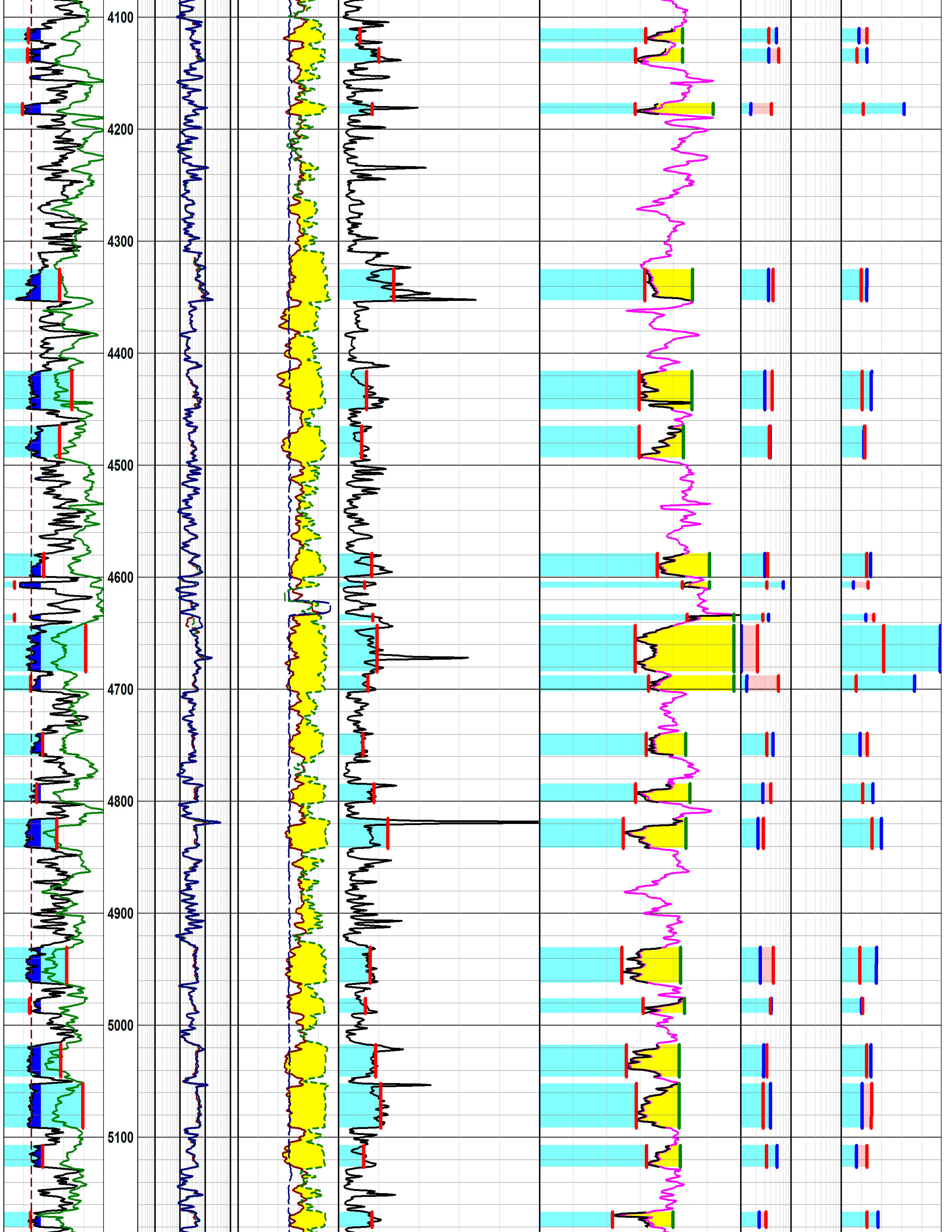



800
900
WSTCG (Opr pick)
1000
Surface Casing
1100
1200
WSTCG (Upper)
1300
1400
1500
WSTCG (Lower)
1600
1700
1800
FTUN


1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900



WSTC (Lower)
3000
3100
OHCRK
3200
3300
3400
MVRD (Opr pick, Upper)
3500
3600
3700
3800
3900
Bottom of Analysis
4000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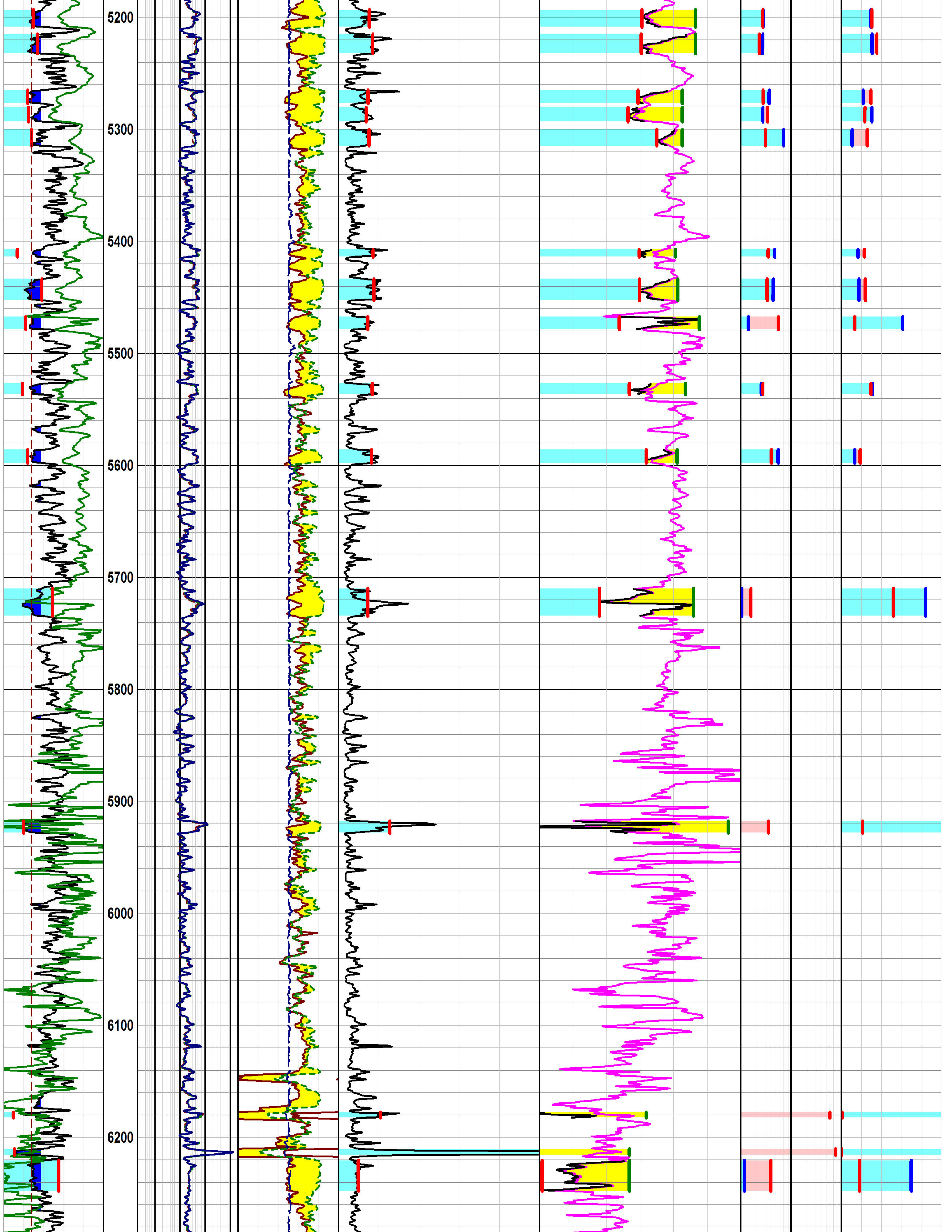
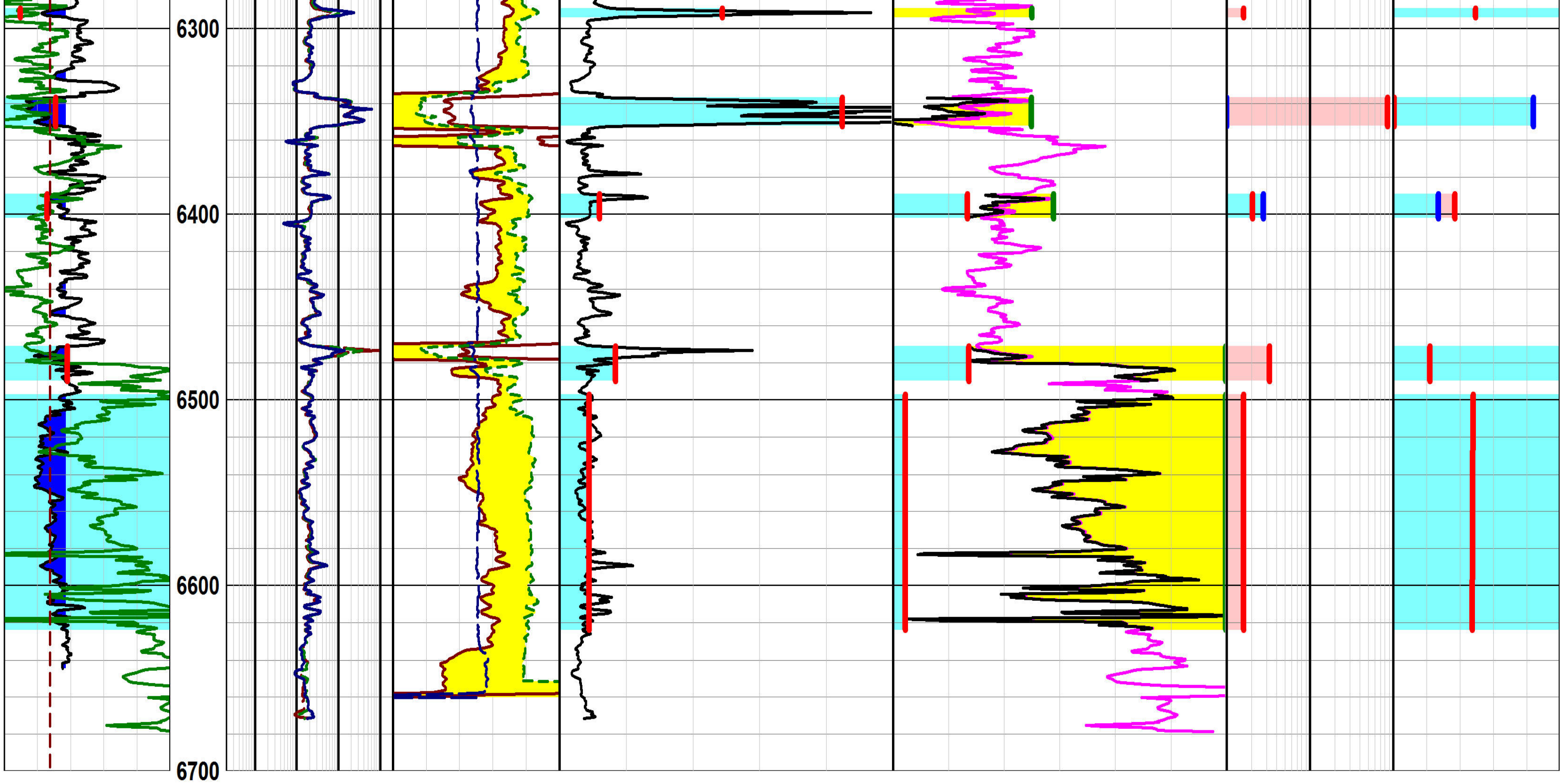
4200
4300
4400
4500
4600
4700
4800
4900
5000
5100



5200
5300
5400
5500
5600
5700
5800
5900
6000
6100
6200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