Upper Bahariya Thin Laminated Low Resistivity Pay Sandstone Reservoir, Safwa Field, Abu Gharadig Basin, Western Desert, Egypt

By

PetroSafwa Exploration Department

Agenda

- Location
- Safwa Field Overview
- Upper Bahariya Reservoir and Sub-division
- Sabbar-1 Well Re-evaluation and Test
- Safwa NW-3 Second Well Test Results
- Conclusion and Recommendation

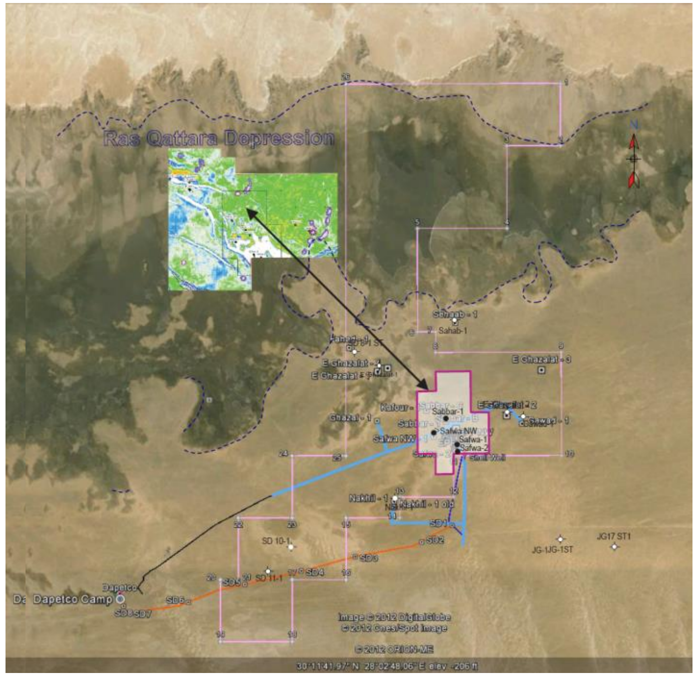
NORTH PETROLEUM INTERNATIONAL COMPANY S.A.

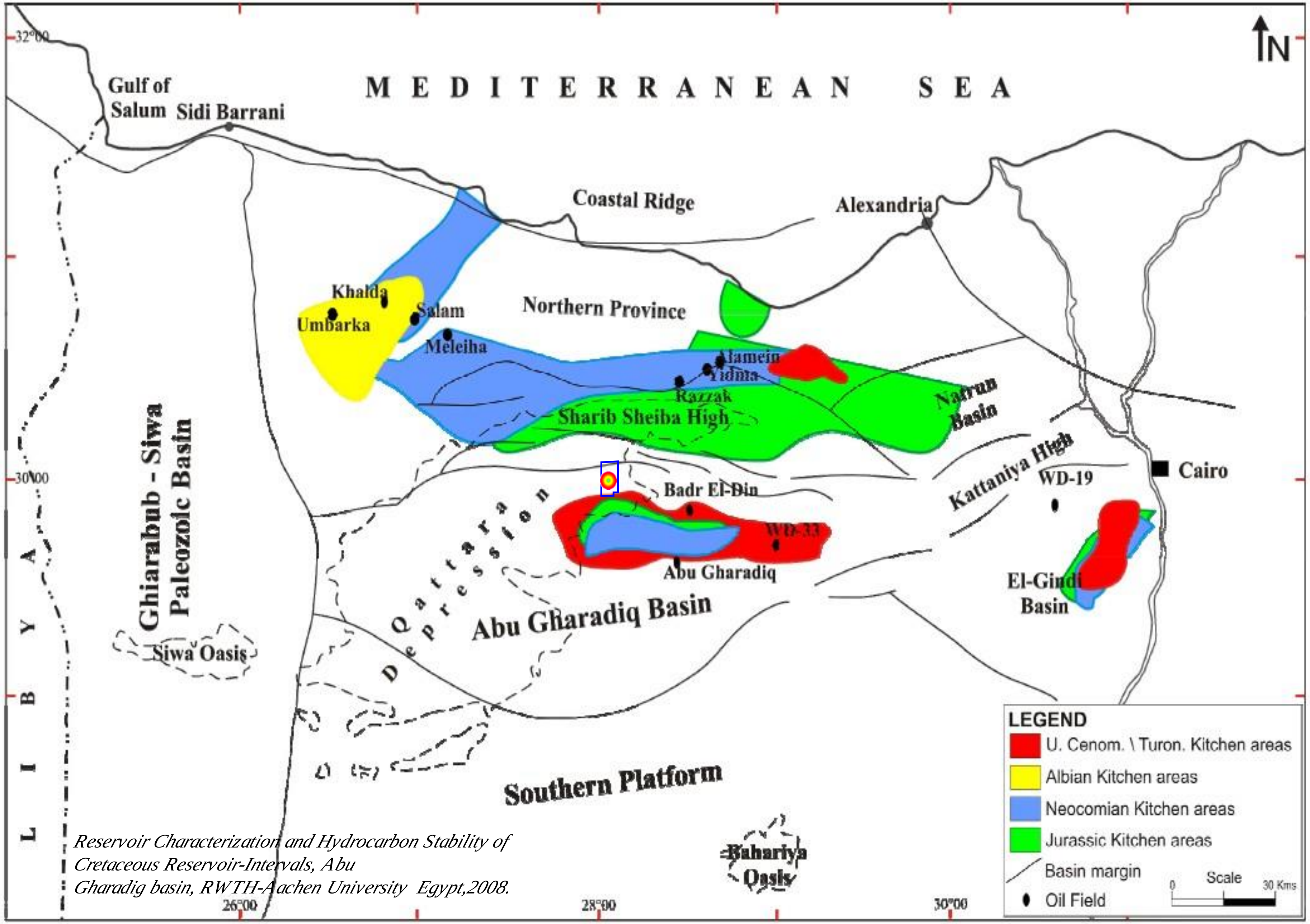
振华石油 ZhenHua Oil

➢ Location

Safwa oil field is located in the East Ghazalat Concession in the proven and prolific Abu Gharadig basin, Western Desert. About 250 Km to the southwest of Cairo.

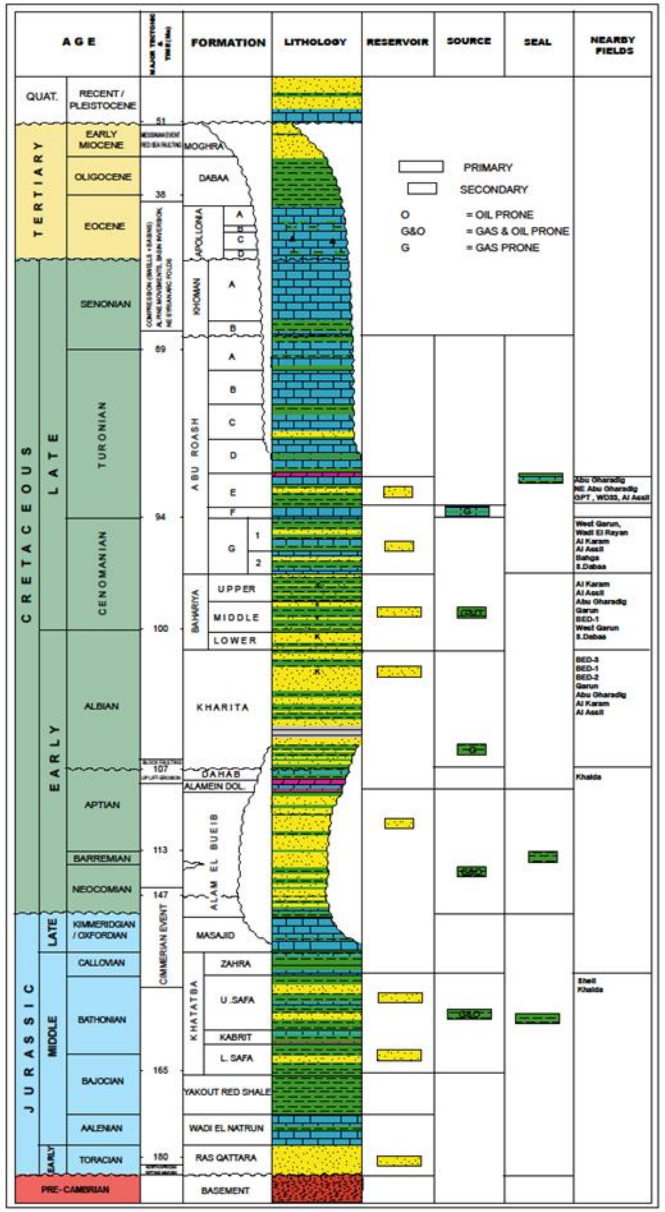
It's located in the vicinity of several *producing fields ranging from small to large size of hydrocarbon accumulation, adjacent to the NW-SE trending major Abu Gharadig fault which is throwing SW*

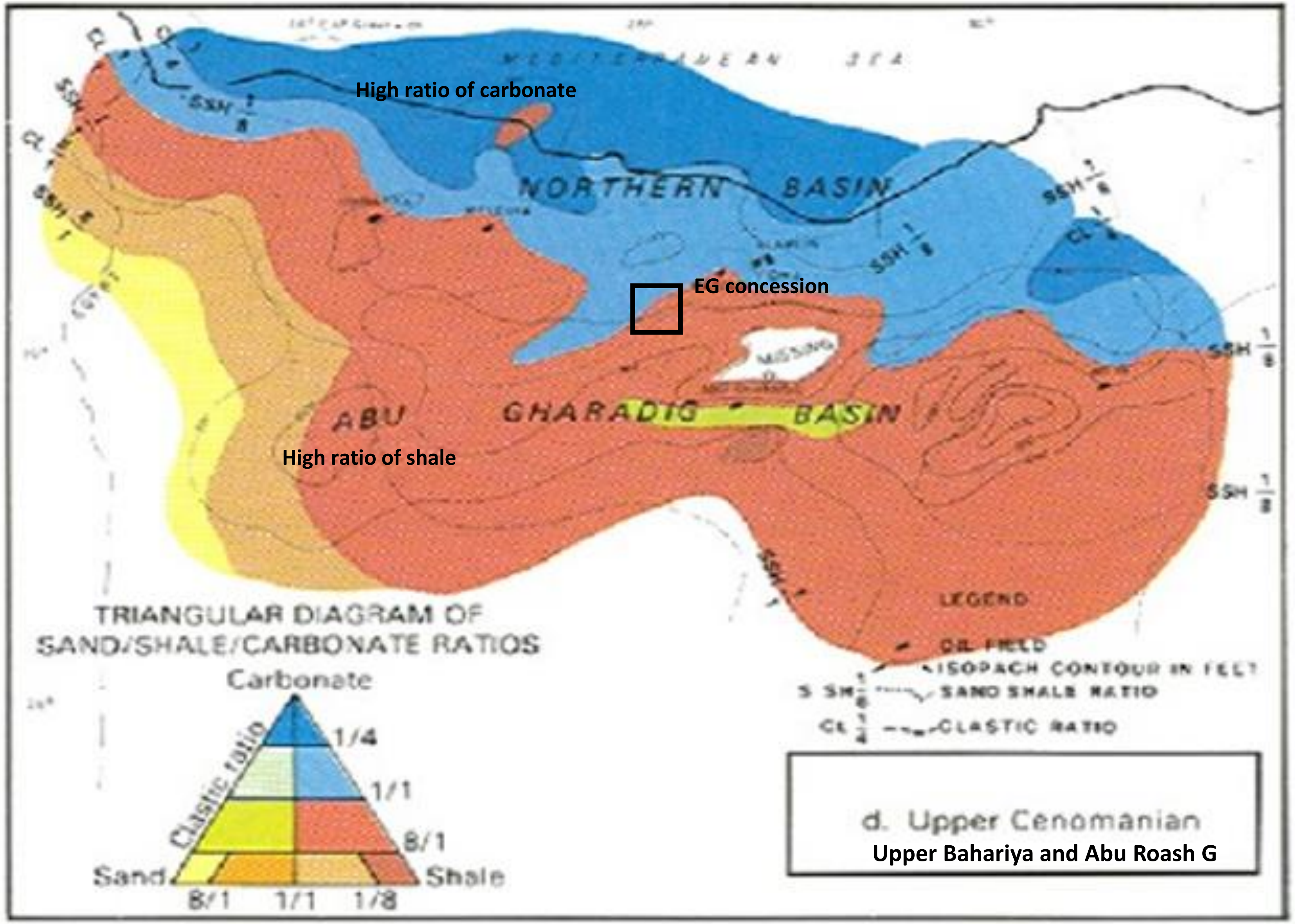




Reservoir Characterization and Hydrocarbon Stability of Cretaceous Reservoir-Intervals, Abu Gharadig basin, RWTH-Aachen University Egypt,2008.

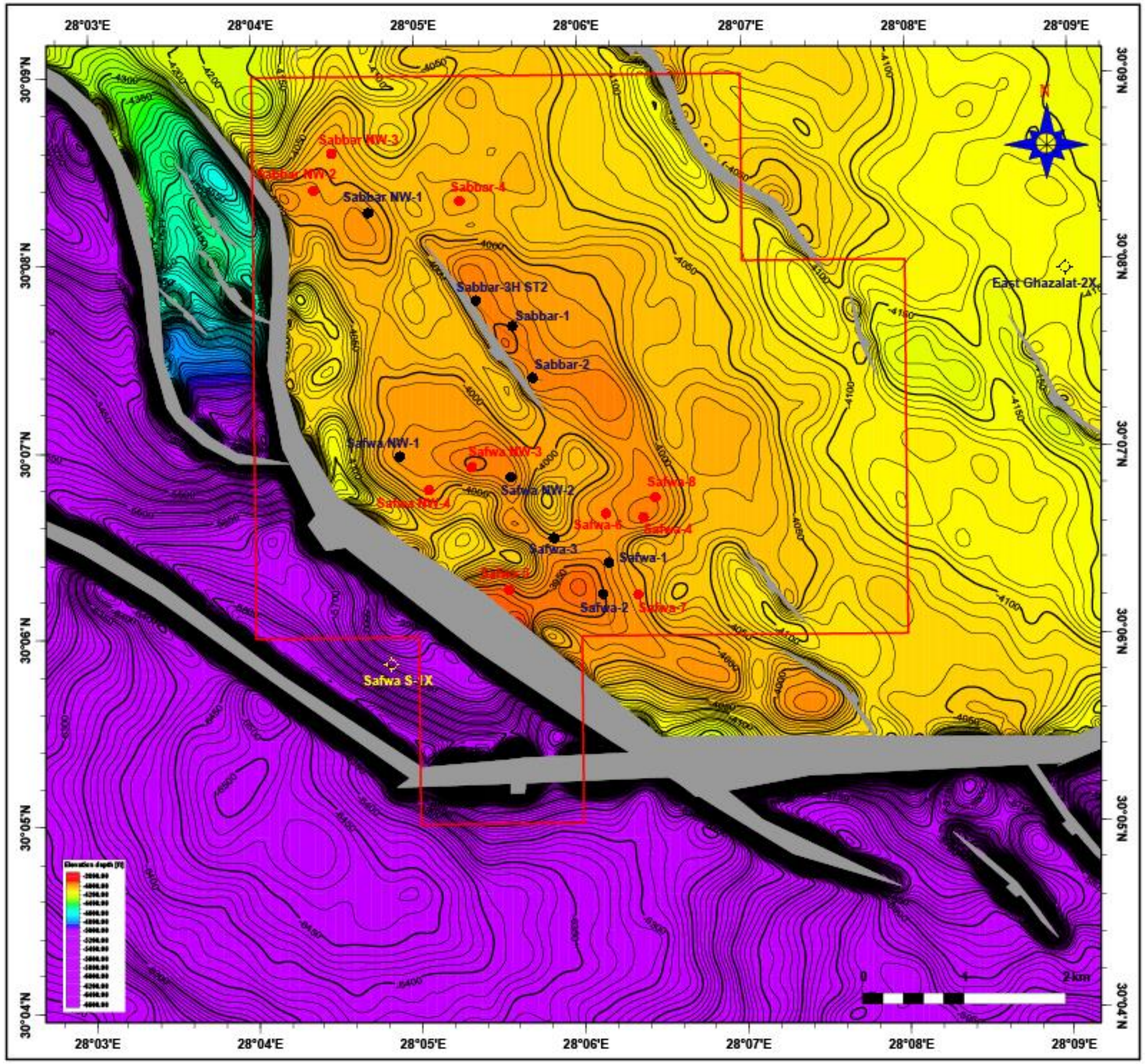
➢ Safwa Field Overview





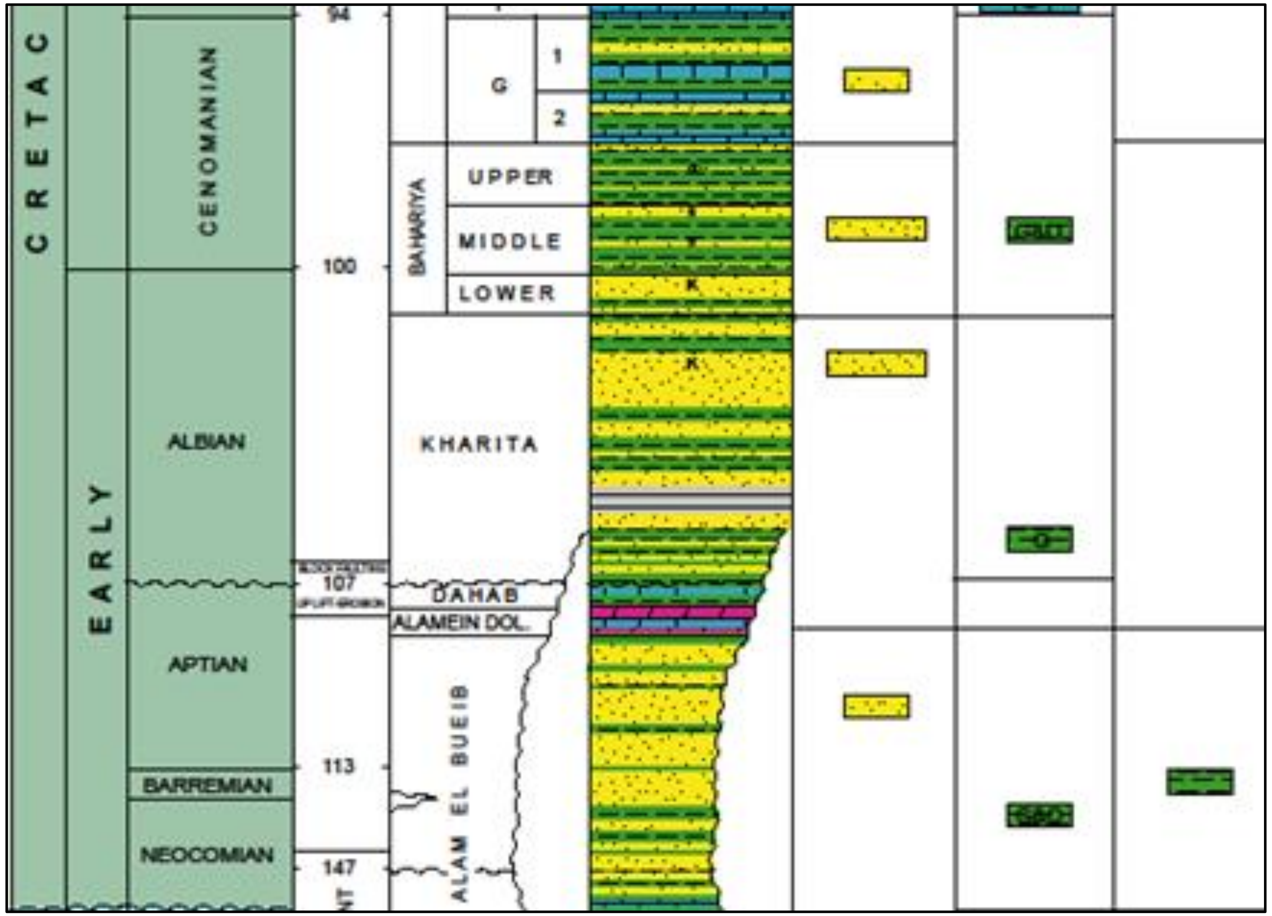
➢ Safwa Field Overview

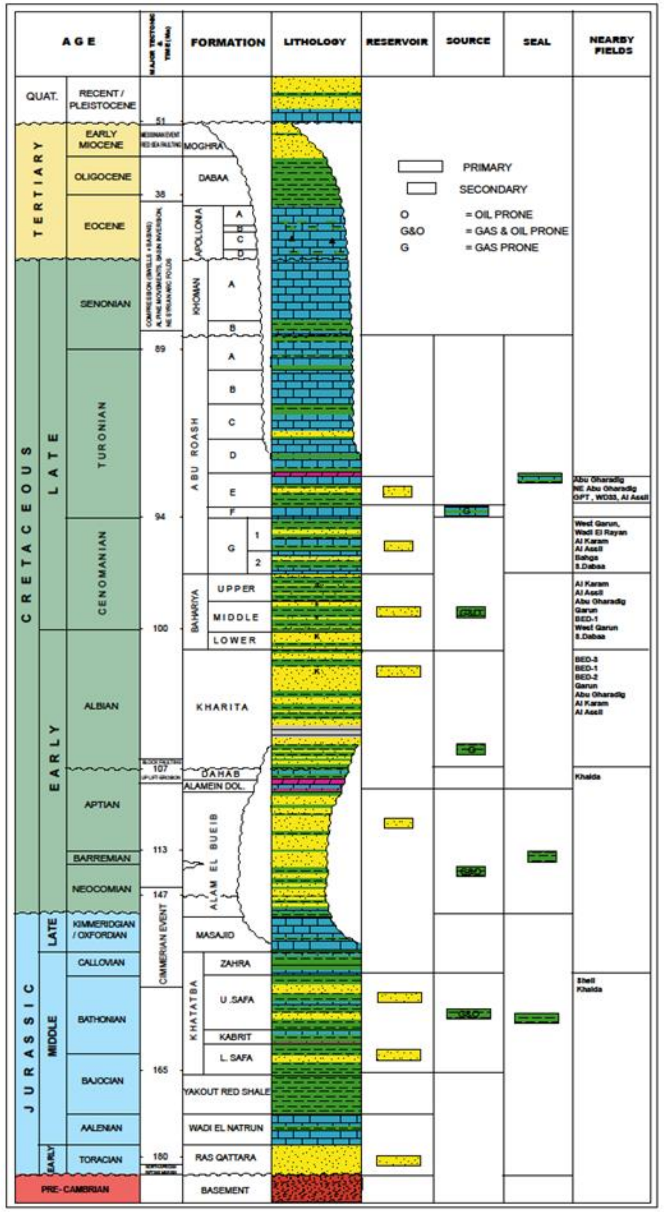
❖ *Bahariya Depth Map*



➢ Upper Bahariya Reservoir and Sub-division

- *Cenomania Age*
- *Mainly Siltstone interbedded with Shale and Sandstone*
- *Divided into eight (8) zones from top to bottom UB-1 to UB-8*
- *Tidal Flat Deposition*





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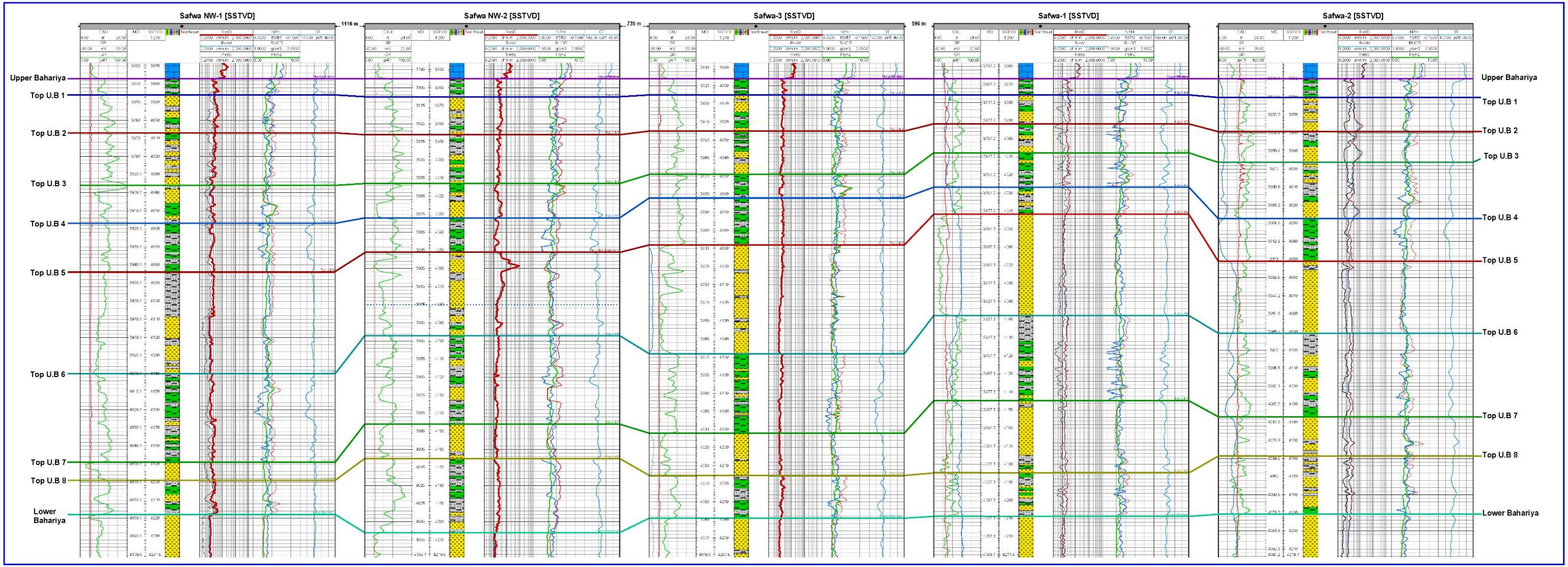
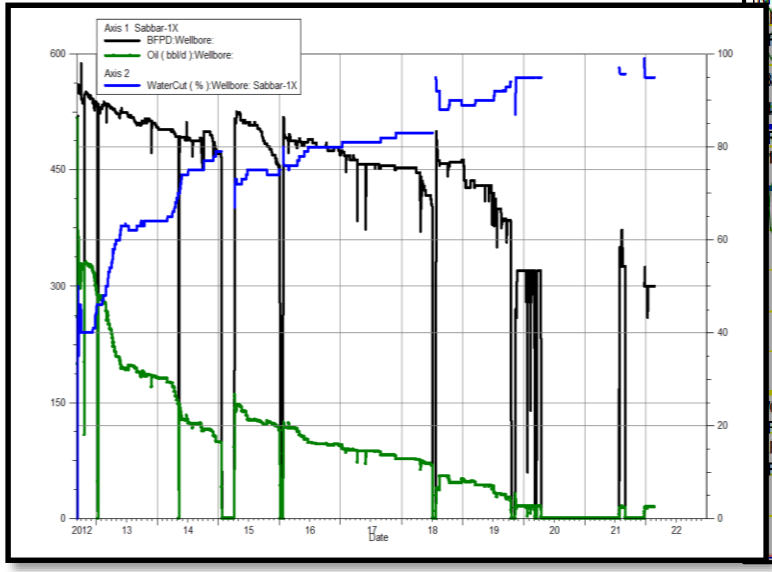
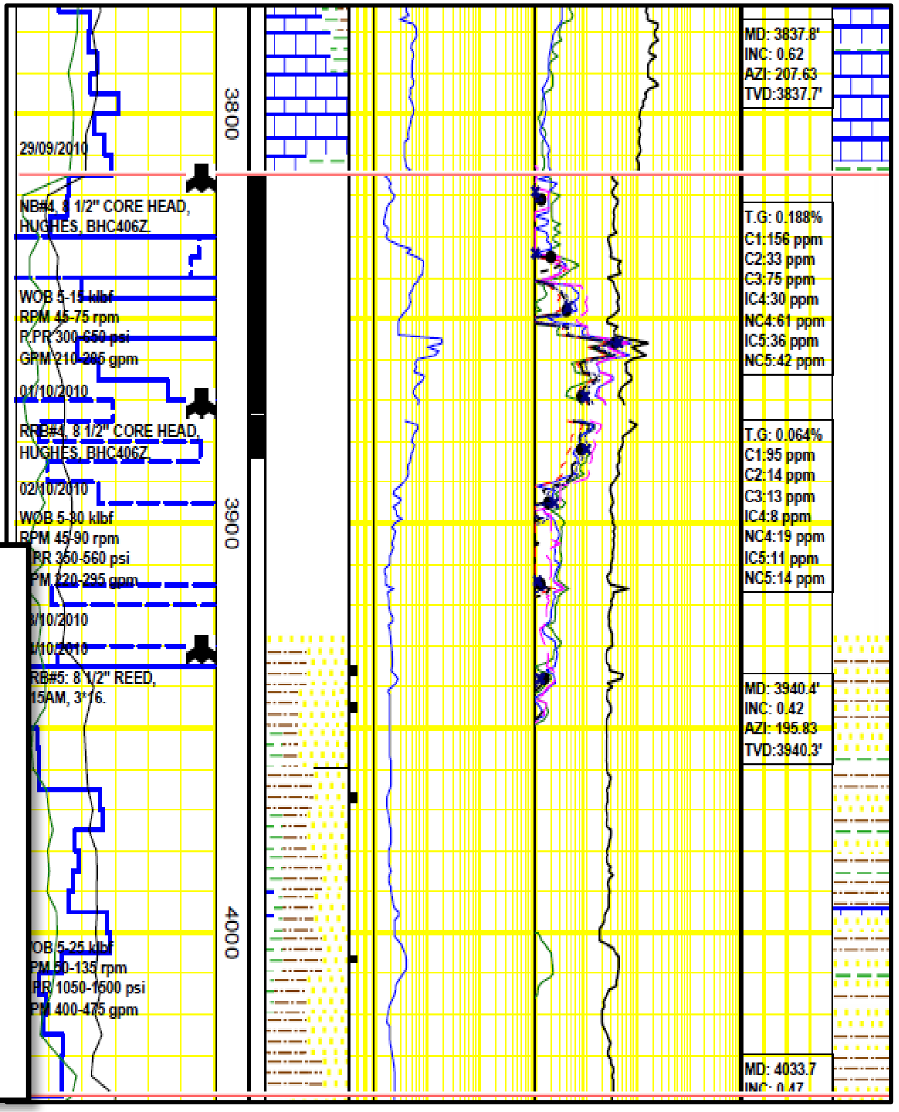
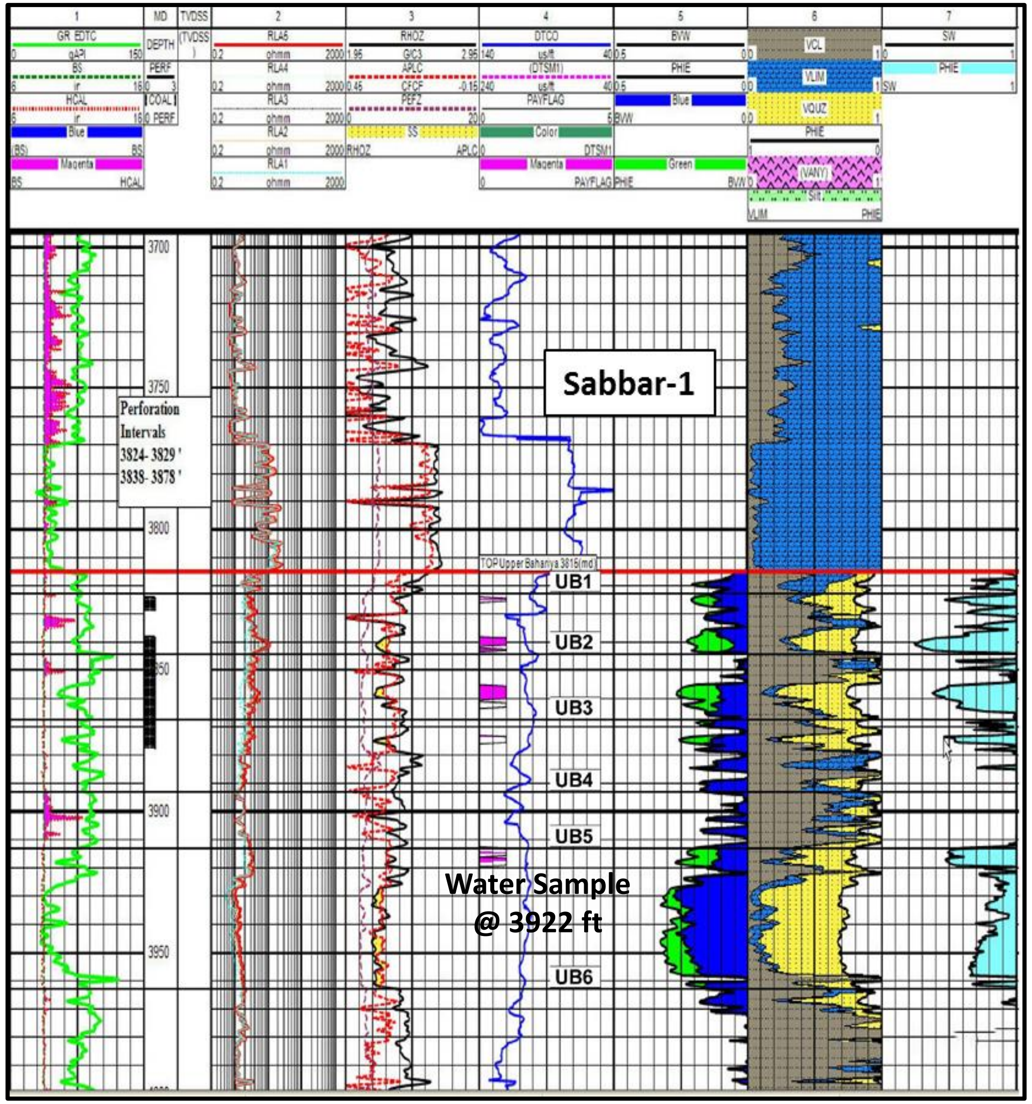


➢ Sabbar-1 Well Re-evaluation and Test

- *Drilled in 2010*
- *UB-1, UB-2 & UB-3 were Perforated and Produced*
- *Initial test results 500 bbl/d of oil*
- *Other upper Bahariya reservoirs were water bearing (original CPI & MDT gradient)*
- *Water Sample @ 3922 ft (-4050 ft TVDss)*







➢ Sabbar-1 Well Re-evaluation and Test

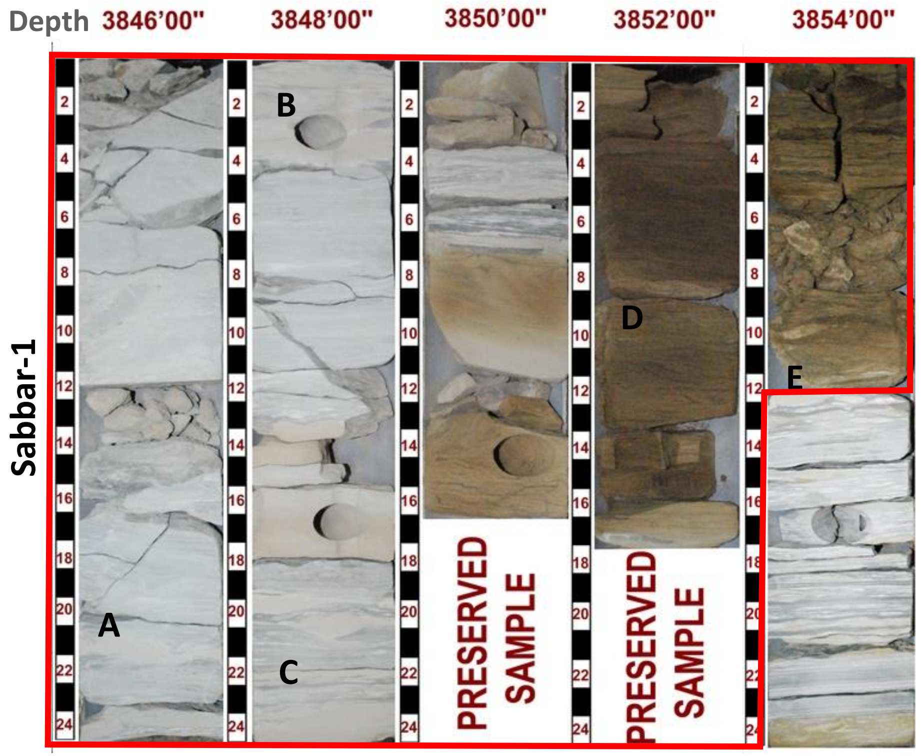
❖ *Core data confirmed showed high water saturation as CPI*

SAMPLE NO.	DEPTH (ft)	NITROGEN PERMEABILITY mD			HELIUM POROSITY %	GRAIN DENSITY g/cm³	Porosity By Fluid Summation (%)	RESIDUAL SATURATION BY RETORT %		RESIDUAL SATURATION BY DEAN STARK %		GRAIN DENSITY g/cm³	LITHOLOGIC DE[SCRIPTION AND] REM[ARKS]	
		HORIZONTAL	VERTICAL	PROBE				Oil	Water	Oil	Water			
Core No. 1		Core Intervals : 3814'00" - 3873'00"											Formation	
1	3814.00	0.21	0.09	0.04	13.2	2.77	15.1	0.0	70.3	0.0	67.7	2.77	S.S;	dk gn,fg,glauc s srtd,mic
2	3815.00	17.4	4.40	3.15	25.4	2.73	19.6	10.3	48.9	10.4	43.8	2.73	A.A;	
3	3816.00	16.7	3.26	2.39	25.3	2.72	21.7	8.1	48.9	8.5	41.4	2.72	A.A;	
4	3817.00	0.15	0.02	0.05	12.0	2.76	10.2	0.0	88.9	2.4	81.8	2.76	S.S;	lt to dk gy,fg, ar
5	3818.00	12.3	2.33	0.04	24.0	2.66	9.8	0.0	83.2	2.5	63.4	2.66	S.S;	lt gy,fg,arg cmt,
6	3819.00	4.21	2.94	0.03	17.2	2.75	13.5	4.4	75.2	6.0	69.9	2.75	S.S;	lt gn,fg,glauc s,a
7	3820.00	6.27	13.2	0.21	21.8	2.63	20.1	0.9	59.4	5.2	51.9	2.63	S.S;	dk gy, , v fg,arg
8	3821.00	2.67	6.34	0.10	21.5	2.62	17.0	5.5	67.6	8.9	62.5	2.62	A.A;	frac,carb matter
9	3822.00	7.48	1.42	1.52	22.9	2.63	18.1	5.0	57.8	8.2	49.9	2.63	A.A;	
10	3823.00	0.47	Broken	0.05	18.1	2.66	17.3	3.4	60.3	2.0	51.0	2.66	A.A;	carb matter
11	3824.00	101	Broken	10.6	23.2	2.66	20.0	12.9	44.1	15.0	35.8	2.66	S.S;	lt gy,fg,arg cmt, w cmt,w srtd, mic
12	3825.00												Mdst	
13	3826.00	0.13	Broken	0.08	9.6	2.74	16.1	2.6	60.9	8.1	74.4	2.74	S.S;	lt gy, fg, calc cmt,wcmt,w srtd,mic,carb matter
14	3827.00												Mdst	
15	3828.00												Mdst	
16	3829.00												Mdst	

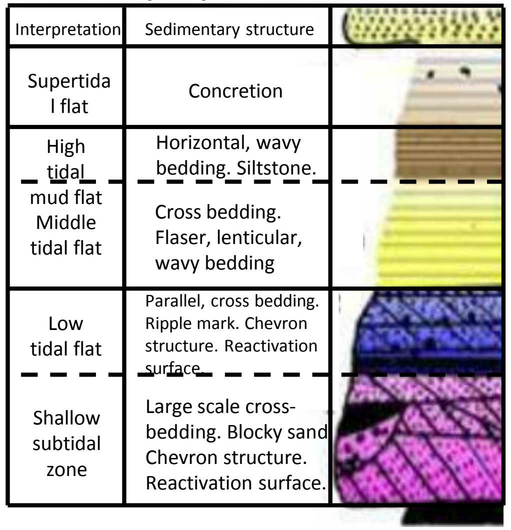
SAMPLE NO.	DEPTH (ft)	NITROGEN PERMEABILITY mD			HELIUM POROSITY %	GRAIN DENSITY g/cm³	Porosity By Fluid Summation (%)	RESIDUAL SATURATION BY RETORT %		RESIDUAL SATURATION BY DEAN STARK %		GRAIN DENSITY g/cm³	LITHOLOGIC DESCRIPTION AND REMARKS	
		HORIZONTAL	VERTICAL	PROBE				Oil	Water	Oil	Water			
20	3833.00	616	421	85.4	27.9	2.67	21.5	11.6	42.7	10.1	36.1	2.67	S.S;	dk gy, fg,arg cmt,w cmt,w srtd,mic
21	3834.00	797	130	52.6	31.7	2.62	20.7	10.0	46.0	14.3	41.5	2.62	A.A;	
22	3835.00	315	266	13.6	30.3	2.61	17.9	13.7	48.9	21.5	37.0	2.61	A.A;	arg lam
23	3836.00	724	217	13.7	32.1	2.62	20.1	12.9	38.6	14.5	36.4	2.62	A.A;	
24	3837.00	Broken	NPP	14.8	30.6	2.63	17.4	15.3	46.8	19.6	47.1	2.63	A.A;	
25	3838.00	493	63.3	22.2	30.3	2.63	21.2	13.1	39.3	18.7	46.5	2.63	A.A;	
26	3839.00	321	33.8	68.0	30.1	2.65	21.5	13.9	35.9	20.1	31.9	2.65	A.A;	arg lam
27	3840.00	162	18.6	28.9	27.0	2.83	19.4	9.3	35.3	13.4	32.1	2.83	A.A;	
28	3841.00	3.94	3.88	2.62	17.8	2.65	19.7	5.8	57.2	8.8	52.5	2.65	S.S;	lt gy, fg,arg cmt, w cmt , w srtd,mic
29	3842.00												Mdst	
30	3843.00												Mdst	
31	3844.00												Mdst	
32	3845.00												Mdst	
33	3846.00												Mdst	
34	3847.00												Mdst	
35	3848.00	6.01	0.43	2.96	24.4	2.64	15.9	9.7	55.7	18.0	50.2	2.64	S.S;	lt gy, fg , sil cmt , w cmt , w srtd
36	3849.00	114	22.4	32.8	28.1	2.74	20.6	13.4	43.9	15.5	36.7	2.74	S.S;	lt gy, fg ,arg cmt,wcmt,w srtd,mic,arg lam
37	3850.00	61.5	50.0	7.40	28.0	2.61	19.2	17.6	45.9	18.0	39.3	2.61	A.A;	
38	3851.00	333	119	4.59	31.1	2.62	21.8	18.6	41.2	23.7	34.0	2.62	A.A;	
39	3852.00	470	81.6	29.8	31.2	2.62	23.7	9.9	32.0	16.1	31.6	2.62	A.A;	
40	3853.00	569	278	83.8	32.4	2.62	22.7	11.3	46.8	14.4	42.4	2.62	S.S;	bn,fg,arg cmt,wcmt,w srtd,mic,arg lam
41	3854.00	475	116	59.1	33.4	2.63	19.7	15.0	42.2	21.2	32.3	2.63	A.A;	
42	3855.00	3.21	0.11	1.55	17.5	2.70	16.0	3.6	54.8	8.1	51.6	2.70	S.S;	lt gy, fg ,arg cmt , w cmt , w srtd, arg lam

Lithological association of muddy tidal flat

Facies	Subfacies	Microfacies	Lithofacies
Tidal falt	Supertidal		Main of mud and siltstone, oxidation tint, exposed structure, gypsum, horizontal bedding.
	Intertidal	Mud flat	Brown mud with siltstone interlayers. Horizontal, wavy bedding. Bioturbation.
		Mixed flat	Greyish-green thin mud with thin sand interlayer. Complex bedding. Bioturbation.
		Sand flat	Thick sand with thin muddy siltstone interlayer. Double clay bands. Flaser bedding.
	Subtidal		Inverse rhythm. Tidal cross-bedding.
	Tidal creek		Fine-medium sand. Positive rhythm. Tidal cross-bedding.



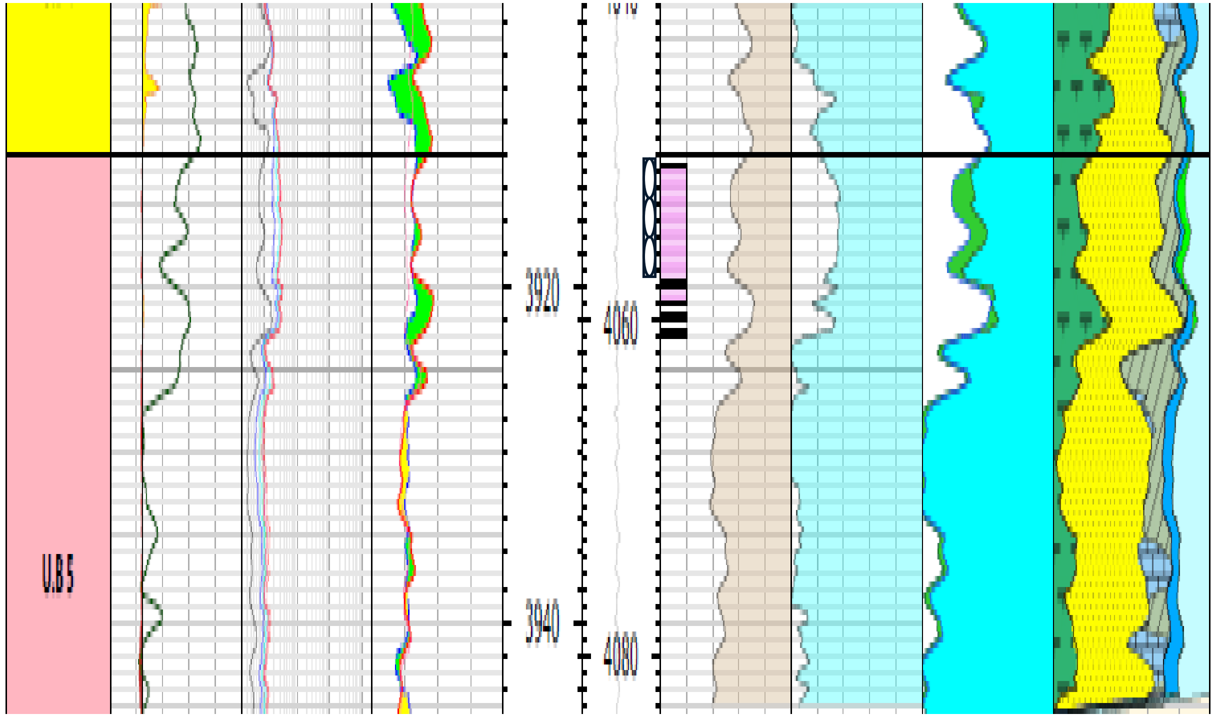
Sedimentary sequence model of tidal-flat

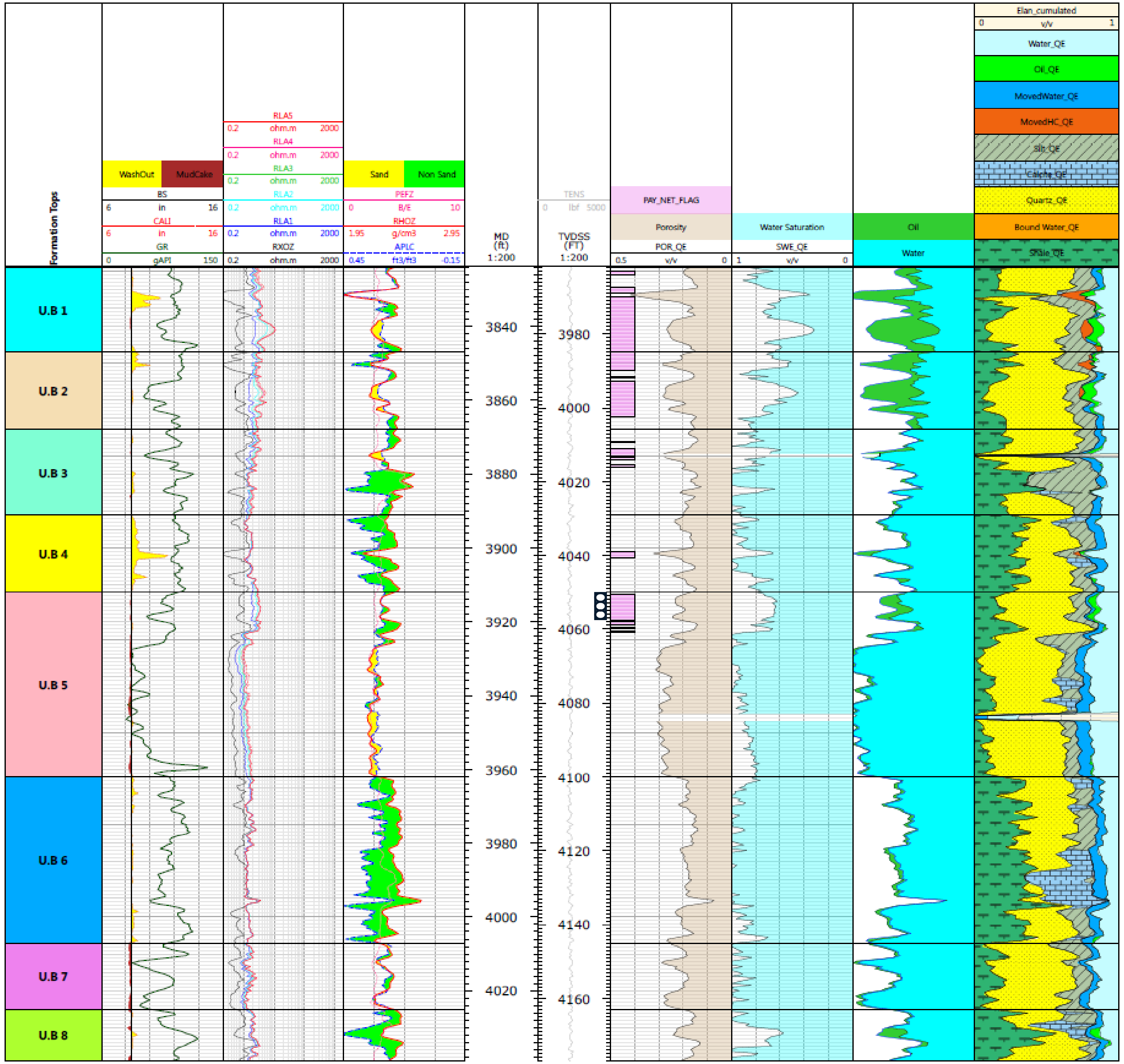


A. Lenticular bedding
B. Flaser bedding
C. Waving bedding
D. Herringbone cross bedding
E. Reactivation surface

➢ Sabbar-1 Well Re-evaluation and Test

- *New interpretation showed 9 feet of silty facies Net Pay with 21% porosity and SW of 67%*
- *The well was producing 15 bbl/d of oil with 95% water*
- *After perforated the new zone, the well initial tested 350 bbl/d of oil with No water*





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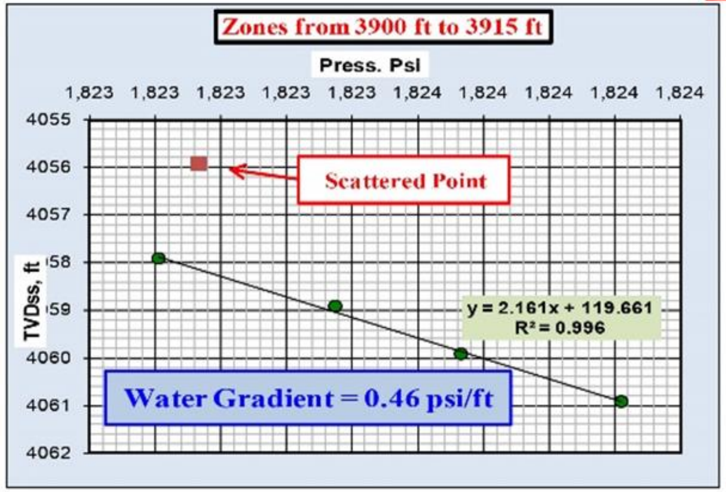
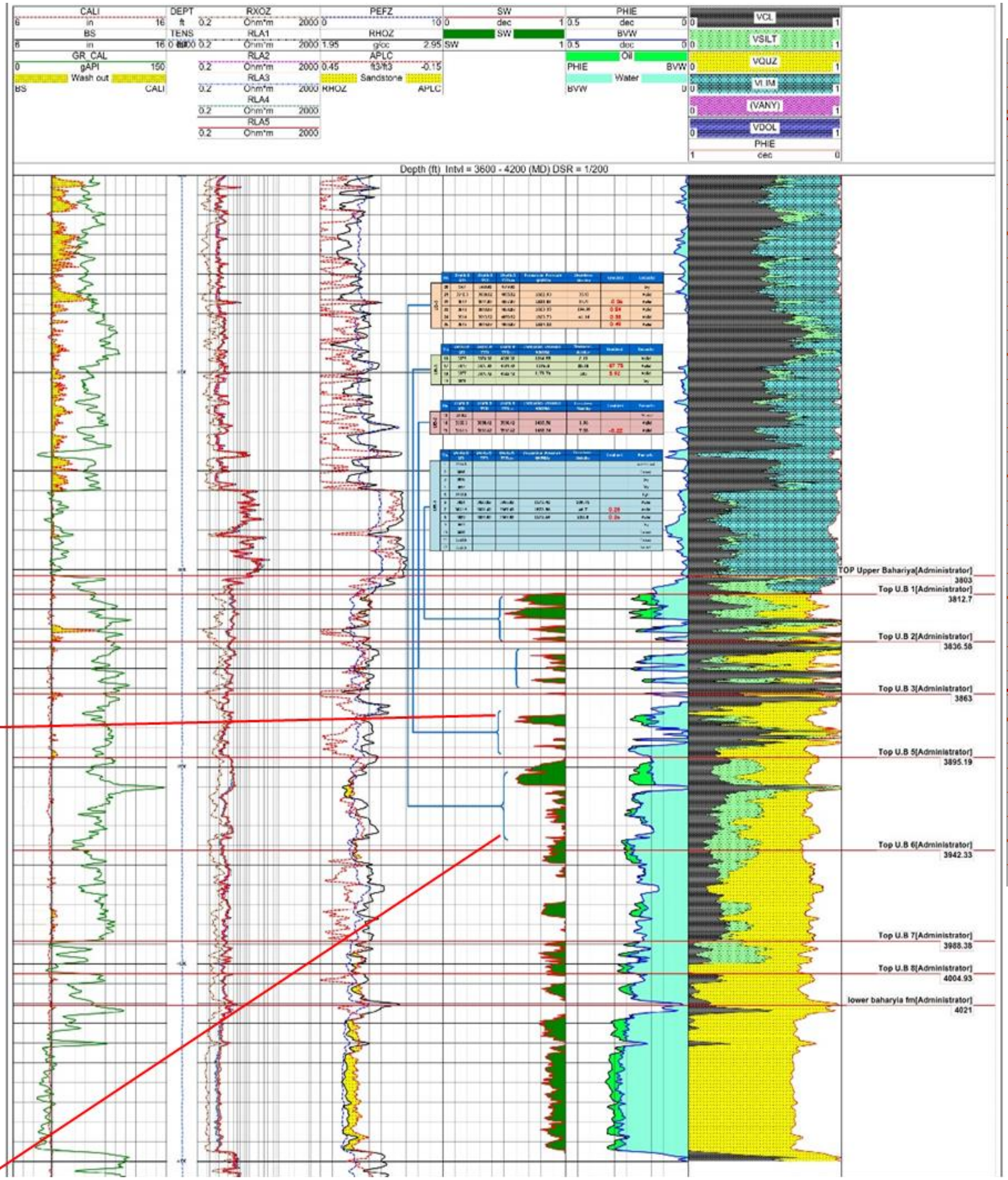
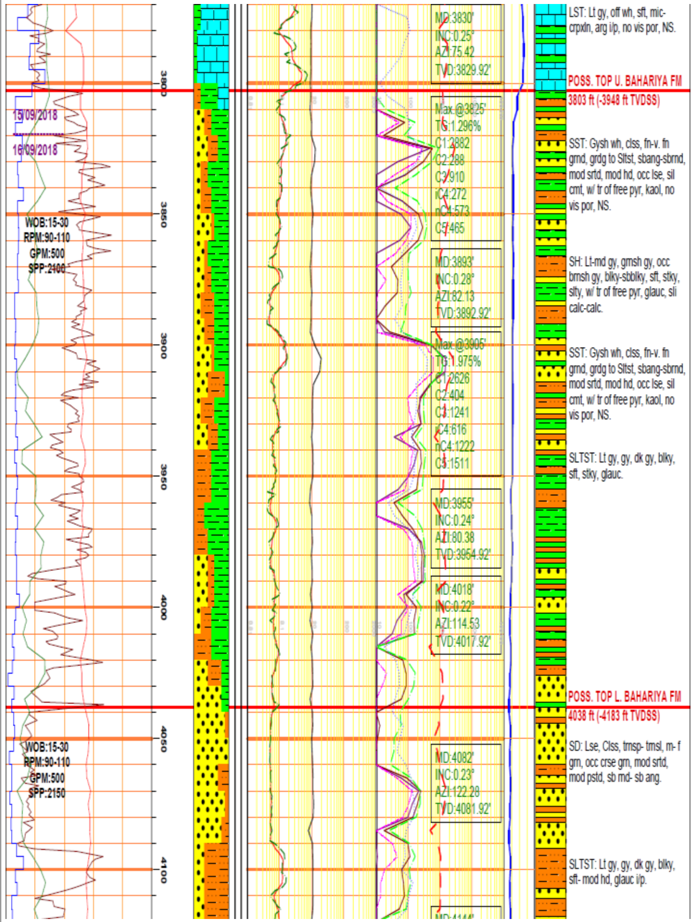
➢ Safwa NW-3 Second Well Test Results

- *Drilled in 2018*
- *Only UB-1 were Perforated and Produced*
- *The well initially had low PI of 0.15 bbl/PSI*
- *By frac UB1; well test 500 bbl/d of oil with 27% of water*
- *Other upper Bahariya reservoirs were water bearing as MDT gradient indicates*

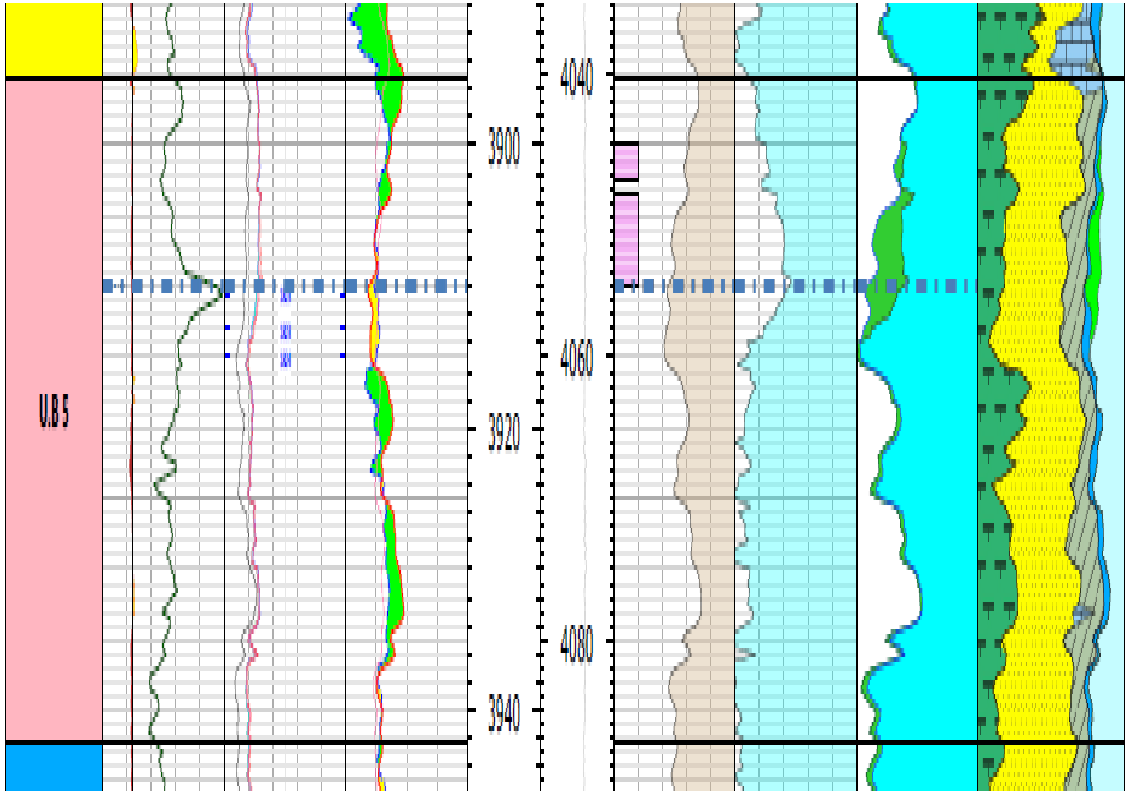


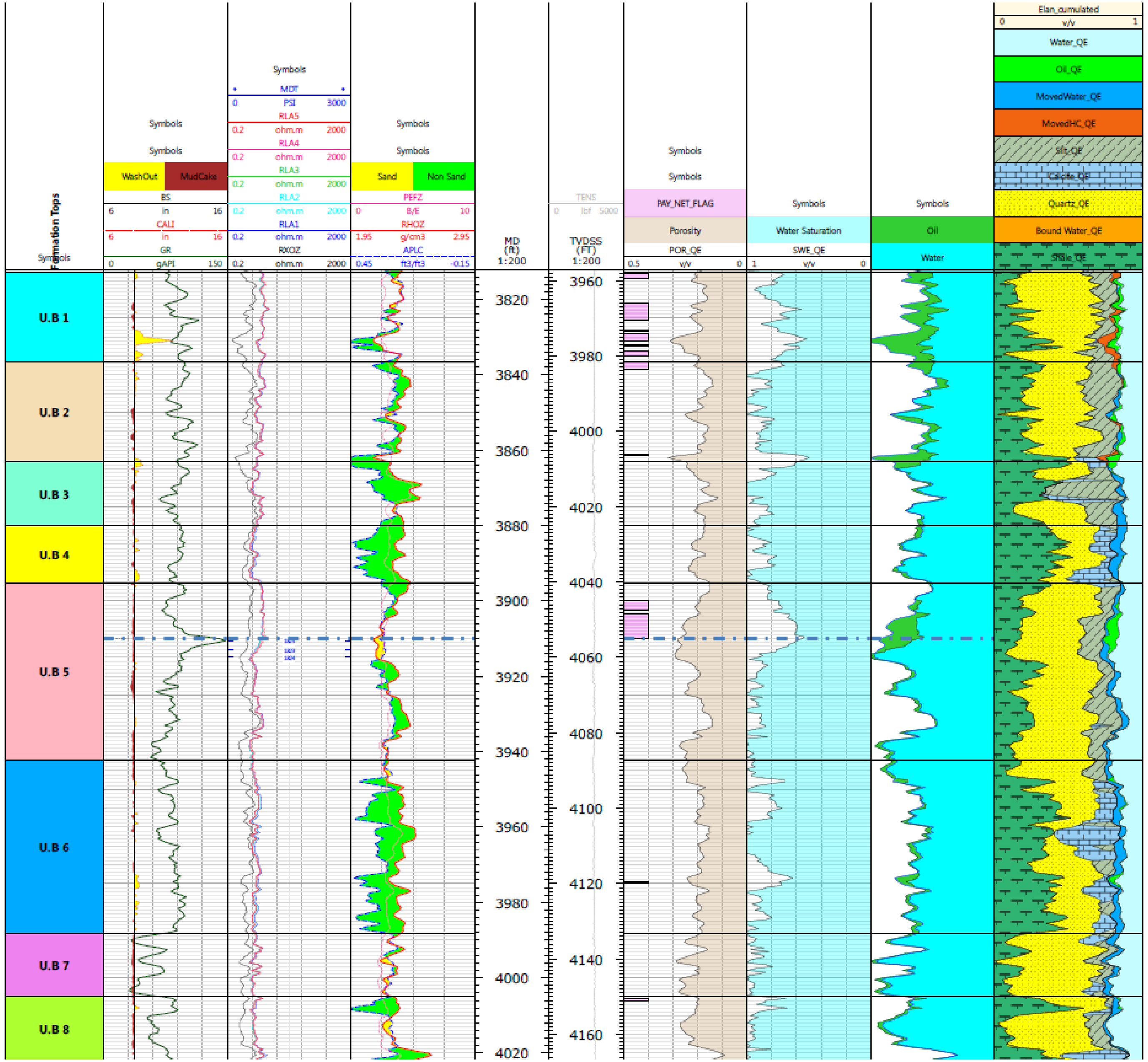




➢ Safwa NW-3 Second Well Test Results

- *New interpretation showed 8 feet of silty facies Net Pay with 24% porosity and SW of 64%*
- *The well was producing 10 bbl/d of oil with 90% water*
- *After perforated the new zone, the well initial tested 1000 bbl/d of oil with no water*





Conclusion and Recommendation

- *For the complex depositional environment; the thin laminated silty sand reservoir has a good chance to produce oil*
- *This thin laminated reservoir will produce with resistivity of 2-3 ohm (> 1 ohm)*
- *In the log, SW could be > 70% and well initially produce with no water*
- *Re-evaluation of all existing wells should be done without bias to conventional cut off for clear and clean reservoirs*
- *In complex sedimentary facies, it will be better to acquire CMR/NMR logs to identified the thin reservoirs, as well as, irreducible and residual oil*
- *Select the best candidate well to test a new approach to unlock the existing and remaining potential*