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Bahariya Reservoir Performance as Deduced from Well Logs Data Interpretation at East Bahariya Concession, Western Desert, Egypt

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Abstract

The present work evaluates the sandstones of Bahariya Formation in East Bahariya Concession at the northern Western Desert. The analysis of the available well logs data for two wells (EBAH- D-1X and EBAH- E-1 X) drilled in the study area reflects good reservoir quality for oil production in specific zones within Bahariya Formation. The applied cutoff parameters in delineating these zone intervals are; Vsh<0.4, PHIE 0.10, SW<0.5 and Calip-B.S.<+2 inch. Zones that passed all of these parameters together (i.e. reservoir zones) in EBAH- D-1X Well locate between depths; 6783 - 6786 ft, 6789 – 6796 ft, 6815 – 6823 ft, 6838 – 6860 ft and 6865 - 6900 ft. While in EBAH- E-1X Well the best reservoir intervals locate between depths; 6501 - 6506 ft, 6514 – 6528 ft, 6530 – 6536 ft, 6551 – 6560 ft, 6584 – 6586 ft and 6596 - 6614 ft.

Keywords: Well logging - Bahariya Formation - Reservoir evaluation- East Bahariya Concession - Western Desert.

1. Introduction

The Egyptian Western Desert includes many sedimentary basins most of them occur in the northern part. These basins were affected by compressional tectonic episode attributed to the Laramide tectonic event. This compressional phase originated in the Santonian age and continued to the Early Tertiary as a result of the NW-SE compressive stress due to the right lateral movement of African comparative to Laurasian plates (Moustafa, 2008; Sarhan, 2017).

All commercial hydrocarbon accumulations have been found in the northern part of the Western Desert, north of Latitude 29° 00' and confined to the Cretaceous (Said, 1990). The Upper Cretaceous Bahariya Formation and Abu Roash Formation represent together about 90 % of the hydrocarbon reserves in the Western Desert (Richardson et al., 1998).

The Late Cretaceous time span contains all conditions required for hydrocarbon occurrence including; source rocks and reservoirs which are sorted in the Cretaceous age in both carbonates reservoirs such as Abu Roash Formation (eg. Sarhan et al., 2017a) and in sandstone reservoirs such as Bahariya Formation (eg. Sarhan et al., 2017b). Moreover, both structural and stratigraphic traps in addition to the cap rocks are found in the Cretaceous time.

The Bahariya Formation represents the Cenomanian age and was deposited in a shallow marine environment. It is mainly composed of fine to very fine sandstone with shale interbeds and limestone streaks (EGPC, 1992). The entire sandstones of Bahariya Formation is the greatest hydrocarbon producer in most fields of the Western Desert (EGPC, 1992; Sestini, 1995) Accordingly, the present work aims to evaluate the Bahariya Formation which represents the main hydrocarbon reservoir along the East Bahariya Concession at the northern Western Desert, using well log data interpretation.

2. Study Area and Available Data

The study area is located in the northern part of the Western Desert between latitude 29.5 and 30° N and between longitudes 29 and 30 ° E (Fig. 1).
A suite of well log data is available for two wells (EBAH- D-1X and EBAH- E-1 X) distributed in the study area. These data were provided as LAS Files and imported through TECHLOG Software and displayed in analog format. The data are presented in four tracks (1-4) from left to right (Figs. 2 and 3). Track one represents the depth in feet. Gamma-ray (HCGR), Caliper (HCAL) and Bit Size (BS) are presented in track two. Track three contains deep (RLA5), medium (RLA3) and shallow (RXOZ) resistivity. Porosity logs in the form of density (RHOZ) with correction (HDRA) and neutron (APLC) are presented in track four. The Photoelectric (PF) is also recorded in this track and available for EBAH- D-1X well and not recorded in EBAH- E-1 X.

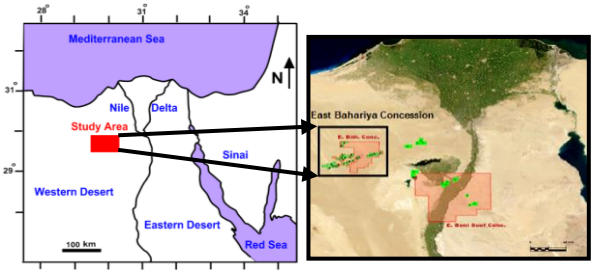

Figure (1): Regional map represents the location of East Bahariya Concession in northern Western Desert.

3. Results

3.1 Qualitative interpretation and segmentation of the available well log data

The first step before any detailed well log data interpretation is to qualitatively interpret the log curve shapes to differentiate them into segments (zones), each segment possess their own characteristic log shape.

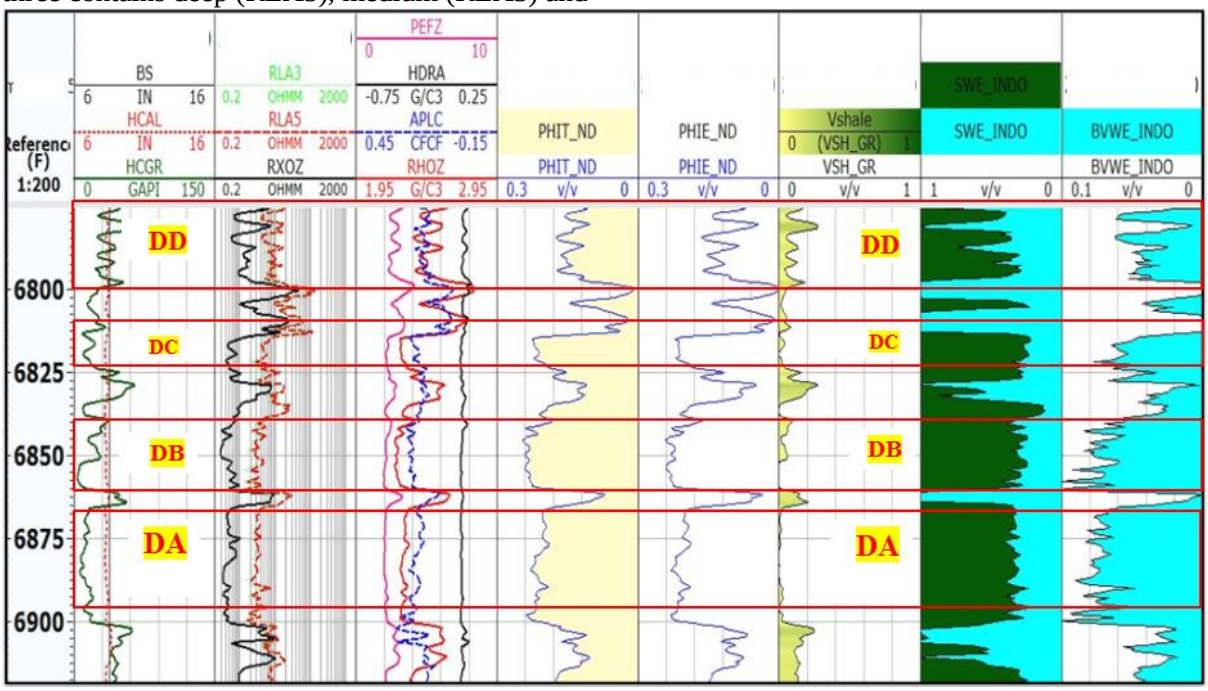

Figure (2): Input well log data segmentation (tracks 1- 4 from the left) and the output results (tracks 5-9) for Bahariya Formation in EBAH- D-1X Well.

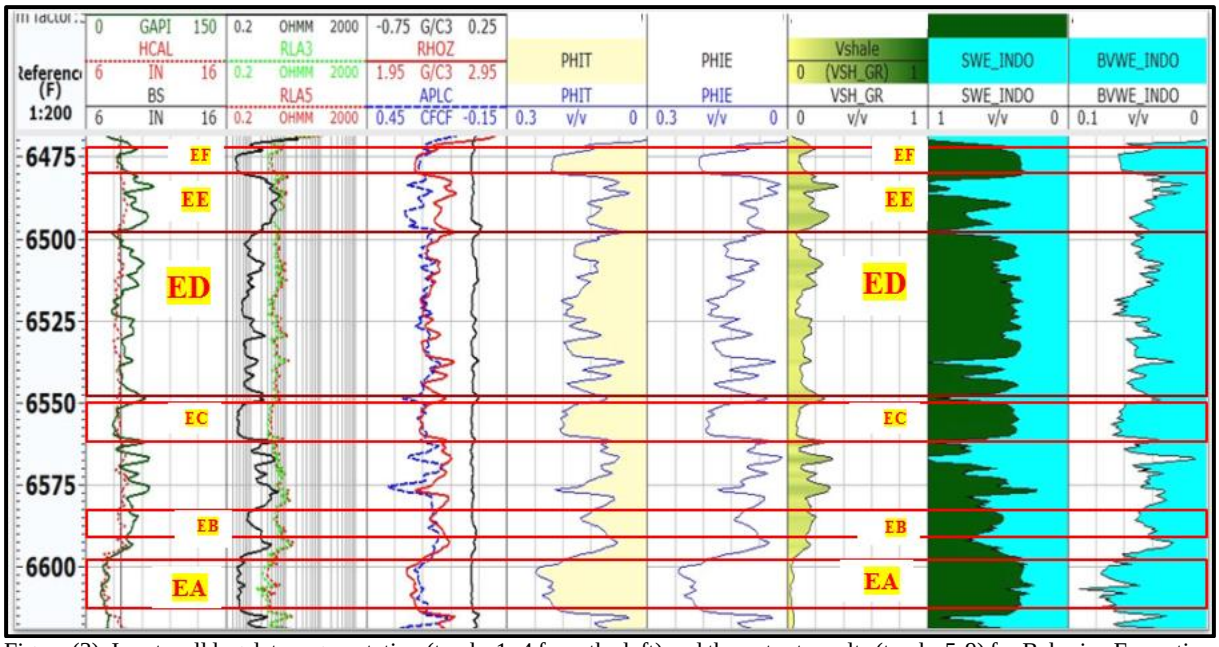

Figure (3): Input well log data segmentation (tracks 1- 4 from the left) and the output results (tracks 5-9) for Bahariya Formation in EBAH- E-1 X Well.

Through the qualitative interpretation of such segments, intervals that are most optimistic to be potentially hydrocarbon-bearing can be identified. These logs reflects the effect of the contained matrix, shale, porosity and fluids. It is of prime importance to compare and correlate all the curve shapes opposite zones of interest. The following section represents segmentation and full description of the available well log data recorded for Bahariya Formation in the study two wells (EBAH- D-1X and EBAH- E-1 X).

3.1.1 EBAH- D-1X

Figure (2) represents the input well log data analog format with segmentation and the output results for Lower Bahariya Formation in EBAH- D-1X well. This formation was segmented into distinctive five intervals (DA, DB, DC and DD) from bottom to top. Segment DA is the lowermost one. It has 35 feet thick (6865 -6900 feet). All log curve shapes opposite this interval reflect possible good reservoir. This segment has very low gamma reading (about 15 API) with the presence of mud cake as noticed on track 2 with bit size (BS) reads less than that of the caliper (HCAL). Also, the applied density correction due to hole conditions (HDRA in track 4) is zero gm/cc indicating excellent hole conditions. Positive resistivity separation (RLA5>RXOZ) is also noticed on track 3. The sandstone nature of this reservoir is clearly seen on both PEF, RHOZ and APLC curves (Track 4). The Litho-Density Tool (PEF) reads constant value of 2, which is typical for quartz. Also, the neutron-density separation (about 3 porosity units) is indicative of sandstone matrix (neutron on the right with respect to that of density). The porosity can be read directly on the neutron scale as the midway between neutron and density curves. In this case, it equals to about 0.21. Interval DB (6840-6860) is separated from the underlying segment (DA) by a distinctive shale layer with high gamma-ray reading. This zone seems nearly identical to that of DA but with higher porosity (about 0.25) and the upper part is slightly shaly (i.e fine upward sequence). Another optimistic interval (6810-6823) is also present and denoted as DC with high porosity (0.25) and has the same characteristic features as DA and DB. The less reservoir quality is expected for segment DD(6775 -6800). It is shaly with a high gamma-ray. The neutron and density curves track each other with PEFZ near 3 confirming the effect of shale. On the other hand, positive resistivity separation is still noticed.

3.1.2 EBAH- E-1 X

Lower Bahariya Formation in this well was differentiated into six segments (EA,EB,EC,ED,EE and EF) as presented in Figure (3). Segment EA (6597-6625) show a very thick mud-cake where hole size (dotted line) is much lower than the Bit Size as appear on track two. This needs mud-cake resistivity correction before any further detailed interpretation for this zone. The separation of neutron and density curves is much reduced in such sandstone which may be due to carbonate cement as the gamma-ray reads

low values. This interval is the cleanest one among all the recognized segments. The positive resistivity separation (track 3) reflects good porosity and permeability. High porosity is evidenced on track 3 to read about 0.22.

The thin segment EB (6583-6590) although has relatively high gamma reading (about45 API) it shows good hole condition with mud-cake. Also, neutron and density curves tracked each other but in this case due to shale effect (i.e shaly sandstone). The porosity is 0.14 as read directly on the neutron scale (track 4). Positive resistivity separation is existed. Ten feet of shaly sandstone with 0.15 porosity and positive resistivity separation which greatly resembles EB segment is observed in Fig (3) as EC(6650-660). A thick shaly sandstone segment ED(6497-6548) is separated from the underlying EC segment by a very thin shale streak. They have exactly the same log curve shapes. On the contrary segment EE(6480-6497) is not a candidate for hosting hydrocarbons. The gamma-ray reads high value with slightly hole enlargement. The three resistivity curves track each other suggesting no effective porosity and permeability. The neutron curve is located on the left side with respect to the density in a configuration similar to that for shale. The uppermost segment EF (6473-6480) can be considered to be shaly sandstone as described for zones EC and ED.

3.2 Quantitative well log data interpretation

The above qualitative well log interpretation answers where and what type of fluid is present in each detected segment. Quantitative techniques answer the question about the expected amount of oil which will be recovered during productions. In this respect, a set of petrophysical parameters in the form of shale content (Vsh), total porosity (PHIT), effective porosity (PHIE), water saturation (SW), hydrocarbon saturation and Bulk Volume of Water (BVW) have been calculated for Bahariya Formation in the two studied wells and tabulated (Tables 1-10).

It is important here to mention that before taking any decisions as a result of applying these parameters, a set of cutoff values must be tested. These cutoff values have been selected based on general standard percentages since we don't have any core reports for the examined wells. The cutoff parameters used in this study are:

Vsh<0.4

PHIE 0.10

SW<0.5

Calip-B.S.<+2 inch

It is of prime importance here to mention that zones, which approved all the above cutoff parameters together, will be described as (P) while zones that failed any or all parameters will be denoted (F) and considered non-reservoir. The petrophysical parameters will be interpreted as a means of correlation to evaluate quantitatively the (P) zones for reservoir dynamic parameters encountered for each detected segment as will be discussed in the following sections.

-EBAH- D-1X

**Segments DA and DB*

These thick intervals are characterized by uniform log curve shapes and all zones have a cutoff flag (P) (Tables 1 and 2). The negative differential caliper indicates good hole conditions as stated above and hence all the recorded logs can be trusted. Also, high effective porosity (~ 0.20) is noticed. The shale content, in general, is the minimum. The calculated water saturation (SW) is also low (ranging between 0.23 and 0.46). The majority of the tabulated values for water saturation is approximately 0.34.

Although these values are strong positive indicators of an excellent reservoir, they are not quite enough. Ignoring the Bulk Volume of Water (BVW) which is the product of effective porosity multiplied by water saturation (Φ.SW), can lead to the erratic conclusion about the actual production. This parameter indicates whether or not the reservoir is at irreducible state. Reservoir at an irreducible state means that it will produce only oil without water. The Table given below lists BVW values for sandstones as a function of the grain size (Asquith,1985).

Grain Sizes (millimeters)	Bulk Volume of Water (BVW)
Coarse 1.0-0.5 mm	0.02 to 0.025
Medium 0.5-0.25 mm	0.025 to 0.035
Fine 0.25-0.125	0.035 to 0.05
Very fine 0.125-0.0625	0.05 to 0.07
Silt < 0.0625	0.07 to 0.09

Table (1): Well log data and output petrophysical parameters for segment DA, D-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2 inch.(P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	PEF	Calip.-B.S.	Vshale	PHIT	PHIE	Sw	Cut off* Flag	BVW

6865	8.43	40.93	1.51	11.52	0.17	2.45	2.37	-0.07	0.12	0.15	0.12	0.34	**P**	0.04
6865.5	8.20	25.04	0.82	4.81	0.17	2.37	2.26	-0.30	0.05	0.17	0.16	0.36	**P**	0.06
6866	8.17	15.44	0.59	4.26	0.18	2.33	2.17	-0.33	0.02	0.19	0.19	0.32	**P**	0.06
6866.5	8.23	14.39	0.52	3.49	0.19	2.31	2.12	-0.27	0.01	0.20	0.20	0.34	**P**	0.068
6867	8.21	15.64	0.48	3.50	0.20	2.31	2.10	-0.29	0.02	0.20	0.20	0.34	**P**	0.068
6867.5	8.21	14.39	0.45	3.76	0.19	2.31	2.10	-0.29	0.01	0.20	0.20	0.32	**P**	0.064
6868	8.23	13.51	0.43	3.04	0.18	2.30	2.10	-0.27	0.01	0.20	0.20	0.35	**P**	0.07
6868.5	8.23	12.51	0.42	2.83	0.17	2.29	2.12	-0.27	0.01	0.20	0.20	0.35	**P**	0.07
6869	8.25	12.01	0.44	3.09	0.17	2.29	2.11	-0.25	0.01	0.20	0.20	0.34	**P**	0.068
6869.5	8.28	10.35	0.47	3.17	0.18	2.29	2.08	-0.22	0.00	0.20	0.20	0.33	**P**	0.066
6870	8.32	10.69	0.46	3.23	0.17	2.29	2.05	-0.18	0.00	0.20	0.20	0.33	**P**	0.066
6870.5	8.30	11.11	0.46	3.21	0.17	2.30	2.02	-0.20	0.00	0.20	0.20	0.34	**P**	0.068
6871	8.29	13.64	0.49	3.66	0.16	2.30	2.03	-0.21	0.01	0.19	0.19	0.32	**P**	0.068
6871.5	8.29	13.94	0.53	3.94	0.16	2.30	2.04	-0.21	0.01	0.19	0.19	0.31	**P**	0.06
6872	8.32	15.29	0.50	3.41	0.16	2.30	2.07	-0.18	0.02	0.20	0.19	0.33	**P**	0.06
6872.5	8.30	15.42	0.45	2.51	0.17	2.30	2.09	-0.20	0.02	0.20	0.20	0.38	**P**	0.076
6873	8.29	15.83	0.43	2.67	0.17	2.30	2.08	-0.21	0.02	0.20	0.20	0.37	**P**	0.074
6873.5	8.28	13.09	0.45	2.87	0.18	2.30	2.06	-0.22	0.01	0.20	0.20	0.36	**P**	0.07
6874	8.26	10.89	0.53	3.30	0.18	2.30	2.03	-0.24	0.00	0.20	0.20	0.33	**P**	0.066
6874.5	8.25	9.38	0.72	4.25	0.18	2.29	2.00	-0.25	0.00	0.21	0.21	0.29	**P**	0.06
6875	8.21	10.58	1.02	4.11	0.17	2.29	1.98	-0.29	0.00	0.20	0.20	0.30	**P**	0.06
6875.5	8.25	12.18	0.88	2.61	0.16	2.29	2.00	-0.25	0.01	0.20	0.20	0.38	**P**	0.076
6876	8.23	14.06	0.63	2.46	0.16	2.31	2.03	-0.27	0.01	0.19	0.19	0.41	**P**	0.078
6876.5	8.23	13.64	0.50	2.85	0.16	2.33	2.06	-0.27	0.01	0.19	0.19	0.39	**P**	0.074
6877	8.23	12.47	0.48	3.27	0.17	2.33	2.06	-0.27	0.01	0.19	0.19	0.37	**P**	0.07
6877.5	8.24	11.40	0.52	3.19	0.17	2.32	2.07	-0.26	0.00	0.19	0.19	0.36	**P**	0.07
6878	8.20	11.04	0.65	3.35	0.17	2.30	2.08	-0.30	0.00	0.20	0.20	0.34	**P**	0.07
6878.5	8.20	11.11	0.77	3.26	0.17	2.29	2.07	-0.30	0.00	0.20	0.20	0.34	**P**	0.07
6879	8.20	10.17	0.80	3.37	0.18	2.30	2.03	-0.30	0.00	0.21	0.20	0.34	**P**	0.07
6879.5	8.19	9.21	0.78	4.03	0.19	2.30	1.99	-0.31	0.00	0.21	0.21	0.31	**P**	0.06
6880	8.17	7.35	0.84	4.09	0.19	2.28	2.01	-0.33	0.00	0.21	0.21	0.29	**P**	0.06
6880.5	8.18	6.73	0.80	3.43	0.21	2.27	2.01	-0.32	0.00	0.22	0.22	0.32	**P**	0.07
6881	8.19	7.10	0.65	3.02	0.20	2.28	1.99	-0.31	0.00	0.22	0.22	0.34	**P**	0.08
6881.5	8.17	7.44	0.57	2.72	0.21	2.28	1.98	-0.33	0.00	0.22	0.22	0.35	**P**	0.08
6882	8.19	7.21	0.52	2.79	0.20	2.28	1.99	-0.31	0.00	0.22	0.22	0.34	**P**	0.08
6882.5	8.18	9.45	0.45	2.89	0.20	2.27	2.00	-0.32	0.00	0.22	0.22	0.33	**P**	0.08
6883	8.21	10.56	0.38	2.69	0.20	2.27	2.00	-0.29	0.00	0.22	0.22	0.34	**P**	0.08
6883.5	8.23	10.28	0.35	2.84	0.22	2.27	2.01	-0.27	0.00	0.23	0.23	0.33	**P**	0.08
6884	8.23	7.47	0.35	3.17	0.22	2.26	2.02	-0.27	0.00	0.23	0.23	0.31	**P**	0.07
6884.5	8.24	6.13	0.35	3.16	0.23	2.27	2.00	-0.26	0.00	0.23	0.23	0.31	**P**	0.07
6885	8.23	5.74	0.34	3.17	0.21	2.27	1.98	-0.27	0.00	0.22	0.22	0.31	**P**	0.07
6885.5	8.23	6.19	0.34	3.00	0.20	2.27	1.98	-0.27	0.00	0.22	0.22	0.32	**P**	0.08
6886	8.22	7.22	0.34	2.92	0.19	2.27	2.02	-0.28	0.00	0.22	0.22	0.33	**P**	0.08
6886.5	8.25	9.16	0.34	2.80	0.19	2.28	2.05	-0.25	0.00	0.21	0.21	0.34	**P**	0.08
6887	8.22	11.90	0.33	2.38	0.18	2.28	2.08	-0.28	0.01	0.21	0.21	0.37	**P**	0.08
6887.5	8.23	12.32	0.33	2.07	0.18	2.28	2.09	-0.27	0.01	0.21	0.21	0.40	**P**	0.09
6888	8.25	11.92	0.34	2.14	0.18	2.28	2.13	-0.25	0.01	0.21	0.21	0.39	**P**	0.09
6888.5	8.28	11.96	0.36	2.42	0.18	2.30	2.16	-0.22	0.01	0.20	0.20	0.38	**P**	0.08
6889	8.26	13.21	0.41	2.69	0.17	2.31	2.16	-0.24	0.01	0.20	0.19	0.38	**P**	0.08
6889.5	8.29	15.23	0.54	5.00	0.18	2.32	2.14	-0.21	0.02	0.19	0.19	0.29	**P**	0.06
6890	8.32	17.93	0.59	7.14	0.19	2.31	2.14	-0.18	0.02	0.20	0.19	0.24	**P**	0.05
6890.5	8.33	16.92	0.47	4.12	0.19	2.29	2.12	-0.17	0.02	0.21	0.20	0.29	**P**	0.06
6891	8.35	16.78	0.37	3.40	0.19	2.27	2.11	-0.15	0.02	0.22	0.21	0.30	**P**	0.07
6891.5	8.36	16.31	0.33	3.01	0.20	2.27	2.11	-0.14	0.02	0.22	0.21	0.32	**P**	0.07
6892	8.37	17.88	0.33	2.35	0.21	2.28	2.17	-0.13	0.02	0.22	0.21	0.38	**P**	0.08
6892.5	8.39	20.20	0.40	2.44	0.22	2.31	2.26	-0.11	0.03	0.22	0.21	0.40	**P**	0.08
6893	8.43	21.30	0.47	3.76	0.22	2.32	2.28	-0.07	0.03	0.21	0.20	0.33	**P**	0.07
6893.5	8.39	19.29	0.52	3.00	0.22	2.31	2.23	-0.11	0.03	0.21	0.21	0.36	**P**	0.076
6894	8.38	16.06	0.43	2.91	0.22	2.29	2.12	-0.12	0.02	0.22	0.22	0.34	**P**	0.075
6894.5	8.34	15.56	0.43	2.83	0.22	2.28	2.06	-0.16	0.02	0.22	0.22	0.34	**P**	0.075
6895	8.31	13.82	0.47	3.38	0.20	2.28	2.03	-0.19	0.01	0.22	0.21	0.32	**P**	0.07
6895.5	8.30	10.56	0.50	5.95	0.20	2.27	2.04	-0.20	0.00	0.22	0.22	0.23	**P**	0.05
6896	8.31	9.14	0.46	4.60	0.19	2.27	2.06	-0.19	0.00	0.22	0.22	0.26	**P**	0.06
6896.5	8.32	10.08	0.38	2.87	0.19	2.27	2.09	-0.18	0.00	0.22	0.22	0.33	**P**	0.07
6897	8.31	12.33	0.35	2.13	0.19	2.27	2.12	-0.19	0.01	0.22	0.22	0.38	**P**	0.08
6897.5	8.29	15.61	0.35	1.91	0.22	2.28	2.13	-0.21	0.02	0.23	0.22	0.41	**P**	0.09
6898	8.29	19.00	0.41	1.99	0.24	2.27	2.17	-0.21	0.03	0.24	0.23	0.40	**P**	0.09
6898.5	8.26	19.09	0.49	3.92	0.25	2.27	2.20	-0.24	0.03	0.24	0.23	0.29	**P**	0.067
6899	8.25	16.39	0.54	4.24	0.23	2.26	2.20	-0.25	0.02	0.23	0.23	0.27	**P**	0.06
6899.5	8.23	14.86	0.41	1.62	0.21	2.27	2.19	-0.27	0.01	0.22	0.22	0.44	**P**	0. 097
6900	8.22	17.64	0.42	1.86	0.21	2.31	2.22	-0.28	0.02	0.21	0.21	0.46	**P**	0. 097

Table (2): Well log data and output petrophysical results for segment DB, D-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2.(P) means that, the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	PEF	Calip.-B.S.	Vshale	PHIT	PHIE	Sw	Cutoff * Flag	BVW
6838.5	8.21	21.04	0.67	5.63	0.19	2.30	2.23	-0.29	0.03	0.20	0.19	0.27	P	0.05
6839	8.28	32.26	0.69	4.93	0.19	2.34	2.33	-0.22	0.08	0.19	0.17	0.32	P	0.06
6839.5	8.36	37.08	0.77	5.40	0.18	2.36	2.43	-0.14	0.10	0.18	0.16	0.33	P	0.05
6840	8.29	38.21	0.77	4.86	0.19	2.36	2.50	-0.21	0.10	0.18	0.16	0.35	P	0.06
6840.5	8.25	32.87	0.62	3.28	0.20	2.34	2.53	-0.25	0.08	0.20	0.18	0.39	P	0.07
6841	8.22	30.73	0.61	4.45	0.22	2.31	2.51	-0.28	0.07	0.21	0.19	0.31	P	0.06
6841.5	8.20	27.63	0.53	5.37	0.24	2.27	2.45	-0.30	0.06	0.23	0.22	0.25	P	0.06
6842	8.20	27.34	0.40	3.89	0.24	2.24	2.41	-0.30	0.06	0.24	0.23	0.27	P	0.07
6842.5	8.19	27.81	0.31	2.35	0.23	2.25	2.41	-0.31	0.06	0.24	0.22	0.35	P	0.08
6843	8.20	29.58	0.35	2.42	0.20	2.28	2.39	-0.30	0.07	0.22	0.20	0.37	P	0.08
6843.5	8.19	26.55	0.42	3.42	0.20	2.29	2.35	-0.31	0.05	0.21	0.20	0.32	P	0.07
6844	8.20	20.76	0.60	5.45	0.21	2.27	2.26	-0.30	0.03	0.22	0.21	0.25	P	0.06
6844.5	8.20	16.08	0.50	4.78	0.23	2.25	2.19	-0.30	0.02	0.24	0.23	0.25	P	0.06
6845	8.20	15.10	0.42	4.51	0.22	2.23	2.15	-0.30	0.01	0.24	0.24	0.24	P	0.06
6845.5	8.20	14.84	0.33	3.60	0.23	2.22	2.13	-0.30	0.01	0.25	0.24	0.26	P	0.07
6846	8.23	15.99	0.34	2.64	0.22	2.23	2.11	-0.27	0.02	0.24	0.24	0.31	P	0.08
6846.5	8.25	17.79	0.34	2.74	0.22	2.23	2.10	-0.25	0.02	0.24	0.24	0.31	P	0.08
6847	8.26	22.01	0.34	2.94	0.21	2.23	2.10	-0.24	0.04	0.23	0.23	0.30	P	0.08
6847.5	8.26	23.68	0.30	3.69	0.21	2.24	2.10	-0.24	0.04	0.23	0.22	0.27	P	0.07
6848	8.28	24.18	0.28	3.01	0.20	2.25	2.09	-0.22	0.04	0.23	0.22	0.31	P	0.07
6848.5	8.28	23.74	0.28	2.35	0.21	2.25	2.09	-0.22	0.04	0.23	0.22	0.35	P	0.08
6849	8.27	24.69	0.28	2.83	0.22	2.25	2.10	-0.23	0.05	0.23	0.22	0.31	P	0.08
6849.5	8.25	25.49	0.28	2.68	0.23	2.24	2.11	-0.25	0.05	0.24	0.23	0.32	P	0.08
6850	8.25	27.68	0.28	2.68	0.23	2.23	2.14	-0.25	0.06	0.24	0.23	0.31	P	0.08
6850.5	8.27	28.58	0.30	2.80	0.22	2.23	2.17	-0.23	0.06	0.24	0.23	0.31	P	0.08
6851	8.29	27.44	0.36	3.47	0.21	2.24	2.17	-0.21	0.06	0.23	0.22	0.29	P	0.07
6851.5	8.23	20.58	0.49	4.61	0.22	2.25	2.15	-0.27	0.03	0.23	0.22	0.25	P	0.06
6852	8.24	11.44	0.61	4.90	0.21	2.24	2.10	-0.26	0.00	0.23	0.23	0.24	P	0.06
6852.5	8.22	7.99	0.59	4.56	0.22	2.23	2.07	-0.28	0.00	0.24	0.24	0.24	P	0.06
6853	8.23	5.81	0.53	4.06	0.22	2.22	2.05	-0.27	0.00	0.24	0.24	0.25	P	0.06
6853.5	8.23	5.48	0.50	4.00	0.22	2.22	2.04	-0.27	0.00	0.24	0.24	0.25	P	0.07
6854	8.25	5.29	0.45	2.55	0.22	2.23	2.02	-0.25	0.00	0.24	0.24	0.32	P	0.08
6854.5	8.23	5.16	0.49	2.00	0.22	2.24	1.99	-0.27	0.00	0.24	0.24	0.37	P	0.09
6855	8.24	4.53	0.58	3.35	0.21	2.24	1.96	-0.26	0.00	0.23	0.23	0.29	P	0.07
6855.5	8.25	3.46	0.78	3.56	0.21	2.24	1.96	-0.25	0.00	0.23	0.23	0.28	P	0.07
6856	8.25	3.67	0.75	3.51	0.20	2.24	1.95	-0.25	0.00	0.23	0.23	0.29	P	0.07
6856.5	8.26	3.05	0.69	3.43	0.21	2.24	1.97	-0.24	0.00	0.23	0.23	0.29	P	0.07
6857	8.27	3.16	0.61	3.18	0.20	2.24	1.97	-0.23	0.00	0.23	0.23	0.30	P	0.07
6857.5	8.26	3.72	0.51	1.97	0.20	2.25	1.98	-0.24	0.00	0.23	0.23	0.38	P	0.09
6858	8.26	4.94	0.57	1.63	0.20	2.26	1.97	-0.24	0.00	0.23	0.23	0.43	P	0.10
6858.5	8.30	5.94	0.72	3.58	0.21	2.26	1.96	-0.20	0.00	0.22	0.22	0.30	P	0.07
6859	8.34	6.60	0.95	4.33	0.21	2.26	1.96	-0.16	0.00	0.22	0.22	0.27	P	0.06
6859.5	8.33	7.15	0.71	2.95	0.21	2.27	1.99	-0.17	0.00	0.22	0.22	0.33	P	0.08
6860	8.32	11.88	0.51	1.77	0.19	2.32	2.08	-0.18	0.01	0.20	0.20	0.48	P	0.10

By comparing the calculated BVW with that included in the above table for the described grain size, one can detect whether if this reservoir at the irreducible state or not. For segments DA and DB, the sandstone was described as medium to fine grain sizes, accordingly, the BVW must be less than 0.05 to be at an irreducible state. The majority of the calculated BVW is indeed more than 0.05 and even reaches above 0.1. This indicates that these reservoirs will produce water in addition to oil. It is wise here to point that water disposal is a difficult process and requires time and money and hence reduces greatly the return interest.

**Segment DC*

This segment is located higher than that of DA and DB. Also, all zones of this segment have cut off the flag (P) as shown in Table (3). It has the lowest shale content with a maximum value of 4%. It also has a high effective porosity (0.19-0.22). The water saturations are less than 30%.

In addition to the positive indications for the excellent reservoir, the Bulk Volume of Water (BVW) is generally less than 0.07 with the majority between 0.06 and 0.05. For this fine to very fine sand, this reservoir can be expected to be

at an irreducible state which will produce oil with no water.

Table (3): Well log data and the output petrophysical results for zone DC, D-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	PEF	Calip.-B.S.	Vshale	PHIT	PHIE	Sw	Cutoff* Flag	BVW
6815	8.23	16.65	1.00	7.07	0.22	2.26	2.24	-0.27	0.02	0.23	0.22	0.22	P	0.05
6815.5	8.22	19.15	0.75	6.91	0.21	2.26	2.19	-0.28	0.03	0.23	0.22	0.21	P	0.05
6816	8.23	21.62	0.57	6.36	0.21	2.27	2.22	-0.27	0.04	0.22	0.21	0.23	P	0.05
6816.5	8.21	21.42	0.47	4.50	0.21	2.27	2.25	-0.29	0.04	0.22	0.21	0.27	P	0.06
6817	8.21	21.46	0.44	4.00	0.21	2.27	2.30	-0.29	0.04	0.22	0.21	0.28	P	0.06
6817.5	8.20	20.28	0.45	4.54	0.20	2.26	2.29	-0.30	0.03	0.22	0.21	0.26	P	0.06
6818	8.22	16.71	0.49	4.61	0.19	2.26	2.24	-0.28	0.02	0.22	0.21	0.26	P	0.06
6818.5	8.23	13.31	0.60	4.70	0.18	2.26	2.17	-0.27	0.01	0.21	0.21	0.26	P	0.06
6819	8.20	10.15	0.73	5.49	0.18	2.27	2.12	-0.30	0.00	0.21	0.21	0.24	P	0.06
6819.5	8.22	9.24	0.82	6.09	0.18	2.27	2.11	-0.28	0.00	0.21	0.21	0.23	P	0.05
6820	8.20	10.06	0.70	6.24	0.19	2.27	2.12	-0.30	0.00	0.21	0.21	0.23	P	0.05
6820.5	8.20	11.78	0.57	4.96	0.20	2.27	2.14	-0.30	0.01	0.22	0.22	0.26	P	0.06
6821	8.23	14.71	0.46	4.69	0.21	2.27	2.16	-0.27	0.01	0.22	0.22	0.26	P	0.06
6821.5	8.21	14.97	0.40	3.75	0.20	2.27	2.18	-0.29	0.01	0.22	0.21	0.29	P	0.07
6822	8.21	17.09	0.40	2.83	0.18	2.29	2.17	-0.29	0.02	0.21	0.20	0.29	P	0.058
6822.5	8.23	18.56	0.46	5.17	0.18	2.31	2.18	-0.27	0.03	0.20	0.19	0.29	P	0.055
6823	8.29	18.78	0.54	7.72	0.17	2.31	2.18	-0.21	0.03	0.19	0.19	0.23	P	0.05
6823.5	8.27	19.65	0.50	4.65	0.17	2.30	2.21	-0.23	0.03	0.20	0.19	0.29	P	0.06

**Segment DD*

This is the uppermost zone. It can be considered shaly as the volume of shale (Vsh) is higher than that for the lower segments (Table 4). This is illustrated in many zones denoted (F) on Cut off Flag column. Zones with (P) flag can be differentiated into two groups.

Table (4): Well log data and output petrophysical results for zone DD, D-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	PEF	Calip.-B.S.	Vshale	PHIT	PHIE	Sw	Cutoff* Flag	BVW
6780	8.35	53.73	1.58	9.51	0.15	2.51	2.76	-0.15	0.19	0.12	0.08	------	F	------
6780.5	8.38	62.34	3.49	18.28	0.13	2.56	2.93	-0.12	0.26	0.10	0.04	------	F	------
6781	8.42	64.07	7.57	18.90	0.15	2.57	3.02	-0.08	0.27	0.11	0.05	-----	F	------
6781.5	8.40	65.10	6.23	14.08	0.18	2.56	3.04	-0.10	0.28	0.12	0.06	------	F	------
6782	8.40	63.28	3.99	10.60	0.20	2.55	3.01	-0.10	0.27	0.14	0.08	-----	F	------
6782.5	8.31	55.59	3.39	12.33	0.18	2.52	2.90	-0.19	0.20	0.14	0.09	------	F	------
6783	8.34	41.20	1.85	15.61	0.17	2.49	2.76	-0.16	0.12	0.14	0.11	0.36	P	0.03
6783.5	8.29	31.25	1.00	5.23	0.16	2.43	2.60	-0.21	0.07	0.15	0.14	0.43	P	0.06
6784	8.28	26.25	0.66	4.28	0.16	2.38	2.48	-0.22	0.05	0.17	0.16	0.39	P	0.06
6784.5	8.22	24.36	0.58	4.19	0.16	2.36	2.42	-0.28	0.05	0.18	0.16	0.36	P	0.06
6785	8.23	25.90	0.57	4.28	0.17	2.36	2.48	-0.27	0.05	0.18	0.16	0.36	P	0.06
6785.5	8.25	29.77	0.60	4.83	0.16	2.38	2.60	-0.25	0.07	0.17	0.15	0.36	P	0.06
6786	8.32	33.56	0.69	5.09	0.15	2.42	2.79	-0.18	0.08	0.15	0.13	0.41	P	0.06
6786.5	8.42	38.71	0.98	6.45	0.13	2.48	2.99	-0.08	0.10	0.13	0.10	0.51	F	-----
6787	8.54	43.02	1.49	10.71	0.14	2.53	3.16	0.04	0.13	0.11	-----	------	F	-----
6787.5	8.48	44.69	2.90	17.16	0.18	2.56	3.21	-0.02	0.14	0.12	------	------	F	------
6788	8.54	43.84	2.97	14.74	0.20	2.55	3.10	0.04	0.13	0.13	0.10	0.68	F	-----
6788.5	8.46	37.97	1.91	8.34	0.19	2.51	2.90	-0.04	0.10	0.14	0.12	0.58	F	------
6789	8.35	29.92	1.42	6.34	0.16	2.46	2.66	-0.15	0.07	0.15	0.13	0.45	P	0.05
6789.5	8.32	25.13	1.25	7.90	0.17	2.41	2.45	-0.18	0.05	0.16	0.15	0.33	P	0.05
6790	8.31	24.09	1.33	8.50	0.17	2.40	2.32	-0.19	0.04	0.16	0.15	0.30	P	0.04
6790.5	8.32	25.54	1.32	9.18	0.17	2.41	2.31	-0.18	0.05	0.16	0.15	0.31	P	0.04
6791	8.32	32.10	1.63	8.35	0.17	2.44	2.40	-0.18	0.08	0.15	0.13	0.37	P	0.04
6791.5	8.44	38.56	1.94	11.14	0.18	2.45	2.52	-0.06	0.10	0.15	0.13	0.35	P	0.04
6792	8.54	42.77	1.52	6.26	0.18	2.46	2.56	0.04	0.13	0.15	0.12	0.49	P	0.05
6792.5	8.59	44.14	1.55	7.11	0.17	2.46	2.53	0.09	0.13	0.15	0.12	0.46	P	0.04
6793	8.66	37.98	1.49	15.95	0.15	2.45	2.45	0.16	0.10	0.14	0.12	0.29	P	0.03
6793.5	8.42	29.20	1.70	9.12	0.15	2.42	2.37	-0.08	0.06	0.15	0.13	0.33	P	0.04

6794	8.28	22.36	1.17	7.45	0.16	2.39	2.32	-0.22	0.04	0.16	0.15	0.31	P	0.05
6794.5	8.29	24.51	1.01	7.46	0.17	2.37	2.30	-0.21	0.05	0.17	0.16	0.29	P	0.05
6795	8.29	27.44	0.88	7.18	0.15	2.38	2.37	-0.21	0.06	0.16	0.15	0.31	P	0.05
6795.5	8.32	27.73	0.83	5.86	0.13	2.42	2.48	-0.18	0.06	0.14	0.13	0.38	P	0.05
6796	8.29	26.97	1.01	10.72	0.12	2.47	2.66	-0.21	0.05	0.12	0.11	0.36	P	0.04
6796.5	8.37	26.72	1.54	11.70	0.13	2.51	2.86	-0.13	0.05	0.11	0.10	0.45	P	0.04
6797	8.33	34.86	1.63	5.35	0.15	2.51	3.03	-0.17	0.09	0.13	0.11	0.70	F	-------
6797.5	8.31	44.91	1.89	6.92	0.16	2.57	3.34	-0.19	0.14	0.11	0.08	------	F	-------
6798	8.41	52.49	2.41	14.75	0.16	2.65	3.68	-0.09	0.18	0.09	0.05	-----	F	--------
6798.5	8.46	48.58	7.16	15.99	0.13	2.74	4.04	-0.04	0.16	0.06	0.02	-----	F	--------
6799	8.44	39.34	10.32	21.91	0.08	2.77	4.15	-0.06	0.11	0.03	0.01	------	F	--------
6799.5	8.41	30.09	16.05	50.56	0.04	2.78	4.09	-0.09	0.07	0.01	0.00	-----	F	--------
6800	8.40	24.46	33.53	96.37	0.04	2.79	3.94	-0.10	0.05	0.01	0.00	-----	F	-------

The first one (6783-6786) has a constant BVW value of 0.06. This indicates the expectation of water production in addition to oil. The second group (6789-6796.5) possesses better reservoir quality, although they have nearly the same range of water saturations, as the BVW values are lower and nearly constant (0.04-0.05) reflecting irreducible state.

-EBAH- E-1 X

** Segment EA*

The most important and challenging feature which must be noticed for this segment is the exception mud cake thickness appeared as large negative values of the differential caliper (Calip-B.S., Table 5). It reaches values larger than -1.0 and reached a value of -1.45. This thick cake affects greatly well log tool measurements, especially, the resistivity logs. Accordingly, resistivity correction for mud cake thickness has been carried out for this segment and is given in Table (5).

Generally, all zones passed all cut off parameters (i.e "P" flagged) except the most lower below depth 6614 ft. Although the calculated water saturations are generally low, the higher BVW values for this fine sandstone reservoir (>0.05) reduce reservoir quality and expected to produce also water in addition to oil.

Table (5): Well log data and output petrophysical results for segment EA, E-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	Calip-B.S.	VSH	PHIT	PHIE	Sw	Cutoff* Flag	BVW
6596.5	7.38	28.57	0.61	4.57	0.16	2.38	-1.12	0.06	0.16	0.15	0.41	P	0.06
6597	7.53	25.83	0.53	6.14	0.17	2.37	-0.97	0.05	0.16	0.16	0.33	P	0.05
6597.5	7.32	21.46	0.47	4.77	0.17	2.35	-1.18	0.04	0.17	0.17	0.35	P	0.06
6598	7.19	22.08	0.49	3.55	0.19	2.34	-1.31	0.04	0.18	0.18	0.39	P	0.07
6598.5	7.27	23.32	0.65	3.80	0.20	2.33	-1.23	0.04	0.18	0.18	0.37	P	0.07
6599	7.45	21.48	0.66	5.58	0.21	2.32	-1.05	0.04	0.19	0.19	0.29	P	0.05
6599.5	7.42	18.24	0.52	3.33	0.21	2.28	-1.08	0.02	0.21	0.21	0.34	P	0.07
6600	7.68	18.30	0.41	3.36	0.22	2.25	-0.82	0.02	0.23	0.22	0.31	P	0.07
6600.5	7.42	18.82	0.40	3.18	0.24	2.24	-1.08	0.03	0.24	0.23	0.31	P	0.07
6601	7.33	19.40	0.44	2.97	0.25	2.24	-1.17	0.03	0.24	0.23	0.32	P	0.08
6601.5	7.23	21.16	0.43	2.99	0.23	2.24	-1.27	0.03	0.24	0.23	0.32	P	0.07
6602	7.36	23.64	0.53	2.85	0.22	2.24	-1.14	0.04	0.24	0.23	0.33	P	0.08
6602.5	7.48	24.57	0.46	2.96	0.23	2.24	-1.02	0.05	0.23	0.23	0.33	P	0.07
6603	7.57	25.22	0.47	2.95	0.23	2.26	-0.93	0.05	0.23	0.22	0.34	P	0.07
6603.5	7.45	23.92	0.40	3.40	0.23	2.27	-1.05	0.04	0.22	0.21	0.33	P	0.07
6604	7.30	23.25	0.41	3.88	0.23	2.29	-1.20	0.04	0.21	0.20	0.32	P	0.07
6604.5	7.11	21.55	0.44	3.77	0.22	2.30	-1.39	0.04	0.20	0.20	0.34	P	0.07
6605	7.05	19.31	0.57	4.87	0.22	2.30	-1.45	0.03	0.20	0.20	0.30	P	0.06
6605.5	7.23	16.45	0.68	6.98	0.22	2.29	-1.27	0.02	0.20	0.20	0.24	P	0.05
6606	7.50	17.42	0.57	4.00	0.22	2.28	-1.00	0.02	0.21	0.21	0.31	P	0.06
6606.5	7.46	18.53	0.44	1.97	0.21	2.29	-1.04	0.03	0.21	0.21	0.45	P	0.09
6607	7.37	16.66	0.41	2.61	0.21	2.31	-1.13	0.02	0.20	0.20	0.41	P	0.08
6607.5	7.17	16.58	0.54	3.48	0.22	2.30	-1.33	0.02	0.20	0.20	0.35	P	0.07
6608	7.10	15.92	0.55	4.94	0.22	2.28	-1.40	0.02	0.21	0.21	0.28	P	0.06
6608.5	7.35	16.66	0.48	2.94	0.22	2.26	-1.15	0.02	0.22	0.22	0.34	P	0.08
6609	7.54	16.60	0.41	2.79	0.22	2.27	-0.96	0.02	0.22	0.22	0.36	P	0.08
6609.5	7.73	18.52	0.43	3.42	0.24	2.29	-0.78	0.03	0.21	0.21	0.34	P	0.07
6610	7.51	19.84	0.48	3.13	0.22	2.29	-0.99	0.03	0.21	0.20	0.36	P	0.07

6610.5	7.31	20.02	0.44	3.49	0.21	2.29	-1.19	0.03	0.21	0.20	0.34	P	0.07
6611	7.27	19.63	0.48	3.69	0.19	2.30	-1.23	0.03	0.20	0.20	0.34	P	0.07
6611.5	7.27	19.73	0.47	3.84	0.19	2.30	-1.23	0.03	0.20	0.20	0.33	P	0.07
6612	7.54	21.07	0.48	2.92	0.19	2.30	-0.96	0.03	0.20	0.20	0.38	P	0.08
6612.5	7.65	21.67	0.47	3.53	0.19	2.31	-0.85	0.04	0.20	0.19	0.36	P	0.07
6613	7.41	23.22	0.52	3.77	0.19	2.32	-1.09	0.04	0.19	0.18	0.36	P	0.07
6613.5	7.36	22.03	0.58	3.61	0.19	2.33	-1.14	0.04	0.18	0.18	0.38	P	0.07
6614	7.45	23.15	0.76	5.51	0.21	2.40	-1.05	0.04	0.15	0.14	0.39	P	0.05
6614.5	7.65	24.24	1.19	10.47	0.20	2.49	-0.85	0.04	0.10	0.09	----	F	-----
6615	8.13	24.31	3.00	16.46	0.14	2.58	-0.37	0.05	0.04	0.04	----	F	----
6615.5	8.49	24.63	2.46	15.98	0.10	2.59	-0.01	0.05	0.04	0.03	----	F	-----
6616	8.32	24.18	1.48	6.95	0.11	2.54	-0.18	0.04	0.07	0.06	-----	F	-----
6616.5	8.31	23.54	0.98	4.91	0.12	2.49	-0.19	0.04	0.10	0.09	-----	F	-----
6617	8.28	22.98	0.83	3.98	0.14	2.46	-0.22	0.04	0.11	0.11	0.60	F	----
6617.5	8.40	23.61	0.94	3.52	0.19	2.46	-0.10	0.04	0.11	0.11	0.63	F	----
6618	8.53	24.32	1.26	4.07	0.27	2.48	0.03	0.05	0.10	0.10	0.65	F	----
6618.5	8.70	22.92	2.24	9.79	0.30	2.50	0.20	0.04	0.09	0.08	0.49	F	-----
6619	8.88	21.75	3.75	13.31	0.23	2.52	0.38	0.04	0.08	0.07	0.47	F	----

**Segment EB*

This very thin layer (3.5 feet) is considered shaly. This led to a reduction in the porosity (marginal) and increase water saturation (>0.46) (Table 6). The most important point here is the constant and low BVW values (0.05) which tell us about the production with no water. On the other hand, the reservoir is very thin with low porosity and high water saturation which make economic production is not expected. This sheds more light on the importance of correlating all the petrophysical parameters without ignoring the importance of the reservoir capacity.

**Segment EC*

This reservoir has (P) as cut off flag (Table 7). The shale content is almost low (i.e clean). Water saturation values are relatively high. The porosity is good. In addition, the BVW is greater than 0.05 which indicates that this reservoir is not at an irreducible state. It will produce with Water Cut (WC).

**Segment ED*

The lowermost five feet of this segment (6501-6506) is considered as a possible reservoir with (P) flag (Table 8). It is shaly as the shale content (Vsh) is larger than 0.10. The constant BVW (0.05) suggests this reservoir to be at an irreducible state.

**Segment EE*

This segment is not considered a reservoir as the (P) flag prevailed in Table (9). This is can be attributed to the massive nature (compacted) with low porosity. This is also indicated on high densities (RHOZ). The positive differential caliper may be due to low permeability because of shale.

**Segment EF*

This segment possesses (P) flag (Table 10). It is considered shaly (Vsh>0.15) with good porosity and low water saturation (<0.35). The most promising factor is that BVW is low indicating good production.

Table (6): Well log data and output petrophysical results for segment EB, E-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	Calip-B.S.	VSH	PHIT	PHIE	Sw	Cutoff* Flag	BVW
6583	8.24	45.84	0.97	5.66	0.16	2.45	-0.26	0.14	0.12	0.09	----	F	----
6583.5	8.28	46.63	0.86	5.50	0.16	2.45	-0.22	0.15	0.12	0.10	0.52	F	-----
6584	8.34	49.41	0.81	5.93	0.17	2.44	-0.16	0.16	0.13	0.10	0.48	P	0.05
6584.5	8.41	55.79	0.84	5.76	0.17	2.42	-0.09	0.21	0.14	0.10	0.46	P	0.05
6585	8.30	56.87	0.82	5.29	0.17	2.40	-0.20	0.21	0.14	0.11	0.46	P	0.05
6585.5	8.27	53.38	0.78	4.99	0.18	2.40	-0.23	0.19	0.14	0.11	0.46	P	0.05
6586	8.27	50.99	0.82	5.31	0.16	2.42	-0.23	0.17	0.14	0.11	0.46	P	0.05
6586.5	8.35	51.55	0.93	6.15	0.15	2.43	-0.15	0.18	0.13	0.10	0.48	P	0.05

Table (7): Well log data and output petrophysical results for zone EC, E-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	Calip-B.S.	VSH	PHIT	PHIE	Sw	Cutoff* Flag	BVW
6550	8.45	49.33	0.76	3.88	0.21	2.42	-0.05	0.16	0.14	0.11	0.53	F	-----
6550.5	8.42	43.60	0.59	4.33	0.20	2.38	-0.08	0.13	0.16	0.13	0.44	P	0.06
6551	8.27	39.97	0.57	4.41	0.20	2.37	-0.23	0.11	0.16	0.14	0.41	P	0.06
6551.5	8.18	35.00	0.53	4.36	0.22	2.37	-0.32	0.09	0.16	0.15	0.40	P	0.06
6552	8.12	32.83	0.48	4.27	0.22	2.35	-0.38	0.08	0.17	0.16	0.38	P	0.06
6552.5	8.08	32.41	0.44	3.94	0.21	2.34	-0.42	0.08	0.18	0.17	0.38	P	0.06
6553	8.21	35.27	0.45	3.88	0.20	2.35	-0.29	0.09	0.17	0.16	0.40	P	0.06
6553.5	8.36	34.12	0.45	4.21	0.21	2.36	-0.14	0.08	0.17	0.16	0.39	P	0.06
6554	8.36	32.96	0.43	4.18	0.21	2.35	-0.14	0.08	0.18	0.16	0.38	P	0.06
6554.5	8.34	31.31	0.40	3.79	0.23	2.33	-0.16	0.07	0.19	0.17	0.38	P	0.07
6555	8.30	31.10	0.42	4.25	0.23	2.33	-0.20	0.07	0.19	0.18	0.35	P	0.06
6555.5	8.27	30.81	0.46	4.41	0.22	2.33	-0.23	0.07	0.18	0.17	0.35	P	0.06
6556	8.36	29.27	0.46	3.60	0.21	2.34	-0.14	0.06	0.18	0.17	0.40	P	0.07
6556.5	8.58	29.04	0.45	3.38	0.21	2.35	0.08	0.06	0.18	0.17	0.42	P	0.07
6557	8.35	28.38	0.44	3.92	0.21	2.35	-0.15	0.06	0.18	0.17	0.38	P	0.06
6557.5	8.31	31.45	0.43	3.70	0.22	2.34	-0.19	0.07	0.18	0.17	0.39	P	0.07
6558	8.31	31.74	0.40	3.98	0.21	2.33	-0.19	0.07	0.19	0.18	0.36	P	0.06
6558.5	8.12	30.96	0.42	4.19	0.20	2.33	-0.38	0.07	0.19	0.17	0.36	P	0.06
6559	8.22	30.72	0.42	3.96	0.19	2.33	-0.28	0.07	0.18	0.17	0.37	P	0.06
6559.5	8.34	29.51	0.45	3.47	0.19	2.35	-0.16	0.06	0.18	0.17	0.41	P	0.07
6560	8.40	30.45	0.43	3.95	0.19	2.37	-0.10	0.07	0.16	0.15	0.42	P	0.06

Table (8): Well log data and output petrophysical results for segment ED, E-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	GRHC (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	Calip-B.S.	VSH	PHIT	PHIE	Sw	Cutoff * Flag	BVW
6495.5	8.64	57.07	2.42	5.53	0.24	2.44	0.14	0.22	0.12	0.09	-----	F	-----
6496	8.28	52.68	2.08	4.87	0.27	2.47	-0.22	0.18	0.11	0.08	------	F	-------
6496.5	8.28	50.74	1.93	6.09	0.23	2.49	-0.22	0.17	0.10	0.07	------	F	------
6497	8.39	45.18	2.24	6.60	0.17	2.53	-0.11	0.14	0.08	0.05	------	F	--------
6497.5	8.39	34.70	1.82	7.17	0.15	2.56	-0.11	0.09	0.06	0.05	-----	F	------
6498	8.18	27.28	1.52	6.12	0.16	2.57	-0.32	0.06	0.05	0.04	------	F	-----
6498.5	8.43	28.73	1.28	5.50	0.18	2.54	-0.07	0.06	0.07	0.06	------	F	------
6499	8.47	30.71	1.04	5.88	0.19	2.49	-0.03	0.07	0.09	0.08	------	F	------
6499.5	8.25	31.93	0.96	7.24	0.19	2.47	-0.25	0.07	0.11	0.10	0.48	P	0.05
6500	8.38	35.92	0.95	6.17	0.17	2.48	-0.12	0.09	0.10	0.09	------	F	------
6500.5	8.34	39.51	0.91	5.46	0.17	2.46	-0.16	0.11	0.11	0.09	------	F	------
6501	8.45	38.35	0.75	5.42	0.17	2.43	-0.05	0.10	0.13	0.11	0.47	P	0.05
6501.5	8.42	35.88	0.66	5.13	0.18	2.40	-0.08	0.09	0.15	0.13	0.42	P	0.06
6502	8.41	36.89	0.68	5.43	0.19	2.39	-0.09	0.10	0.15	0.14	0.39	P	0.05
6502.5	8.40	41.45	0.81	6.56	0.21	2.39	-0.10	0.12	0.15	0.13	0.37	P	0.05
6503	8.35	47.30	0.89	6.44	0.22	2.38	-0.15	0.15	0.15	0.13	0.36	P	0.05
6503.5	8.42	50.66	0.99	6.49	0.18	2.39	-0.08	0.17	0.15	0.13	0.37	P	0.05
6504	8.39	47.30	0.87	5.70	0.18	2.38	-0.11	0.15	0.15	0.13	0.39	P	0.05
6504.5	8.33	46.60	0.83	5.34	0.20	2.38	-0.17	0.15	0.16	0.13	0.39	P	0.05
6505	8.36	47.47	0.87	6.81	0.23	2.38	-0.14	0.15	0.16	0.13	0.35	P	0.05
6505.5	8.36	49.86	0.94	5.76	0.22	2.38	-0.14	0.17	0.16	0.13	0.39	P	0.05
6506	8.27	55.55	1.20	6.34	0.18	2.41	-0.23	0.20	0.14	0.11	0.43	P	0.05
6506.5	8.35	57.63	1.37	6.71	0.18	2.46	-0.15	0.22	0.11	0.08	-------	F	------
6507	8.44	59.99	2.00	8.31	0.15	2.47	-0.06	0.24	0.10	0.07	-----	F	--------
6507.5	8.61	62.00	2.44	9.96	0.16	2.48	0.11	0.25	0.10	0.06	------	F	-------
6508	8.73	61.15	2.48	8.33	0.18	2.46	0.23	0.25	0.11	0.07	-----	F	-------
6508.5	8.77	57.67	1.96	5.89	0.22	2.45	0.27	0.22	0.12	0.08	-----	F	------
6509	8.62	55.03	1.75	8.20	0.21	2.47	0.12	0.20	0.11	0.07	-------	F	-------
6509.5	8.61	55.80	2.02	10.19	0.20	2.47	0.11	0.21	0.10	0.07	------	F	--------
6510	8.35	55.19	1.83	8.28	0.18	2.47	-0.15	0.20	0.11	0.07	------	F	-----
6510.5	8.54	50.04	1.07	5.70	0.16	2.44	0.04	0.17	0.12	0.10	0.51	F	-----
6511	8.67	43.86	0.79	6.30	0.16	2.41	0.17	0.13	0.14	0.12	0.41	P	0.05
6511.5	8.47	43.12	0.84	7.49	0.18	2.39	-0.03	0.13	0.15	0.13	0.34	P	0.04
6512	8.18	49.45	1.11	8.65	0.20	2.39	-0.32	0.16	0.15	0.12	0.33	P	0.04
6512.5	8.04	51.71	1.07	10.83	0.20	2.42	-0.46	0.18	0.13	0.10	0.34	P	0.04
6513	8.14	53.73	0.81	6.66	0.17	2.44	-0.36	0.19	0.12	0.09	------	F	-------
6513.5	8.19	53.75	0.77	6.36	0.16	2.44	-0.31	0.19	0.12	0.09	------	F	-------
6514	8.34	56.53	0.96	8.62	0.17	2.42	-0.16	0.21	0.13	0.10	0.39	P	0.04

6514.5	8.38	53.20	1.24	7.48	0.18	2.42	-0.12	0.19	0.14	0.11	0.40	P	0.04
6515	8.34	47.26	1.03	6.23	0.20	2.41	-0.16	0.15	0.14	0.12	0.42	P	0.05
6515.5	8.13	40.27	0.87	5.84	0.21	2.41	-0.37	0.11	0.14	0.12	0.42	P	0.05
6516	8.03	37.74	0.75	5.72	0.20	2.40	-0.47	0.10	0.14	0.13	0.40	P	0.05
6516.5	8.17	39.72	0.75	5.39	0.19	2.40	-0.33	0.11	0.15	0.13	0.41	P	0.05
6517	8.22	38.77	0.87	5.90	0.20	2.40	-0.28	0.11	0.15	0.13	0.39	P	0.05
6517.5	8.22	37.40	0.90	4.85	0.21	2.39	-0.28	0.10	0.15	0.14	0.41	P	0.06
6518	8.24	34.90	0.71	4.30	0.22	2.36	-0.26	0.09	0.17	0.15	0.40	P	0.06
6518.5	8.16	30.22	0.59	3.60	0.22	2.33	-0.34	0.07	0.18	0.17	0.39	P	0.07
6519	7.90	29.21	0.55	5.04	0.20	2.33	-0.60	0.06	0.19	0.18	0.32	P	0.06
6519.5	8.18	30.45	0.56	4.17	0.19	2.34	-0.32	0.07	0.18	0.17	0.37	P	0.06
6520	8.23	35.18	0.61	3.68	0.19	2.37	-0.27	0.09	0.16	0.15	0.44	P	0.07
6520.5	8.22	32.69	0.59	4.85	0.20	2.38	-0.28	0.08	0.16	0.15	0.39	P	0.06
6521	8.22	31.67	0.62	4.29	0.22	2.37	-0.28	0.07	0.16	0.15	0.40	P	0.06
6521.5	8.06	27.61	0.55	4.15	0.21	2.35	-0.44	0.06	0.17	0.16	0.39	P	0.06
6522	8.09	27.00	0.60	4.72	0.18	2.36	-0.41	0.06	0.17	0.16	0.36	P	0.06
6522.5	8.22	27.36	0.59	4.90	0.17	2.35	-0.28	0.06	0.17	0.16	0.35	P	0.06
6523	8.27	28.35	0.56	3.51	0.18	2.34	-0.23	0.06	0.18	0.17	0.40	P	0.07
6523.5	8.23	33.86	0.61	5.92	0.21	2.36	-0.27	0.08	0.17	0.15	0.34	P	0.05
6524	8.17	43.69	0.86	7.31	0.23	2.40	-0.33	0.13	0.15	0.13	0.36	P	0.05
6524.5	8.12	51.50	1.22	7.85	0.23	2.42	-0.38	0.18	0.13	0.10	0.41	P	0.04
6525	8.15	52.39	1.24	6.84	0.21	2.42	-0.35	0.18	0.13	0.11	0.42	P	0.04
6525.5	8.11	49.24	1.05	5.20	0.22	2.39	-0.39	0.16	0.15	0.12	0.42	P	0.05
6526	8.12	48.15	0.94	5.61	0.23	2.37	-0.38	0.16	0.16	0.14	0.37	P	0.05
6526.5	8.03	46.43	0.93	6.06	0.24	2.36	-0.47	0.15	0.17	0.14	0.34	P	0.05
6527	8.12	50.21	1.13	7.43	0.23	2.37	-0.38	0.17	0.16	0.13	0.33	P	0.04
6527.5	8.28	51.58	1.17	7.94	0.20	2.40	-0.22	0.18	0.15	0.12	0.36	P	0.04
6528	8.30	50.68	1.22	6.38	0.19	2.43	-0.20	0.17	0.13	0.10	0.45	P	0.05
6528.5	8.36	49.51	1.35	8.75	0.19	2.46	-0.14	0.16	0.11	0.08	--------	F	-----
6529	8.53	50.17	2.13	9.68	0.18	2.48	0.03	0.17	0.10	0.08	------	F	--------
6529.5	8.62	45.36	2.58	11.83	0.18	2.48	0.12	0.14	0.10	0.08	--------	F	--------
6530	8.41	41.23	1.56	6.53	0.18	2.45	-0.09	0.12	0.12	0.10	0.47	P	0.05
6530.5	8.17	39.75	0.92	4.46	0.19	2.41	-0.33	0.11	0.14	0.13	0.47	P	0.06
6531	7.95	37.49	0.67	4.87	0.19	2.36	-0.55	0.10	0.17	0.15	0.37	P	0.06
6531.5	7.97	37.94	0.61	5.15	0.19	2.34	-0.53	0.10	0.18	0.16	0.34	P	0.06
6532	8.05	39.01	0.63	5.22	0.18	2.34	-0.45	0.11	0.18	0.16	0.34	P	0.05
6532.5	8.16	40.03	0.66	5.72	0.18	2.35	-0.34	0.11	0.17	0.15	0.34	P	0.05
6533	8.11	41.59	0.72	6.07	0.19	2.35	-0.39	0.12	0.17	0.15	0.33	P	0.05
6533.5	8.14	40.24	0.72	5.71	0.21	2.35	-0.36	0.11	0.17	0.15	0.34	P	0.05
6534	8.02	41.25	0.68	5.57	0.20	2.36	-0.48	0.12	0.17	0.15	0.35	P	0.05
6534.5	8.15	42.41	0.67	5.59	0.19	2.37	-0.35	0.12	0.16	0.14	0.37	P	0.05
6535	8.34	40.65	0.69	5.61	0.17	2.37	-0.16	0.11	0.16	0.14	0.37	P	0.05
6535.5	8.45	41.51	0.70	5.46	0.18	2.37	-0.05	0.12	0.16	0.14	0.37	P	0.05
6536	8.40	41.74	0.86	5.73	0.18	2.42	-0.10	0.12	0.13	0.12	0.44	P	0.05
6536.5	8.30	47.99	1.26	8.45	0.18	2.50	-0.20	0.15	0.09	0.07	-------	F	------
6537	8.32	50.16	1.62	12.15	0.17	2.56	-0.18	0.17	0.06	0.03	-------	F	-------
6537.5	8.31	47.65	1.49	9.41	0.14	2.57	-0.19	0.15	0.05	0.02	--------	F	--------
6538	8.56	41.71	1.34	7.38	0.13	2.55	0.06	0.12	0.06	0.04	--------	F	--------
6538.5	8.72	35.45	1.11	6.00	0.14	2.51	0.22	0.09	0.09	0.07	--------	F	------
6539	8.25	34.20	0.83	5.70	0.16	2.46	-0.25	0.08	0.11	0.10	0.53	F	------
6539.5	8.15	35.28	0.67	5.37	0.18	2.42	-0.35	0.09	0.13	0.12	0.45	P	0.05
6540	8.21	34.28	0.63	4.75	0.17	2.42	-0.29	0.08	0.14	0.12	0.46	P	0.06
6540.5	8.13	36.60	0.73	5.23	0.16	2.45	-0.37	0.09	0.12	0.10	0.51	F	-----
6541	8.25	37.22	0.92	6.23	0.17	2.49	-0.25	0.10	0.10	0.08	-----	F	-------
6541.5	8.49	38.95	1.26	6.92	0.18	2.52	-0.01	0.11	0.08	0.06	------	F	------
6542	8.39	38.20	1.11	6.29	0.19	2.52	-0.11	0.10	0.08	0.06	------	F	------
6542.5	8.32	38.39	1.00	5.39	0.19	2.49	-0.18	0.10	0.10	0.08	------	F	----
6543	8.23	39.02	0.80	4.99	0.20	2.44	-0.27	0.11	0.13	0.11	0.50	F	------
6543.5	8.25	37.31	0.66	4.99	0.22	2.38	-0.25	0.10	0.15	0.14	0.40	P	0.06
6544	8.50	37.72	0.61	4.63	0.22	2.35	0.00	0.10	0.17	0.16	0.37	P	0.06
6544.5	8.56	40.06	0.64	5.43	0.21	2.36	0.06	0.11	0.17	0.15	0.35	P	0.05
6545	8.54	41.09	0.74	5.08	0.21	2.37	0.04	0.12	0.16	0.14	0.39	P	0.05
6545.5	8.44	43.77	0.84	5.11	0.20	2.39	-0.06	0.13	0.15	0.13	0.42	P	0.05
6546	8.31	47.32	1.03	5.56	0.20	2.41	-0.19	0.15	0.14	0.12	0.44	P	0.05
6546.5	8.27	51.75	1.42	6.01	0.20	2.43	-0.23	0.18	0.13	0.10	0.46	P	0.05
6547	8.41	55.03	2.22	6.15	0.20	2.45	-0.09	0.20	0.12	0.08	----	F	-----
6547.5	8.39	56.75	2.21	6.23	0.22	2.47	-0.11	0.21	0.11	0.07	-----	F	-----

Table (9): Well log data and output petrophysical results for segment EE, E-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/m	RLA5 (RT) Ωm2/m	ALPC (ΦN)	RHOZ (ρb) gm/cc	Calip-B.S.	VSH	PHIT	PHIE	Sw	Cutoff* Flag	BVW
6483	8.73	60.39	3.36	6.97	0.25	2.55	0.23	0.24	0.06	0.02	------	F	------
6483.5	8.69	69.85	4.44	5.55	0.27	2.54	0.19	0.33	0.07	0.01	------	F	------
6484	8.61	72.40	3.92	5.18	0.27	2.51	0.11	0.36	0.09	0.03	-------	F	-------
6484.5	8.64	68.15	3.38	5.42	0.22	2.50	0.14	0.31	0.09	0.04	------	F	------
6485	8.67	57.40	3.33	6.18	0.19	2.52	0.17	0.22	0.08	0.05	------	F	------
6485.5	8.87	47.20	4.37	8.95	0.17	2.57	0.37	0.15	0.05	0.03	------	F	------
6486	8.74	40.41	5.42	11.52	0.18	2.59	0.24	0.11	0.04	0.02	------	F	---------
6486.5	8.72	40.01	6.80	8.74	0.20	2.57	0.22	0.11	0.05	0.03	--------	F	------
6487	8.74	46.12	6.38	7.83	0.22	2.53	0.24	0.14	0.07	0.05	------	F	------
6487.5	8.72	53.20	5.99	8.03	0.23	2.51	0.22	0.19	0.08	0.05	------	F	------
6488	8.72	54.34	5.38	6.46	0.23	2.48	0.22	0.20	0.10	0.07	-----	F	--------
6488.5	8.74	52.99	4.25	6.23	0.21	2.45	0.24	0.19	0.12	0.09	-----	F	------
6489	8.90	49.61	3.75	7.50	0.21	2.43	0.40	0.16	0.13	0.10	0.42	P	0.04
6489.5	8.82	47.53	4.05	8.78	0.20	2.44	0.32	0.15	0.12	0.10	0.40	P	0.04
6490	8.98	47.79	4.63	9.39	0.20	2.47	0.48	0.15	0.11	0.08	------	F	-------
6490.5	8.99	50.23	5.11	8.77	0.23	2.49	0.49	0.17	0.10	0.07	--------	F	----
6491	8.83	54.01	5.30	7.52	0.26	2.49	0.33	0.19	0.10	0.06	-------	F	------
6491.5	8.77	58.91	5.26	5.34	0.29	2.48	0.27	0.23	0.10	0.07	------	F	--------
6492	8.87	64.71	4.90	4.48	0.28	2.47	0.37	0.28	0.11	0.06	------	F	------
6492.5	8.81	66.35	4.50	4.38	0.28	2.47	0.31	0.30	0.11	0.06	-----	F	-------
6493	8.68	66.43	4.16	3.66	0.28	2.45	0.18	0.30	0.12	0.07	------	F	------
6493.5	8.63	65.86	3.84	3.39	0.28	2.44	0.13	0.29	0.13	0.08	------	F	-------
6494	8.62	65.27	3.87	3.39	0.28	2.43	0.12	0.28	0.13	0.08	-------	F	-------
6494.5	8.68	63.19	4.29	4.04	0.25	2.43	0.18	0.27	0.13	0.09	------	F	----
6495	8.70	62.49	3.60	4.30	0.23	2.44	0.20	0.26	0.13	0.08	-----	F	----

Table (10): Well log data and output petrophysical results for segment EF, E-1X Well. *Cutoff Flag means that the zone Passed (P) or Failed (F). The applied cutoff parameters which are: Vsh<0.4 - PHIE 0.10- SW<0.5, Calip-B.S.<+2. (P) means that the zone passed all the parameters otherwise will be denoted as Failed (F).

Depth (F)	HCAL inch	HCGR (GR) API	RXOZ (Rxo) Ωm2/ m	RLA5 (RT) Ωm2/ m	ALPC (ΦN)	RHOZ (ρb) gm/cc	Calip-B.S.	VSH	PHIT	PHIE	Sw	Cutoff * Flag	BVW
6473	8.40	49.30	0.59	5.85	0.22	2.32	-0.10	0.16	0.19	0.16	0.31	P	0.05
6480.5	8.36	51.50	0.87	7.98	0.20	2.39	-0.14	0.18	0.15	0.12	0.34	P	0.04

4. Conclusion

The present work aims to assess the Bahariya Formation in East Bahariya Concession at the northern Western Desert using well log data analysis. The interpretation of the available wire-line logs for available two wells drilled in the study area (EBAH- D-1X and EBAH- E-1 X) reflects good reservoir quality for oil production in specific zones within the Bahariya Formation. The cutoff parameters applied in this study include; Vsh<0.4, PHIE 0.10, SW<0.5, Calip-B.S.<+2 inch. Accordingly, zones which passed all of these parameters together will be oil producer while zones which failed in one or all parameters will not produce oil (i.e. non reservoir).

EBAH- D-1X Well includes several zone intervals represent possible good reservoirs. These zones locate between depths; 6783 - 6786 ft, 6789 – 6796 ft, 6815 – 6823 ft, 6838 – 6860 ft and 6865 - 6900 ft.

However, the best zone intervals, which signify potential good reservoirs in EBAH- E-1X Well locate between depths; 6501 - 6506 ft, 6514 – 6528 ft, 6530 – 6536 ft, 6551 – 6560 ft, 6584 – 6586 ft and 6596 - 6614 ft.

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الملخص العربي

عنوان البحث: أداء خزان البحرية كما هو مستنبط من تفسير بيانات تسجيلات الآبار، امتياز شرق البحرية، الصحراء الغربية، مصر

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الملخص العربي

العمل الحالي يقيم خزان بترول الحجر الرملي لمتكون البحرية في منطقة امتياز شرق البحرية في شمال الصحراء الغربية. يعكس تحليل بيانات تسجيلات الآبار المتاحة لبئرين)شرق البحرية -دي- ١ اكس وشرق البحرية -ايه- ١ اكس(وقد تم حفرهما في منطقة الدراسة جودة مكامن جيدة لإنتاج النفط في مناطق محددة داخل متكون البحرية بهما. حدود القطع المطبقة في تحديد هذه المناطق هي حجم الطين يساوي اقل من ٠,٤٠ و مساميه فعالة اكبر من او تساوي ٠,١٠ وتشبع بالماء اقل من ٠,٥٠ و كالبير – حجم البيت اقل من ٢,٠ -المناطق التي اجتازت كل حدود القطع معًا)أي مناطق الخزان(في بئر شرق البحرية -دي- ١ اكس تقع بين أعماق:- ٦٧٨٣- ٦٧٨٦ قدم ، ٦٧٨٩ - ٦٧٩٦ قدم ، ٦٨١٥ - ٦٨٢٣ قدم ، ٦٨٣٨ - ٦٨٥٠ قدم و ٦٨٦٥ - ٦٩٠٠ قدم. بينما المناطق التي اجتازت كل حدود القطع معًا)أي مناطق الخزان(في بئر شرق البحرية -ايه- ١ اكس تقع بين أعماق:- ٦٥٠١- ٦٥٠٦ قدم ، ٦٥١٤ - ٦٥٢٨ قدم ، ٦٥٣٠ - ٦٥٣٦ قدم ، ٦٥٥١ - ٦٥٦٠ قدم ، ٦٥٨٤ - ٦٥٨٦ قدم و ٦٥٩٦ - ٦٦١٤ قدم .