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WELL LOGGING AND ELECTROFACIES OF ZUBAIR FORMATION FOR UPPER SANDSTONE MEMBER IN ZUBAIR OIL FIELD, SOUTHERN IRAQ

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ABSTRACT

The Lower Cretaceous Zubair reservoir is a main producing horizon in the Zubair oil Field, southern Iraq. The reservoir consists of a number of isolated vertical major sandstone units. Sedimentary characteristics can be determined using the well log data as one of the most fundamental methods for reservoir characterization in the oil and gas industry.

The reading of high gamma-ray response indicates the presence of shale which contains clay minerals, K-feldspar, and organic material that emits natural gamma radiation. The clean sandstones emit less radiation so it has a lower gamma-ray count analysis.

Five of electrofacies were identified in the upper sandstone member of Zubair formation in Zubair oil field, in more details H layer divided into three sub-units.

Zubair formation delta deposited through sea regression followed by sea progression because shelf facies overlies other delta facies as shown H layer between K and C units both were shale rocks.

Porosity and permeability of the upper sandstone member of Zubair Formation were identified in twenty oil-wells. The relationship between the porosity and permeability after correction with data obtained from the core analysis data showed an improvement to the north part of the field precisely in Hammar-Shuaiba domes. On the other hand the grain sizes varied from coarse to medium; medium to fine in Hammar dome while fine to medium fine to very fine with clay influence led to a decrease the porosity and permeability thus reduced oil production.

Keywords: Electro-facies; Zubair Formation; Zubair oilfield; H layer (sandstone)

INTRODUCTION

Zubair oil Field is one of the most important oil fields in the southern part of Iraq. It is an anticline structure which has a NNW – SSE trend axis. It has four domes from south to north (Safwan, Rafdhyia, Shuaiba and Hammar) respectively as it is familiar in previous study (ZFOD, 2016).

Many wells have been drilled in Zubair oil field since 1949 to establish exactly the structural configuration and facies distribution of the reservoir rocks. (Morad *et al*., 1989) mentioned that the Zubair oil field represents a gentle anticline fold and the major producing formations in this field are Zubair, Nahr Umr and Mishrif Formations. Zubair oil Field was discovered in 1949 and operated in 1951, Zubair Oil Field is considered as important oil field in Iraq after Rumaila and West Qurna Oil Fields with oil reserves of about 253 Million barrels (ZFOD, 2016).

Zubair Formation is divided into five members namely (Lower Shale member, Lower sandstone member, Middle Shale member, Upper Sandstone member and Upper Shale member) (Aboo and Saffar, 1967) as shown in Tables 1 and 2. The upper sandstone member divided into several sand units; the H layer, one of them was currently focused as shown in Tables 2 and 3.

The term electrofacies was primarily defined as a set of well logs response that describes a bed and authorized it to be recognized from the others (Serra and Abbot, 1980). In this study, conventional well logging has been used in order to identify the electrofacies, porosity and permeability by comparing the results obtained from core analysis, as well as a conventional data processing of electrofacies are calibrated on the core data to ensure their conformity with the geological interpretation, by used a training wells Zb-201, Zb-043, Zb-233st1 and Zb-184 to estimate the geological facies from the well logging data where the core is not available.

(Othman, 1998) recognized four main sedimentary facies, depending on grain size analysis, lithological description, petrological and mineralogical analysis of the deposits of Zubair Formation in the East Baghdad oil field. These facies are: prodelta, delta front, delta plain and marine shelf.

Al-Muhalhal (2004) studied the Zubair Formation in the south of Iraq; basing on core description nine main facies were determined: channels, flood plain, distributary channels, distributary mouth bar, interdistributary bays, marsh and swamps, delta front, prodelta and shelf.

Table 1: Zubair formation members in Zubair oil field, south of Iraq, after (Owen and Nasser, 1958)

Formation	Member	Thickness (m)	Lithology
ZUBAIR	Upper shale Member Z/1	85 – 95	Shale with two units of sandstone contain secondary amount of shale
	Upper sand Member Z/2	95 – 110	Sandstone with few amount of shale
	Middle shale Member Z/4	65 – 75	Black shale with few amount of Sandstone
	Lower sand Member Z/5	50 – 60	Fine to very fine Sandstone with few amount of shale
	Lower shale Member Z/6	60 – 70	Fissile , gray to black Shale , with zone of sandstone

Table 2: Units of upper sandstone member of Zubair formation in Zubair oil field, south of Iraq, (ZFOD, 2016)

Formation	Member	BOC Units	ENI Units R2 Model	ENI Units R3 Model	Lithology
ZUBAIR	Upper Sandstone member Z/2	U SS Mb	AB	A	Sandstone
		Usand C	C	B_0	Shale
		Usand DJ	H3	B	Sandstone
		Usand J2	H2	C	
		Usand J1	H1	D	
		Usand K	K	K	Shale
		Usand L	L3	E	Sandstone
		Usand L2	L2	F	
		Usand L1	L1	G	
				H	
		Usand M	M	H0	Shale
		Usand N	N	H1	Sandstone

Table 3: The distribution of the thickness of H layer in upper sandstone member from selective wells of the study area in Zubair field, south of Iraq

Field Name	Dome Name	Well No.	Formation	Units	Top	Bottom	Thickness (m)
Zubair	Hammar	Zb_201	Zubair Formation Upper Sandstone Memmbe (3rd pay)	H 3	3253.40	3263.30	9.90
				H 2	3263.30	3271.26	7.96
				H 1	3271.26	3281.10	9.84
	Shuaiba	Zb_043		H 3	3378.14	3390.90	12.76
				H 2	3390.90	3410.71	19.81
				H 1	3410.71	3417.16	6.45
	Rafdhiya	Zb_233 st1		H 3	3304.98	3318.84	13.86
				H 2	3318.84	3336.59	17.76
				H 1	3336.59	3347.80	11.21
	Safwan	Zb_180		H 3	3189.38	3204.97	15.59
				H 2	3204.97	3224.12	19.15
				H 1	3224.12	3228.39	4.27

Al-Jubory (2005) studied reservoir properties of the Upper Sandstone Member of Zubair Formation in Southern Rumaila Oil Field and determined the porosity, permeability and the diagenesis which affected them, and he recognized four sedimentary facies: channel, swamp and marshes, distributary mouth bar and prodelta facies.

(Adel, 2009) according to core description and electrofacies analysis established that the Zubair Formation consists of interbedded shales and porous permeable sandstones deposited in a deltaic depositional system.

Twenty oil-wells in Zubair oil Field were studied in terms of petrophysical properties; five wells for each dome aiming to **1)** better understand the lithology of upper sandstone member, **2)** estimate the porosity and permeability and clarify their relationship, **3)** detect the factors affecting production weakness of each dome in Zubair oil Field by using several log interpretation by Geolog 7 and petrel 2015 software.

Oil Field Stratigraphy

Owen and Nasser (1958) determined a conformable section of Zubair Formation in Zubair area, in Well Zb-24; its thickness 362.9 m appears at depth (3523.66 – 3160.76) m, also they divided the section into five members as shown in Table 1 and Fig. 1. The 3rd pay reservoir (Z/2 upper sandstone member) is consist of complex sand and shale, with a total thickness of 110 meters, while the thickness of the units containing oil is approximately 55 meters. The 3rd pay consists of (11) different geological units, but the main reservoir units are A, B, H, L and N. The H layer has a varying thickness as shown in Table 2 and 3, so it was studied in specific consideration in this study.

LOCATION OF THE STUDY AREA

Zubair oil field is located at about 20 Km southwest of Basra city, south of Iraq. The position of the field approximately between (47° 32' – 47° 45') Latitude and (30° 42' – 30° 05') Longitude as shown in Fig. 1a and b covering an area of about 1, 170 Km^2 amount. It is bordered to the north by the Nahran Ummr oil field and to the west by the Rumaila oil field, and at the south by the Kuwait – Iraq border as shown in Fig. 2A and B.

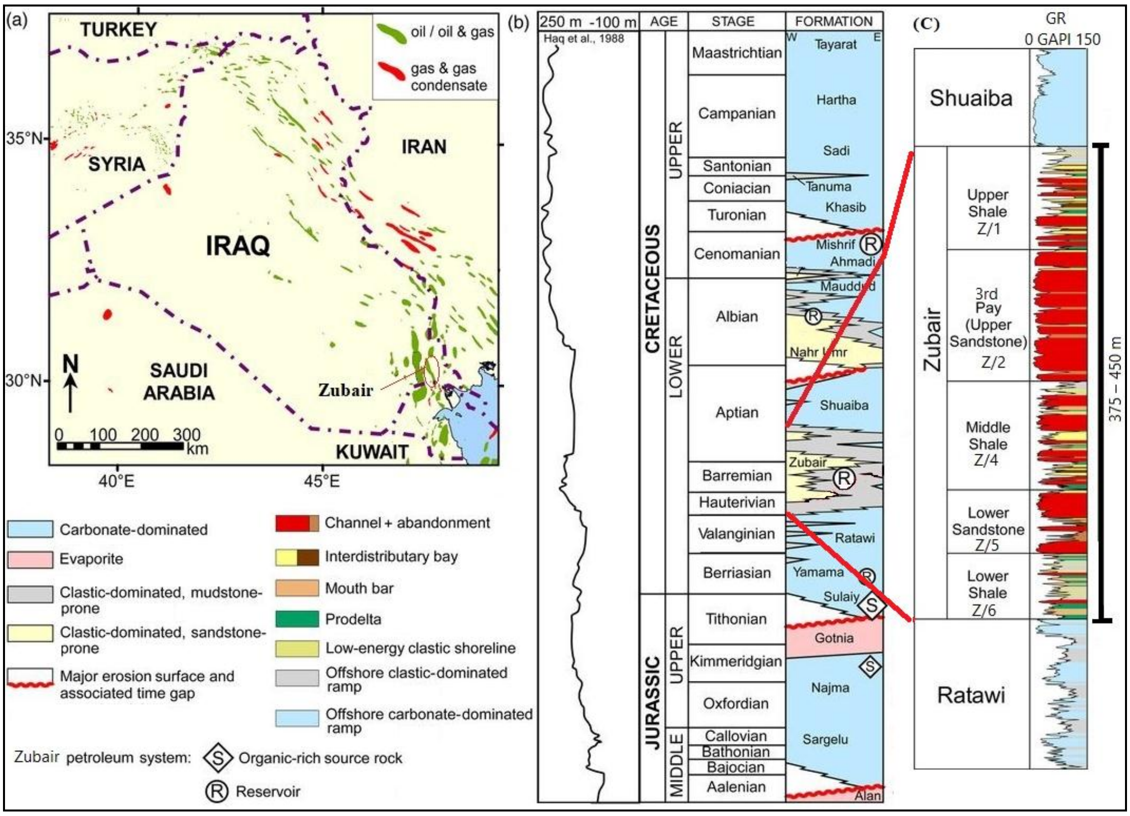

Fig. 1: Location and stratigraphy of the study area.
Location map showing the Zubair Oil field. (b) Middle Jurassic to Upper Cretaceous stratigraphic column of SE Iraq alongside a global relative sea-level curve (after Haq *et al*. 1988). (c) Type well from South Zubair explain the stratigraphic subdivisions and key facies associations (after Wells *et al*., 2017)

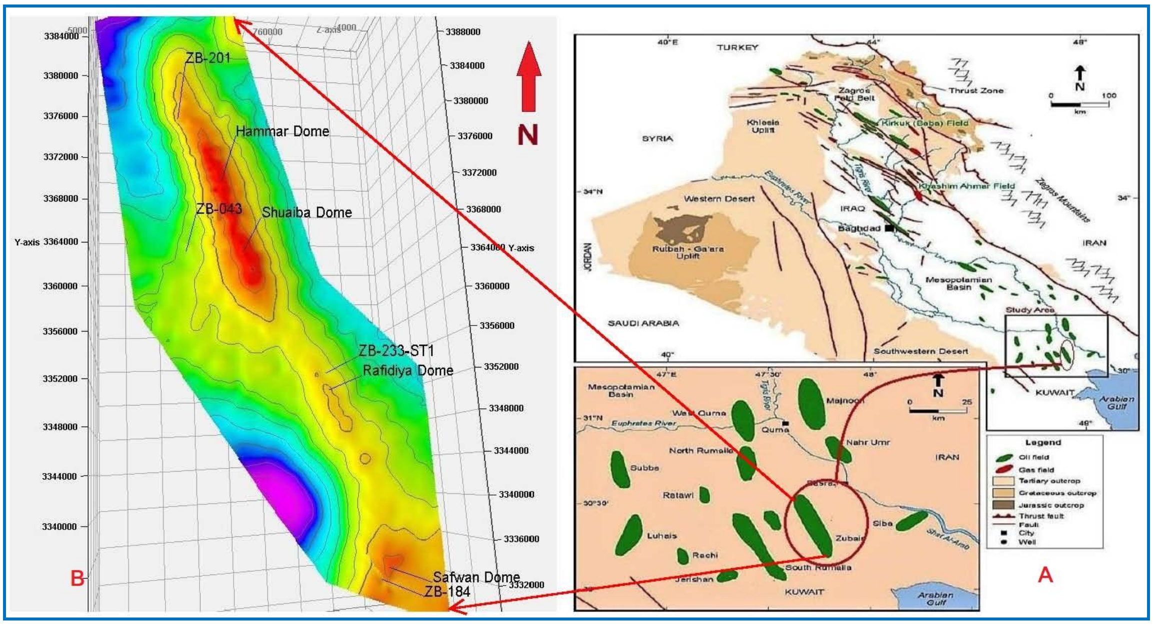

Fig. 2: (A) Location map shows the Zubair oil Field after (Al-Ameri *et al.*, 2009) (B) Structural map of upper sandstone in Zubair Formation in Zubair oil Field

METHODS

Well Logging Responses

The electrofacies of Zubair Formation determined depending on the data obtained from the lithological description: core data, colour, thickness and sedimentary structures. The log response and behaviour have a significant importance for interpreting the horizontal and vertical variation of the sedimentation process, as well as to obtain other properties such as mud content in rocks, porosity and permeability.

In the present study the conventional log has been used as follows: spontaneous potential (SP), gamma ray (GR) and photoelectric effect (PE) for correlation and lithology, as well as Density (RHOB), Neutron (NPHI) and Sonic (DT) for porosity and lithology; calliper (CALL) was used also.

The high reading of gamma-ray indicates the presence of shale, due to the component of shale rock that includes: K-feldspar, clay minerals and organic matter, which that released a natural gamma radiation. Whiles the clean sandstones released less radiation and have a lower gamma-ray count (Slatt, 2006).

The reflected shape for GR and SP in front of the sand layer to gives evidence of change in grain size profile. The response is compared with the electro-facies log shapes typically reflect changing depositional energy from high clean, coarser sand to low shaly sand, finer sand. By using gamma ray log in order to differentiate the shale, shaly sand and non-shale formation. For further clarification and support SP log, could give some corrections to GR log, shale usually has positive reading, while in clean sand formation has a very negative reading on the other hand shaly sand formation lies between them. Resistivity log as well can be used to differentiate the lithology, sandstone have high resistivity, if the gamma ray value is low to medium while shale have low resistivity reading

NPHI and RHOB, logs used to identify both lithology and porosity by using them logs together, one can be distinguished lithology from porosity. NPHI and RHOB logs, together with a CALL measurement recorded by the density tool and a GR log, are commonly run as a combination. This is the most useful logs commonly available for a general aim to a determination of lithology. As well as could differentiate if the formation is tight or not by using these logs. differentiate between shale, shaly sand, and non-shale, shale usually has low density while non-shale formation usually has density higher than shale, shale-sand lies between them, if the formation has a very high-density log reading, classify that formation as a tight formation, when its gamma-ray log reading is around 40 – 50, it called a tight sandstone formation, or if the gamma-ray log reading is very low usually below 10 API. The resistivity and density log reading are very high, it could be anhydrite which is a good cap rock in the petroleum system as shown in Fig. 3 and Table 4.

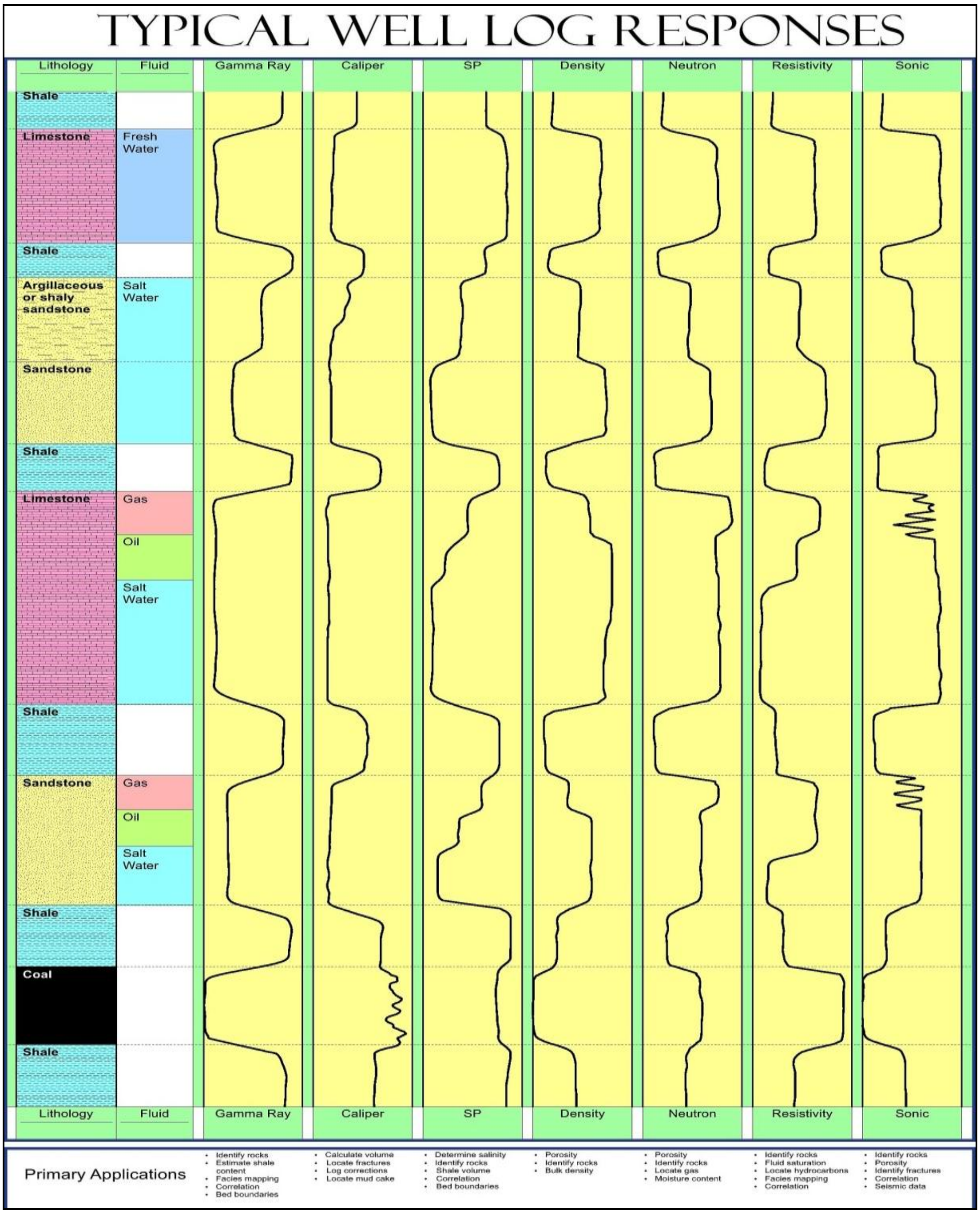

Fig. 3: Log response and behavior in front of different types of rock

Table 4: Log response of types of rocks (after Baker Atlas log responses, 2003)

Lithology		GR	Density	Neutron	Acoustic	Resistivity	PE
Sandstone		Low (Unless RA min)	2.65	-4	53	High	1.81
Limestone		Low	2.71	0	47.5	High	5.08
Shale		High	2.2-2.7 (water content)	High (water content)	50-150 (water content)	low (water content)	1-5
Dolomite		Low (higher if U)	2.87	+4	43	High	3.14
Anhydrite		V.Low	2.98	-1	50	V.High	5.06
Salt		Low (Unless K salt)	2.03 (1.87)	-3 (-2)	67 (74)	V.High	4.65
Water		0	1-1.1 (salt & temp)	100	180-190	0 - infinite (salt & temp)	0.36 (+salt)
Oil		0	0.6-1.0 (api)	70-100 (H2 index)	210-240 (api)	V.High	Low
Gas		0	0.2-0.5 (pressure)	10-50 (H2 index)	~1000	V.High	Low

Cluster Analysis

The cluster Analysis is the module works in two stages. Firstly, the data is divided up into flexible data clusters. The number of clusters should be enough to cover all the different data ranges seen on the logs. Second stage Cluster unification can be done using the crossplot and log plot output to group data, or a hierarchical cluster technique can be used to group the data. The deductive and inductive procedures, applied to well logging data, produce the inferences to get the most out of both methods (Doveton, 1994; Moss, 1997). The integrated approach is the application of hierarchical clustering methods to identify electrofacies groups using log curves (Saikia and Baruah, 2017). Well log data are set of depth values, which is associated with a set of log values corresponding to different physical properties measured along the well pore hole. The results can be plotted by using Geolog 7 displays as shown in Figs. 4; 5A and B.

The purpose of well log cluster analysis is to look for similarities and dissimilarities between data points in the multivariate space of logs, in order to group them into classes also called electrofacies. In the multi-dimensional space of logs, the distance between data points is a measurement of their dissimilarities. Samples with similar log responses will tend to form clusters, separated by areas with a lower density of points. In order to identify the clusters, we can use a density function that measures the number of samples located in a moving interval of a given length around each data point. (Euzen *et al.*, 2010).

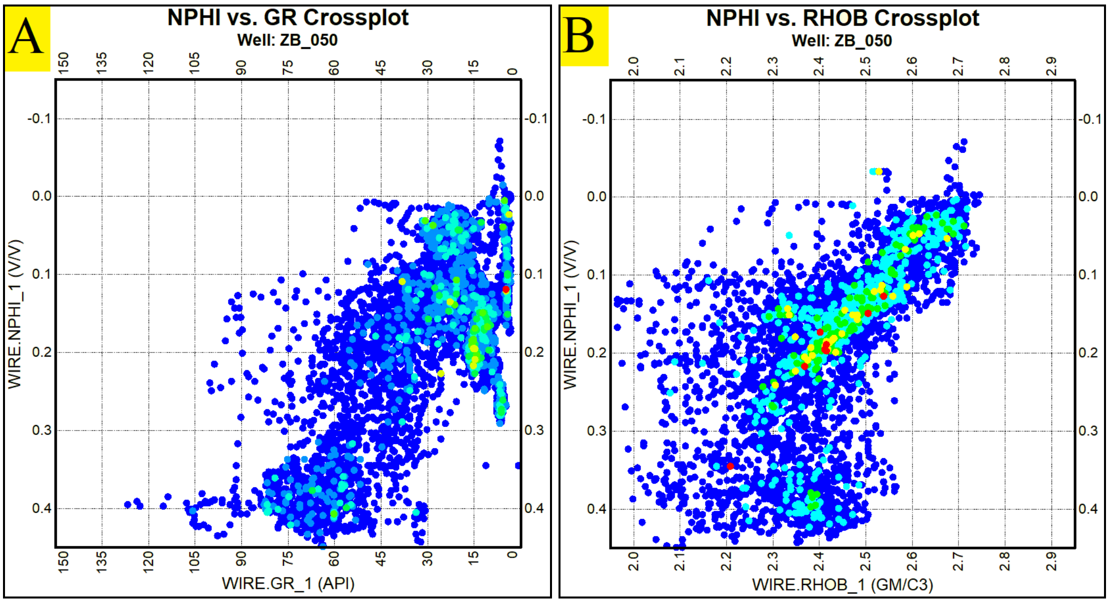

Fig. 4: A and B cross plot porosity Vs density; GR Vs Porosity in the north part of the field

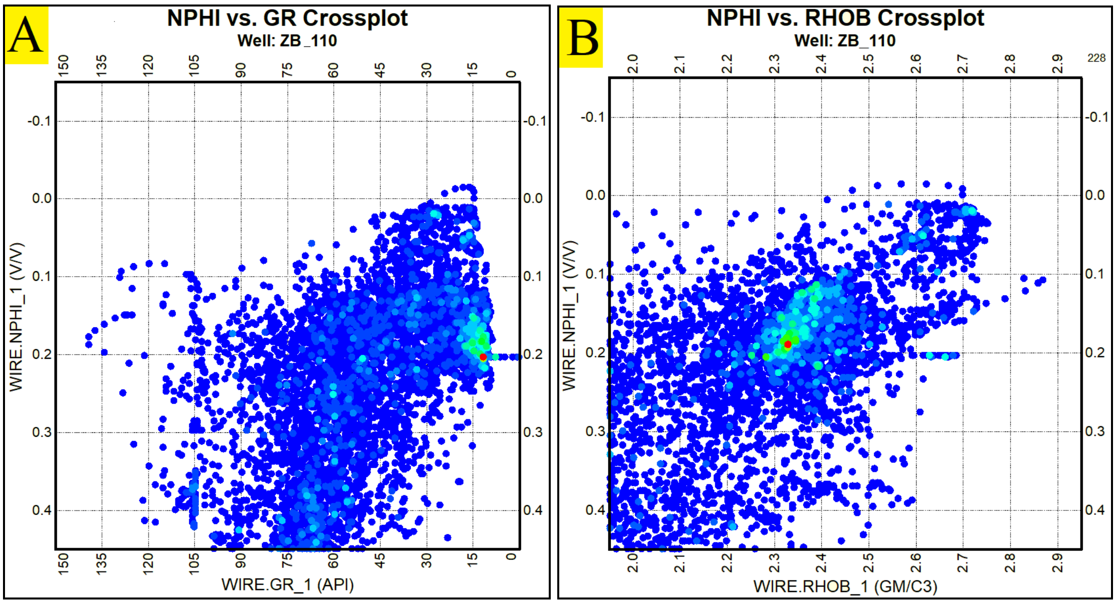

Fig. 5: A and B cross plot porosity Vs density; GR Vs Porosity in South part of the field

RESULTS AND DISCUSSION

The GR shows a low reading in the north of the field, specifically, Hammar and Shuaiba domes may due to an improved in porosity and permeability. GR log responses of the clean sand range between 20 – 40 API in north of the field, while it increases in Safwan and Rafidhiya domes referring to silt and clay cemented in sand grain (Table 5). The rate of clean sandstone decrease in both Safawn and Rafidhyia domes even though sometimes subunits of the H layer was thicker as shown in (Table 3). Simultaneously, the increase of clay and shale content causes decreasing in porosity and permeability Occasionally, Log responses don't give a true correspond of formation lithology if comparison with true core lithology because the sand grains may be covered with clay, in this case GR behaviour would indicate a response similar to shale. (Almayyahi and Aljaberi, 2018) mentioned that the GR in sandstone rocks sometimes does not give a clear reflection of the type rock, because these rocks may be affected by the high content of organic matter or heavy minerals or may contain some radioactive elements (K, Th and U).

Table 5: Grain size analysis of H layer for upper sandstone member of Zubair formation-Zubair oil field

Depth	Dome	Layer	Sand %	Slit %	Clay %
3277.50	Hammar	H1	97.56	2.07	0.38
3267.78		H2	98.30	1.54	0.16
3256.90		H3	96.98	2.60	0.42
3415.72	Shuaiba	H1	96.15	3.70	0.15
3398.84		H2	93.81	5.36	0.82
3386.45		H3	93.43	5.64	0.93
3343.85	Rafidhiya	H1	83.02	7.16	9.82
3331.50		H2	85.86	9.74	4.40
3234.96	Safwan	H1	88.73	7.26	4.55
3201.38		H2	77.69	13.73	8.57
3194.88		H3	76.21	14.54	9.25

In this study full set of the availability well logging data has been used, in order to reduce the misleading ratio for the interpretation as shown in (Figs. 7, 8 and 9). Based on facies analysis criteria (lithology, texture, bedding, sedimentary structures) as well as the examination of core slabbed images, thin sections images and descriptions within cluster analysis, five of electrofacies were identified in upper sandstone member of Zubair formation in Zubair oil field, especially the upper part of the upper sandstone member H layer it has 3 sub-units H1, H2 and H3. As well as an increase in the bioturbation and sand content from top to bottom of upper part of the upper sandstone member from H3, H2, and H1 respectively, can be considered as one of the factors affecting the increase of porosity and permeability as shown in Fig. 6.

An electrofacies analysis is important to clarify the lithological types by using well-logging responses and then to interpret reservoir limited and characterize (Schmitt *et al*., 2012). Depending on the values obtained from well logging data of 20 wells that had been used in the present study by using (Petrel 2014 and Geolog 7). The characteristics of some rocks that can be used to differentiate the lithology. Depending on the core data analysis, the lithology was divided into 4 main lithologies as follow below: sandstone; silty shale; fine to very fine sand with shale; and shale as shown in Figs. 8 and 9.

Shale lithofacies:

Facies (a): most features of this facies show as fine sediment of high fissile grey to dark grey shale with features correspond of shelf sedimentary environment facies with rare bioturbation and rare interbedded silty layers, this facies appears in well Zb-233 at depth 3347.9 – 3350.7 m and Zb-201 at depth 3209.9 – 3217.2 precisely in K layer as shown in Fig. 6a and b very similar to Facies 2. But it is thicker showed higher shale content in Zb-201.

Facies (b): dark grey shales and silty shales with the local presence of marine fossils small bivalve shells as shown in Fig. 6b. This facies appears in well Zb-201at depth 3291 – 3291.5.

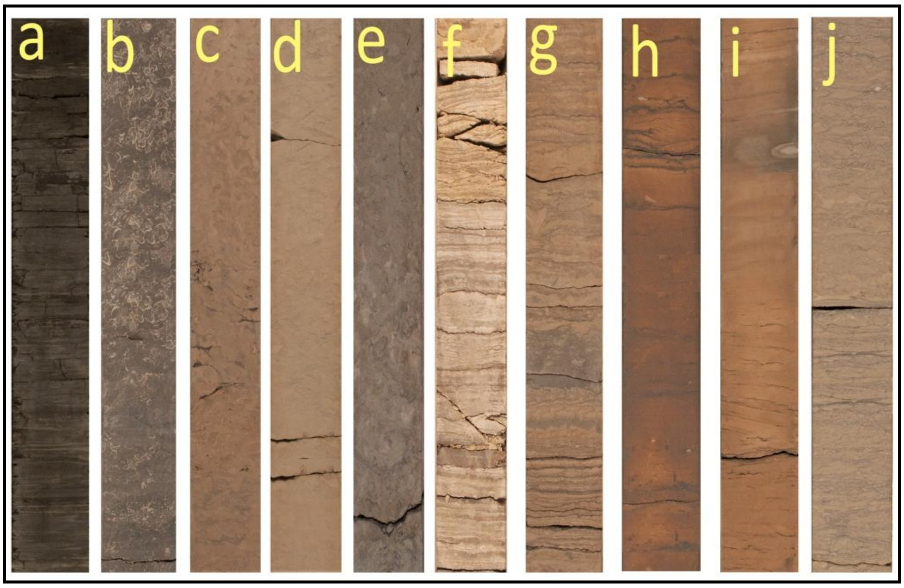

Fig. 6: A lithofacies classification according to core analysis of the upper sandstone member of Zubair formation, Zubair oil field

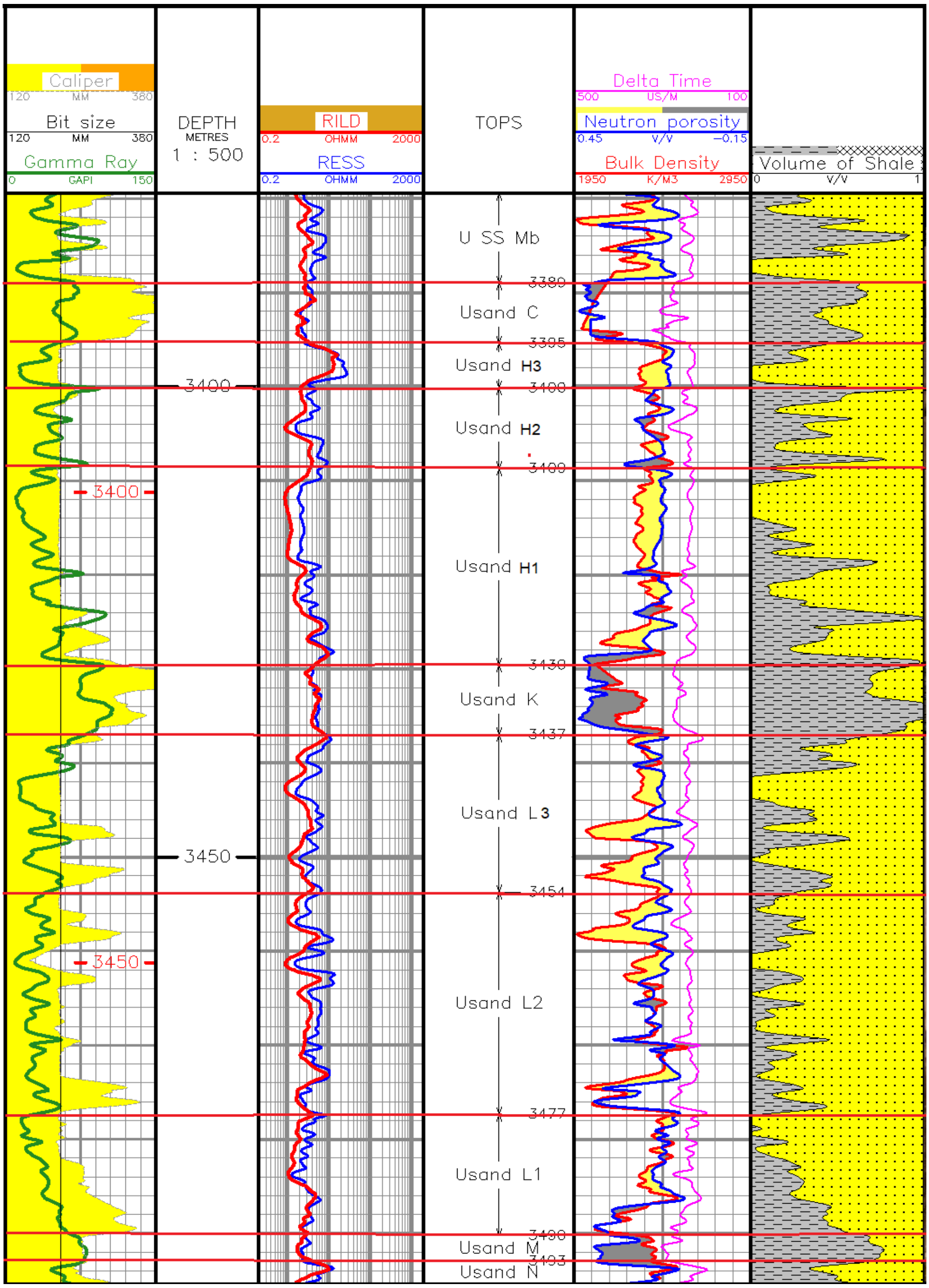

Fig. 7: Response log shows the porosity and lithology for upper sandstone member of Zubair formation in Zubair oil Field, south of Iraq

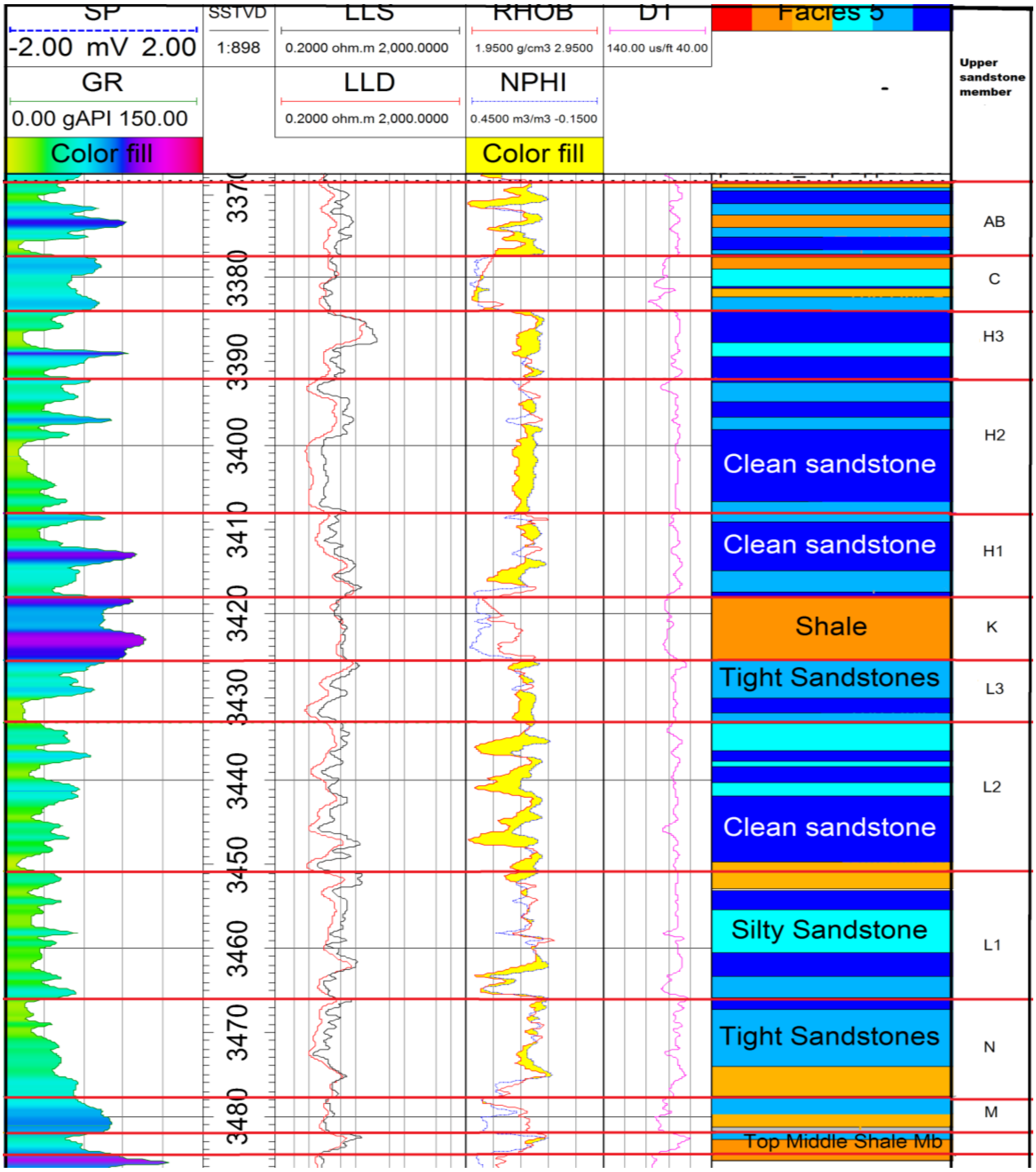

Fig. 8: Electrofacies of upper sandstone member, Zubair formation in Zubair oil Field

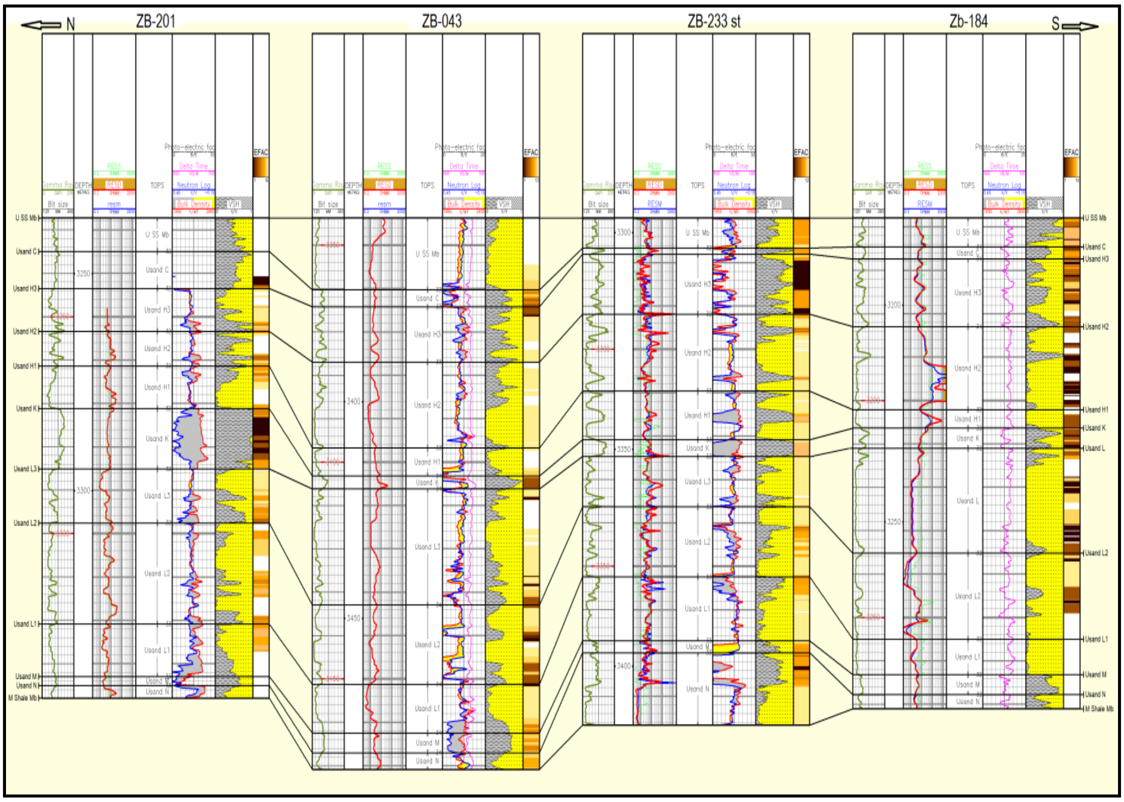

Fig. 9: Correlation of the electrofacies in upper sandstone member of Zubair formation in Zubair oil field

***Fine to very fine sand lithofacies*:**

Facies (c): very fine sandstones layers, in part a presence of mud drapes this facies appears in well Zb-201 at depth 3269 – 3269.5 while appears in Zb-043 at depth 3401.75 – 3402.55 precisely in H1 layer.

Facies (d): fine to very fine sandstone with more bioturbation than facies (c) and with thin layers of silt, sometimes presence of roots and mud drapes as well as this facies appears in Zb-201 at depth 3258.5 – 3259 precisely in H3 unit.

Facies (e): very fine to fine sandstones with more bioturbation, the intense of bioturbation results mainly due to the activity of deposit feeders, which destroy the primary fabric giving evidence of a low-energy, nutrient-rich environment and thin bedding resulting from influxes of sediment from the delta plane **(**Lima and Rossetti, 1999). As well as this facies appeared in Zb-201 at depth 32374.3 – 3274.85 precisely in H1 unit.

Silty-Shale lithofacies:

Facies (f): Alternance of shale-silty shales and very fine to fine thin sandstone layers. with (ripple mark) at the top. Sometimes small scale cross laminations occur, this facies appears in well Zb-043 at depth 3453.3 – 3453.8 while appears in Zb-184 at depth 3262.6 – 3263.3 precisely in L2 unit.

Facies (g): this facies appeared as an alternate of shale-silty shale and very fine thin sandstone layers with parallel laminations, this thin lamination refers to deposition under quiet water conditions, the absence of wave-formed structures refers to a deposition taken place beneath wave base (Sumner *et al.*, 2002). The intense bioturbation, particularly due to the activity of deposit-feeders, gives evidence of a low-energy, nutrient-rich environment (Luis *et al.*, 1999). Most of these features correspond with lower delta plane Facies. As well as this facies appears in Zb-201 at depth 3257.5 – 3258 precisely in H3 unit.

Sand lithofacies:

Facies (h): Very fine to fine-grained sandstones with small scale cross laminations and mud drapes, as well as this facies appears in Zb-201 at depth 3327 – 3327.5 precisely in H3 unit. Mixed sandstone with an amount of mudstone assemblage records external sand input within low energy depositional settings and the occurrence of current ripples within mud refers to shallow water above wave base (Lima and Rossetti, 1999).

Facies (i): Fine to medium-grained laminated and cross-bedded sandstones as well as this facies appears in Zb-233 at depth 3385 – 3385.7 precisely in L1 unit. Presences of coarsening upward pattern and absence of bioturbation as well as high sedimentation rate coincide with that features of distributary mouth bar which described The absence of bioturbation in the coarser grained barrier Facies is probably due to high energy and sedimentation rate and this is supported by high thickness of the Facies.

Facies (j): presence of coarsening upward pattern of sandstone with the absence of bioturbation as well a high sedimentation rate synchronize with that features it may considered as mouth bar. Fine to medium-grained massive sandstones, apparently structureless this facies appears in Zb-201 at depth 3312 – 3315 precisely in L1 unit as shown in Fig. 6. The absence of bioturbation in the coarser grained is probably due to high energy and sedimentation rate (Buatois *et al*., 1999) and this is supported by a high thickness of this facies.

In the present study of sedimentary Facies in the studied four wells, it can be inference that the sandstone and mudstone of Zubair Formation represent sedimentary Facies of delta environment (such as **1-** lower delta plain consist of tidal flat deposits and estuarine channel. **2-** delta front consist of mouth bar and prodelta **3-** shelf open marine like K unit).

The type of sedimentation is significantly different depending on the discharge of the river and the loading of the sediment (river controls) as well as the wave energy and the tidal system (marine controls) of the receiving basin (Wright and Coleman, 1973). Many researchers have identified delta types and have identified most of the specific characteristics of each types. When comparing the characteristics of the Zubair formation with these characteristics, it is clear that Zubair formation is a river-dominated delta because recognized there is a similarity with the river-dominated delta studied by (Bhattacharya and Walker, 1991):

1- The prodelta is composed of clay stones, while the delta front are composed of sandstone.
2- The cycles has been interpreted as distributed mouth bar formed during a lowstand period characterized by the greatest thickness for other features.
3- The properties of soft precipitation are common due to high sedimentation rates and can occur extensively with a large proportion of deposits in the delta front.

Lateral changes of Zubair Formation delta Facies showed This delta is provided by the sediments of the rivers coming from the Arabian Shield and deposited in the sedimentary basin as the delta is oriented east due to remote sub-environments like prodelta, shelf and inter distributaries bay and fine sediments increase towards this trend Figure 6 shows major horizontal and vertical changes in Facies.

According to the electrofacies and logging data correlation, the thickness of the upper sandstone member is about 110 meters as well the average thickness of H layers as shown in Table 3, it was variable depending on the well location in each dome for Zubair oil field, in addition, upper sandstone member it consists of 11 units, but it has five main sandstone units A, B, H, L, and N with thickness more than 55 m of net sandstone that commonly contains oil. In the present study has been the focus on the upper part of the upper sandstone member, specifically on H layers. As well as this layer was divided into three subunits H1, H2 and H3 as shown in (Fig. 7 and Table 3).

Based on the cluster analysis, five of electrofacies were identified in the upper sandstone member of the Zubair formation in the Zubair oil field. Thus are calibrated on core interpretation to ensure their consistency with the geological facies. These training samples are used to define the typical log response of each electrofacies and then to predict their occurrence from logs where core is not available. Based on the distribution of sand and shale ratios, many differences were recorded between the variable thickness and the type of lithology of H layer as shown in (Figs. 7 and 9; and Table 3).

Depositional elements have been grouped in three main portions of the deltaic system: Lower delta plain (tidal flat deposits and estuarine channels); delta front (transgressive reworked sandstones, prodelta fines and mouth bar deposits); pro-delta (open marine shale) (Fig. 10).

Subunit H1: It is similar to subunit H2 in terms of thickness, lithofacies and environmental interpretation reached. Very fine to fine sandstone with more bioturbation than H2 with thin silty layers On the top of the unit could be locally a sequence boundary (Fig. 10).

Subunit H2: It is similar to subunit H1 in terms of observed lithofacies and environmental interpretation fine sandstone with less bioturbation than H1 with thin silty layers, sometimes the presence of roots and mud drapes, the massive sandstone packages are 19.15 m and 19.81 m thick in ZB-180 and ZB-043 respectively as shown in Table 3. In this case both the upper and the lower limit could be erosion in a close similarity of the main estuarine axis with high sediment rate, thus increasing the permeability.

Subunit H3: The thickness of the H3 unit was range between 9.9 to 15.59 m as shown in Table 3. With strong lateral lithological variability and a fining upward trend. Muddy burrowed very fine-grained sandstones, locally with the presence of mud drapes. Also, in this case, the recognized facies are the alternation of shale and sandy beds.

There is a clear relationship between porosity and permeability as shown in Figs. 11, 12, 13 and 14. One of them has been measured by the availability of core data and the other obtained by the well logging tools to make a comparison between the porosity and permeability. The log porosity correlation among the studied boreholes showing an approximate matching with these units. After the application of the wire log porosity procedures. These relationships include NPHI, RHOB and DT logs as shown (Figs. 4, 5A and B) and Table 6. It’s clear that porosity and permeability are gradually improving from south to north, from Safwan to Hammar dome respectively. As well as an increase in porosity specifically in both sub-layers H1, H2 more than H3 as shown in Figs. 11 and 12; and Table 6.

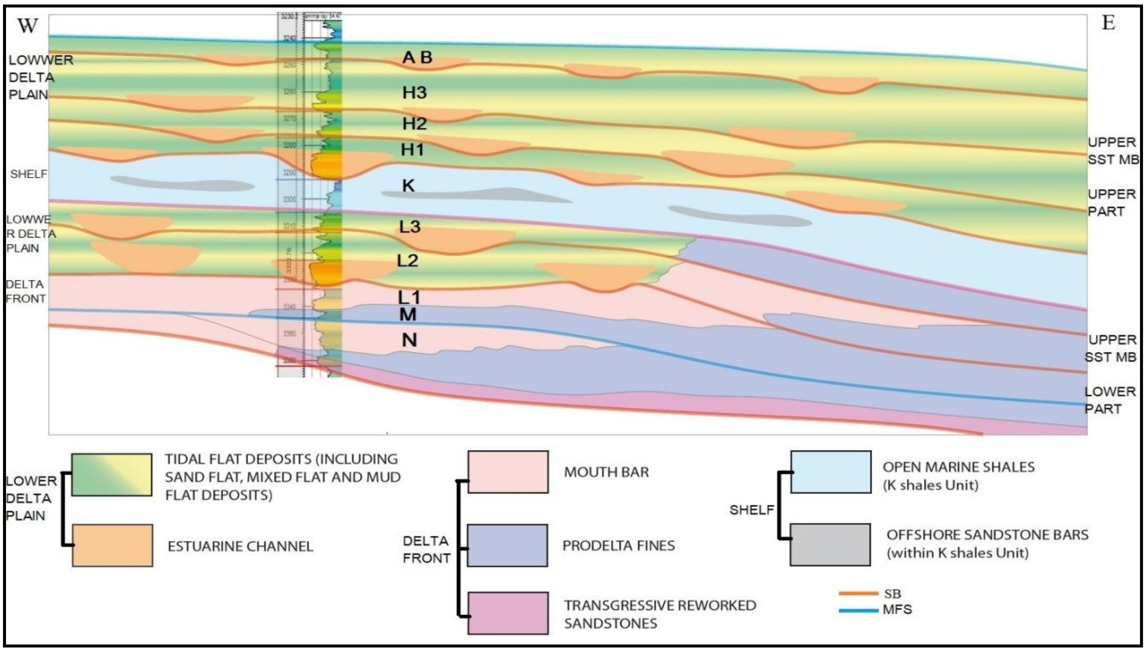

Fig. 10: Depositional model after (ZFOD, 2014)

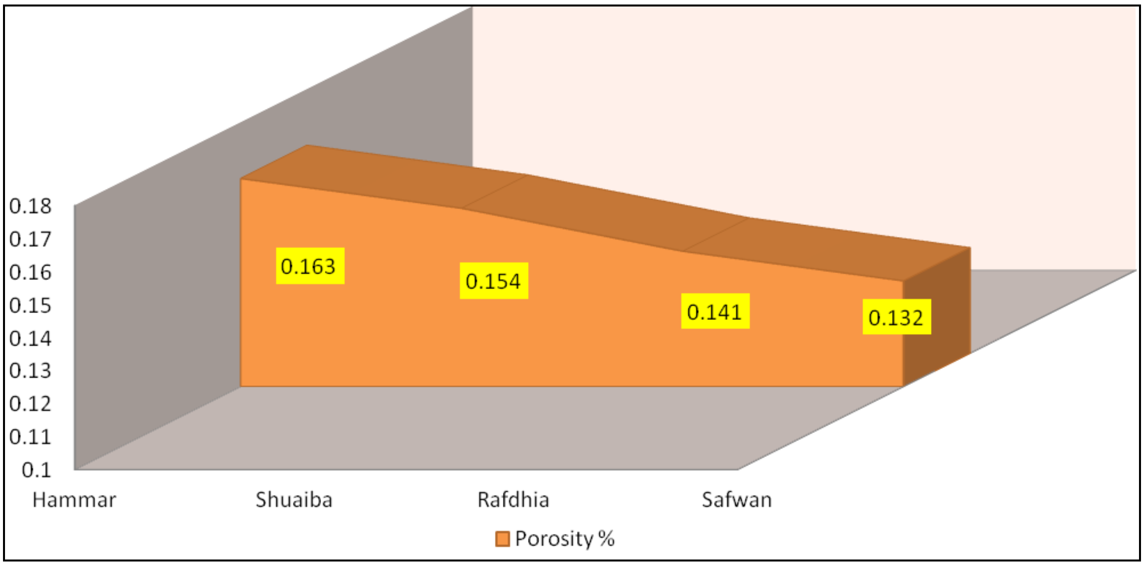

Fig.11: Diagram showing improvement of porosity gradually towards the north

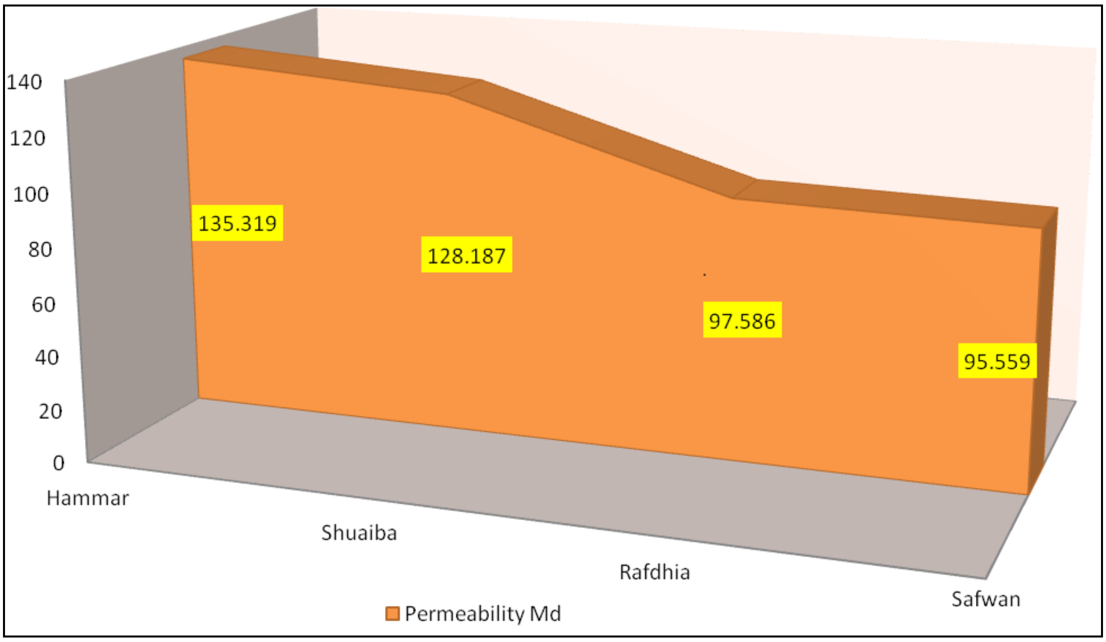

Fig. 12: Permeability variation in the Zubair oil field

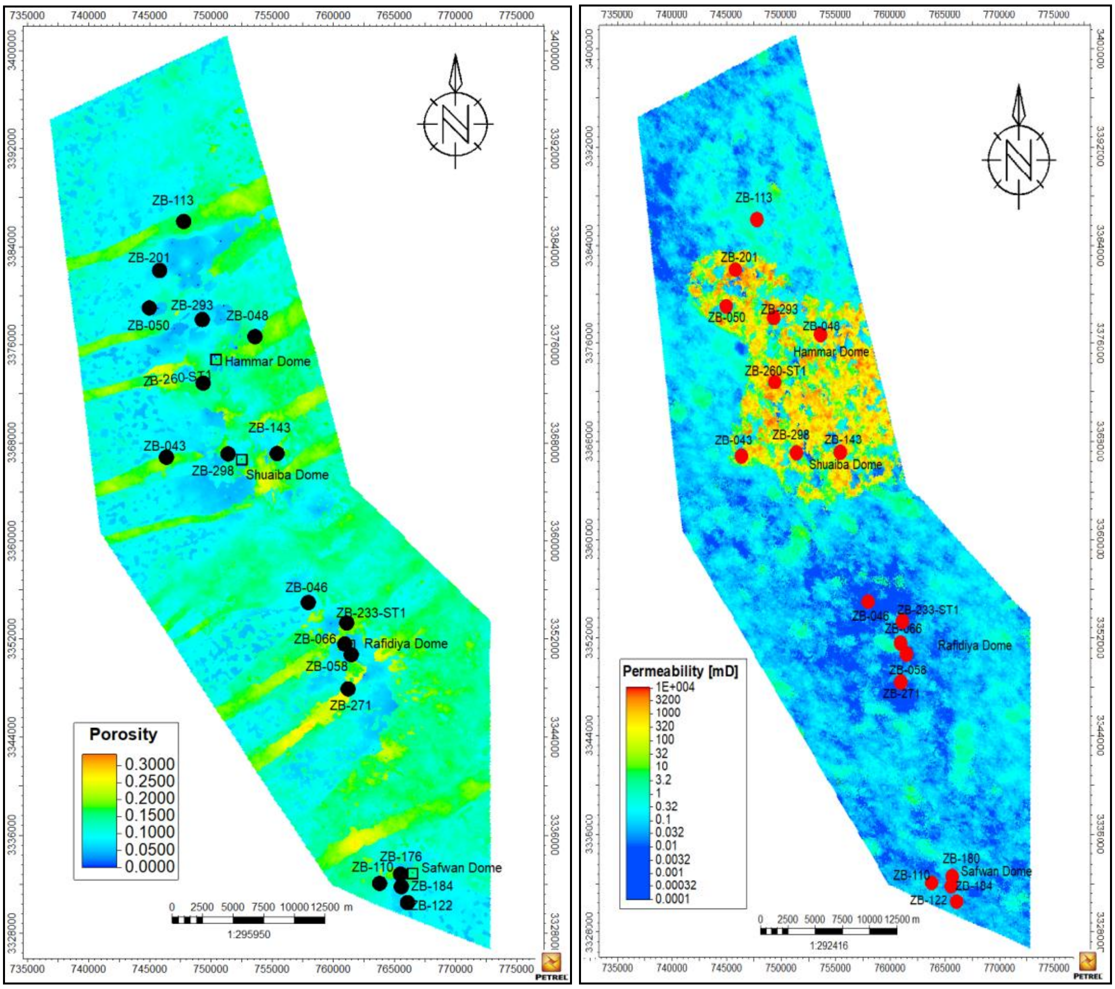

Fig. 13: Distribution of the permeability in the upper sandstone member of selective wells in the study area of Zubair oil field

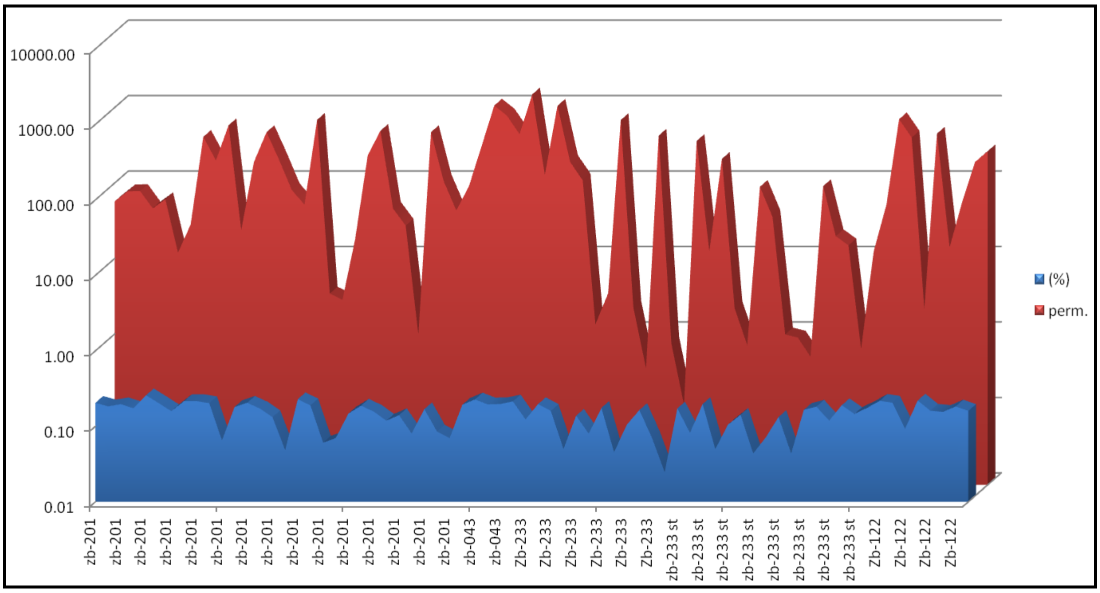

Fig. 14: Distribution of porosity and permeability obtained from well log data from the selective wells of the study area of H layer

Table 6: The distribution of the porosity and permeability with an average of H layer in the study area in Zubair field, south of Iraq

Hammar Dome				Shuaiba Dome				Rafdhyia Dome				Safwan Dome			
Well No.	**Layer**	**Porosity**	**Permeability**	**Well No.**	**Layer**	**Porosity**	**Permeability**	**Well No.**	**Layer**	**Porosity**	**Permeability**	**Well No.**	**Layer**	**Porosity**	**Permeability**
ZB-113	H3	0.17	46.24	**ZB-328**	H3	0.17	159.7	**ZB-046**	H3	0.1	9.221	**ZB-110**	H3	0.15	38.29
	H2	0.18	262.7		H2	0.17	161.1		H2	0.18	281.7		H2	0.15	36.69
	H1	0.16	274.3		H1	0.12	19.02		H1	0.14	98.91		H1	0.16	112.3
ZB-201	H3	0.18	162.4	**ZB-289**	H3	0.15	95.37	**ZB-233st1**	H3	0.11	54.86	**ZB-122**	H3	0.11	2.076
	H2	0.18	163.9		H2	0.18	327.8		H2	0.17	285.5		H2	0.16	184.7
	H1	0.19	321.8		H1	0.16	114.3		H1	0.12	72.7		H1	0.16	199.3
ZB-050	H3	0.15	165.9	**ZB-043**	H3	0.17	104.6	**ZB-271**	H3	0.17	52.04	**ZB-184**	H3	0.1	N/A
	H2	0.19	197.8		H2	0.17	51.45		H2	0.19	113.1		H2	0.16	N/A
	H1	0.15	35.84		H1	0.19	401.1		H1	0.16	48.01		H1	0.16	N/A
ZB-293	H3	0.14	142.4	**ZB-143**	H3	0.12	7.89	**ZB-066**	H3	0.1	28.77	**ZB-180**	H3	0.11	N/A
	H2	0.11	33.13		H2	0.14	58.59		H2	0.16	254		H2	0.11	N/A
	H1	0.17	133.1		H1	0.14	28.23		H1	0.12	25.47		H1	0.12	N/A
ZB-048	H3	0.17	12.38	**ZB-260st1**	H3	0.11	32.68	**ZB-058**	H3	0.13	26.12	**ZB-176**	H3	0.15	N/A
	H2	0.15	5.862		H2	0.12	38.95		H2	0.15	82.57		H2	0.08	N/A
	H1	0.16	72.04		H1	0.2	430.2		H1	0.12	30.83		H1	0.1	N/A
Average		0.163	135.32	Average		0.15	128.19	Average		0.14	97.59	Average		0.13	95.56

As well as give a significant similar correlation between the trend of porosity and permeability in both measurement gives evidence of improvement of reservoir specifications gradually toward the north of upper sandstone member in Zubair oil field precisely, Hammar – Shuaiba domes. Whiles it's a clear effect of clay minerals increasing towards the south of the field specially, Safwan and Rafedhiya domes, respectively the average distribution of the porosity and permeability of the H layer in upper sandstone member in selective wells of study area were ranged as follow (Hammar permeability (K) = 135.32 md, porosity (ϕ) = 0.163), (Shuaiba k = 128.19, ϕ = 0.154), (Rafedhiya K = 97.59, ϕ = 0.141) and (Safwan K = 95.56, ϕ = 0.132). The porosity and permeability in both types of measurement give evidence of improvement of reservoir characteristics specifications gradually toward the north of Zubair oil field Specifically, Hammar and Shuaiba domes. Thus comparing those results with data obtained from the core analysis in order to verify the validity of the results as well as depend on the result that inductor to increase the oil production in the north of the field.

grain size Analysis of

The grain size and texture of a terrigenous clastic rock is generally evidence of the depositional processes. The main descriptive element in all sedimentary rocks is particle size. The particle size analysis can be used to distinguish sediments from different environments and destinations in order to provide further information on the deposition processes and the flow state (Tucker, 1985). The grain size analysis has been done on eleven core samples in four wells of the study area (Zb-201, Zb-043, Zb-233st1and Zb-184) have regularly distributed three samples in three domes except for only one dome it has 2 samples, 20 gm were crushed for each selected sample from the study area to discrimination between sandstone and mudstone by using the sieve 0.063 mm. Silt and clay contents were determined by using Pipette method according Folk (1974) in the Marine Science Center lab of Basrah university in order to determine the grain size analysis distribution specifically in H layer of the upper sandstone member for Zubair Formation in Zubair oil Field. as shown in (Table 5).

There is a difference of sand grain size were obtained from core samples of four wells Zb-201, Zb-043, Zb-233st1and Zb-184. The distribution grain size can give a perception of the type of sedimentary environment in addition to factors energy and change in sea level etc. Zubair formation delta deposited through sea regression followed by sea progression because shelf facies overlies other delta facies as the H layer occurred between K and C units both of them shale as shown in Figs. 7 and 8. As well as in the south may have influenced by the tidal flat and prodelta thus increase the rate of silt and clay in Safwan and Rafidhiya domes, an avarage was 7.46, 11.84 and 7.11, 8.45 respectively, whiles decreased the rate of silt and clay in Hammar and Shuaiba domes with increasing of sand ratio it was domante in the north of the field in Hammar and Shuaiba domes 97.6% and 94.47% respectively while in south Safwan and Rafidhiya domes 84.44% and 80.88% respectively as shown in Table 5 and Fig.15.

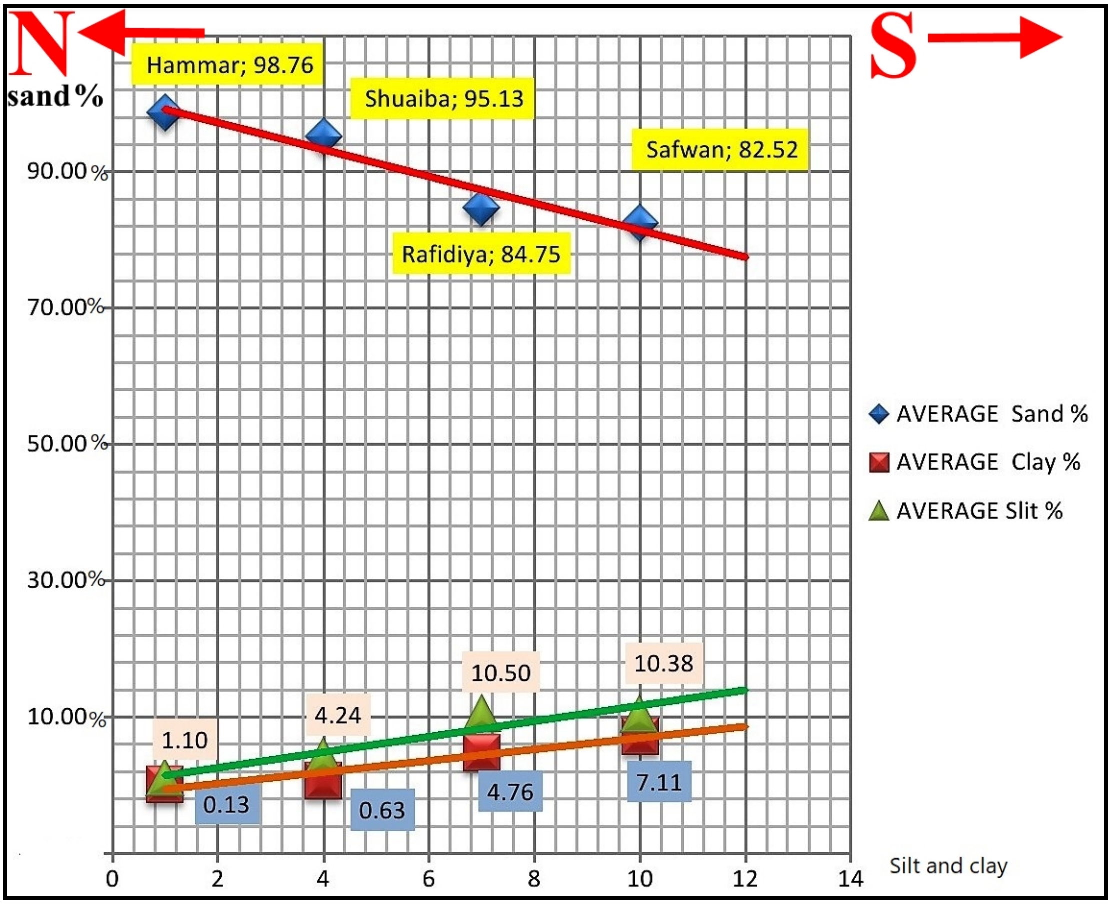

Fig. 15: Sand, silt and clay trends distribution of H layers of upper sandstone member of Zubair formation in Zubair Oil field

CONCLUSIONS

Knowledge of electroficies and rock properties such as porosity, permeability and net clean sand is an important input for increasing oil production. The conventional logging tools have been used to reach better results in interpretation, sometimes the log responses don’t give a true correspond of formation lithology, especially GR if compare with the true core lithology sand grains that may be covered with clay. In this case behavior of GR response similar to the shale. The H layer showed a clear improvement towards the north of the Zubair oil field specially in Hammar-Shuaiba dome greater than the south of the field in Safwan and Rafidhiya dome leading to increasing the oil production in the north of the field. The core samples are dominated with sandstones towards the north of the field at Hammar (97.6%) and Shuaiba domes (94.47%), while to the south sandstones decreased as 84.44% in Safwan and 80.88% in Rafidhiya domes. The porosity and permeability are also increased downwards (H3, H2, and H3). Even though sometimes the H2 layer is thicker in the south depending on the well location in the field, where the rate of oil-production depends on the reservoir characteristics (porosity, permeability). The upper sandstone member from up to bottom consists of 11 units and five main sandstone units (A, B, H, L, and N) with thickness more than 55 m of net sandstone that commonly contains oil.

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