Petrophysical properties evaluation using well logging of the upper sand member of Zubair Formation in Zubair oil Field, Southern Iraq.

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Abstract

The present study aims to determine the petrophysical properties into the upper sandstone member of Zubair Formation at Zubair oil Field by using interpretation a number of different borehole logs for the open wells (Zb-40, Zb 84, Zb-114, Zb-212, Zb-233). These Properties include shale volume (Vsh), effective porosity (Øe), water saturation (S_W), permeability(K) and Pore throat type classification R35.The petrophysical properties (Vsh) ,(Øe) and (S_W) were drawn for each reservoir unit to determine the direction of the improvement of reservoir characteristics within the selected wells.

Depending on gamma- ray log Zubair Formation with in the Zubair oil Field was divided into reservoir units (AB, DJ, and LN) and non-reservoir units (C, and k). The well Zb-84 revealed increases in Vsh was in all the units of Zubair Formation, while the decrease in Vsh in well Zb-114 were obtained in unites AB, and LN. The average of the effective porosity in well Zb-233 in all units was high while low values were obtained in well Zb-84 in unit AB, and LN. There is an increase in water saturation in well Zb-40 in the unit AB while the low values were recorded in well Zb-84 in unite DJ. The petrophysical analysis shows improved porosity and hydrocarbon saturation towards the northern part from studied oil mainly in the well (Zb-40) and the petrophysical characteristics were in unit LN. The dominate type of Pore throat type was between macro - mega pore and meso – mega pore types.

Key words: Well logs, petrophysical properties, Zubair Formation, Iraq.

1. Introduction

Zubair Formation (Lower Cretaceous) can be considered as an important reservoir in the south of Iraq and some of adjacent countries due to the good reservoir properties [1]. Zubair oil field is considered as an important oil field in Iraq after Rumaila and West Qurna Oilfields . It represents a gentle anticline and the major oil producing formations in this field are Zubair, Nahr Umr and Mishrif formations [2]. The Zubair oil field consists of 4 domes from the north to the south, Hammar, Shuaiba, Rafidiyya and Safwan consists of a longitudinal flank extending north west- southeast. The structure is anticline fold of longitudinal dome and the sides of the structure are not identical with slope about (2-3) degree. The western slope is more inclined than the eastern slope at the Shuaiba dome and the Rafidiyya dome [3]. Zubair Formation was defined by [4], they noted that it comprises 389 m of sandstone, siltstone, and shales, it is overlain conformably and gradationally by the Aptian Shuaiba Formation and underlain conformably and gradationally by limestone and shale of the Valanginian – Hauterivian Ratawi Formation [5]. The age of the formation was determined on the basis of both fossils and regional correlation, is Hauterivian till Early Aptian [6], while palyno morf evidence extended this formation up to earliest Albian age [7]. Many previous studies deals with Zubair Formation example: [8] showed that the Zubair formation was deposited in neritic conditions with the possibility to be deltaic environment. [9] determined four palynofacies forms indicating of island barrier at the upper part of Zubair Formation. These palynofacies were found to coincide with the environments of wet delta-plain, delta front, prodelta Shelf Sea. [10] studied the Zubair Formation in the south of Iraq; basing on core description nine main facies was determined: channels, flood plain, distributary channels, distributary mouth bar, interdistributary bays, marsh and swamps, delta front, prodelta and shelf. [11] 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.

The aims of this research project is to evaluate the reservoir petrophysical characteristics including the reservoir porosity, permeability and pore throat classification these properties can provid good information for water flooding processes for enhancing and increase oil production and support reservoir pressure .

Location of the study area

Zubair oil field is located far about (20Km) to the south west of Basra governorate, south of Iraq. The field lies between (47° 32' – 47° 45') Latitude and (30° 05' – 30° 42') Longitude Figure (1). 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. Field have (18 * 65) km width and length respectively with an area about 1, 170 Km^2. 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 ,[2].

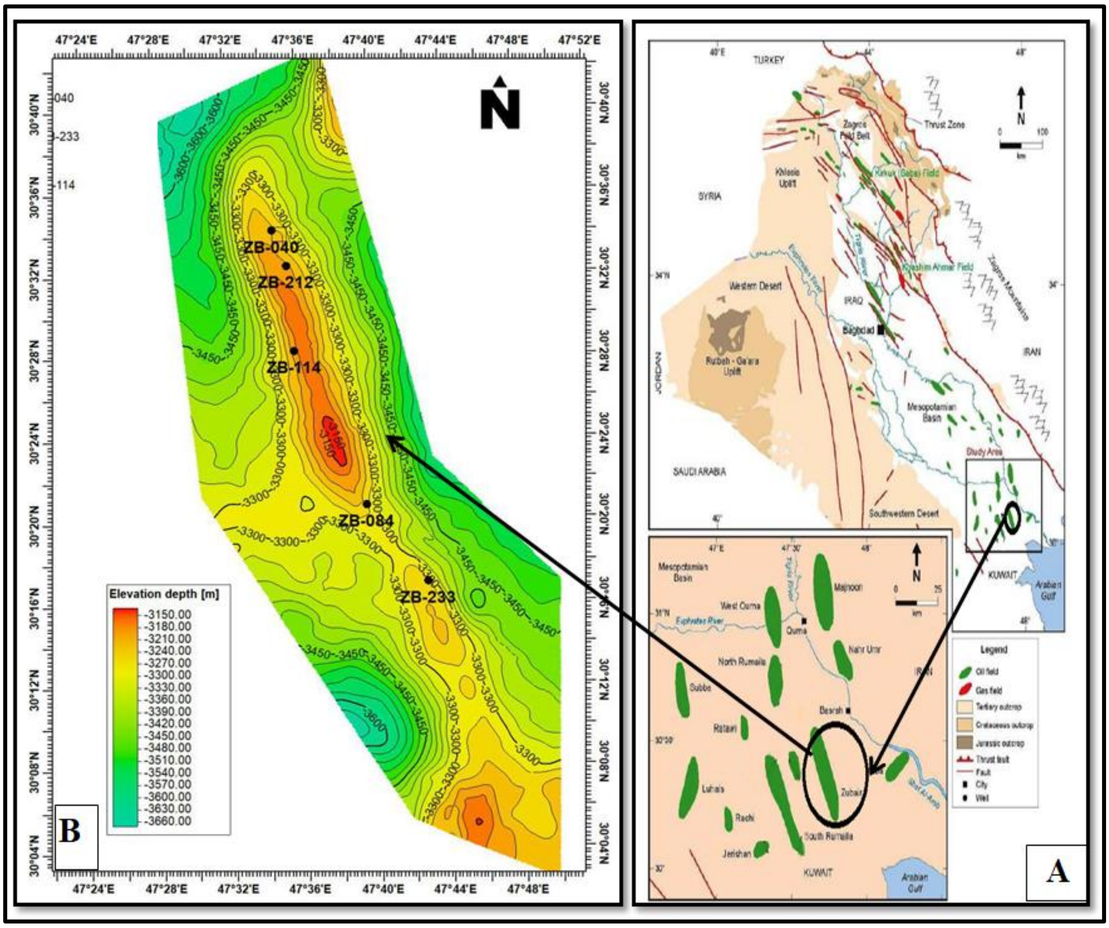

Fig. 1: (A) Location map shows the Zubair oil Field after [9] . (B) Structural map of upper sandstone member in Zubair Formation in Zubair oil Field.

Geological and Stratigraphic setting

Zubair Formation considered as the main formation of the Lower Cretaceous depositional cycle in(Late Berriasian – Aptian sub-cycle) in the south of Iraq [12]. [4] detecte Zubair formation whithin the well Zb-24; its thickness (389.33m) appears at depth (3161-3550m), and they divided the section into five members as shown in Table 1. According to [13], Zubair formation at the Zubair field comprises three pay zone (AB,DJ and LN) reservoirs with two intervening shales (C and K) Figure (2)

Table(1): Zubair formation members in Zubair oil field, south Iraq after [4]

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
	Upper shale Member Z/4	65-75	Black shale with few amount of Sandstone
	Upper sand Member Z/5	50-60	Fine to very fine Sandstone with few amount of shale
	Upper shale Member Z/6	60-70	Fissile , gray to black Shale , with zone of sandstone

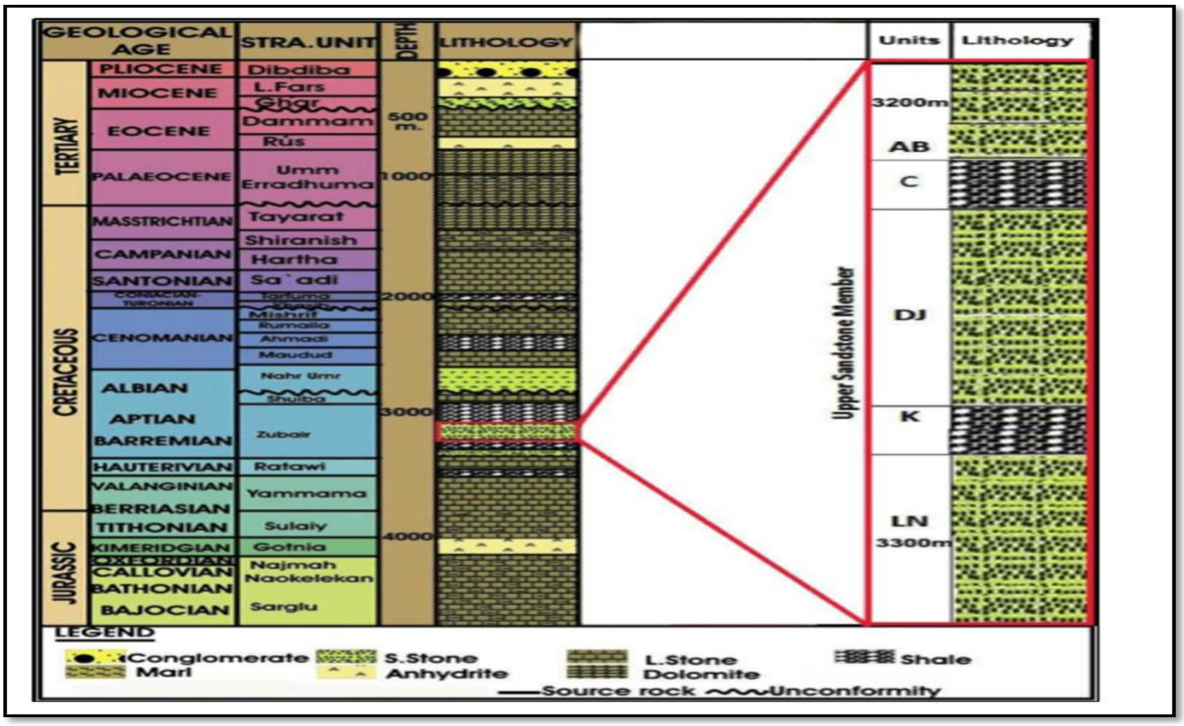

Fig .2 : Stratigraphic column of the five lithological units of upper sandstone member from Zubair formation within the zubair oilfield (Rumaila and Zubair oil fields), (Modified after [14]).

2- Materials and methods

Five wells from Zubair Formation in the Zubair oil field were selected to cover the study area. These wells are Zb-40, Zb-84, Zb-114, Zb-212, and Zb-233 (Table -2 and 3). Self-potential caliper, gamma ray, resistivity and porosity logs were used to collected the data from studied wells for calculation the petrophysical properties of upper sandstone member from Zubair Formation of Zubair oil Field (Fig-3). The reservoir units (AB,DJ ,LN) and non-reservoir units (C,k) have been determined depending on the processing the collected data from logs through using Techlog software.

Table 2: distribution the sandstone member in the studied wells.

Well No.	Top (m)	Bottom (m)	Thickness (m)	R.T.K.B. (m)	Coordinate	
					Easting (m)	Northing (m)
ZB-40	3242	3350.8	108.8	6.60	747144.079	3384769.898
ZB-84	3282.5	3388	105.5	23.80	755632.651	3360184.735
ZB-114	3203	3305.7	102.7	10.00	749156.125	3373941.98
ZB-212	3218.3	3333.8	115.5	12.19	748454.756	3381583.91
ZB-233	3296.6	3413	116.4	26.60	761099.279	3353349.9

Table 3: Thickness of reservoir and non- reservoir units in upper Sandstone member in Zubair formation for study wells.

Well No.	Top of unit (AB)	Top of unit (c)	Top of unit(DJ)	Top of unit(K)	Top of unit(LN)	Top of middle shale member
ZB-40	3242	3251.5	3259	3293.3	3304	3350.8
ZB-84	3282.5	3291.5	3303.5	3332.6	3337	3388
ZB-114	3203	3209.5	3211	3244.5	3255.5	3305.7
ZB-212	3218.3	3225.5	3235.8	3263.2	3277.3	3333.8
ZB-233	3296.6	3303.5	3304.9	3347.8	3351.6	3413

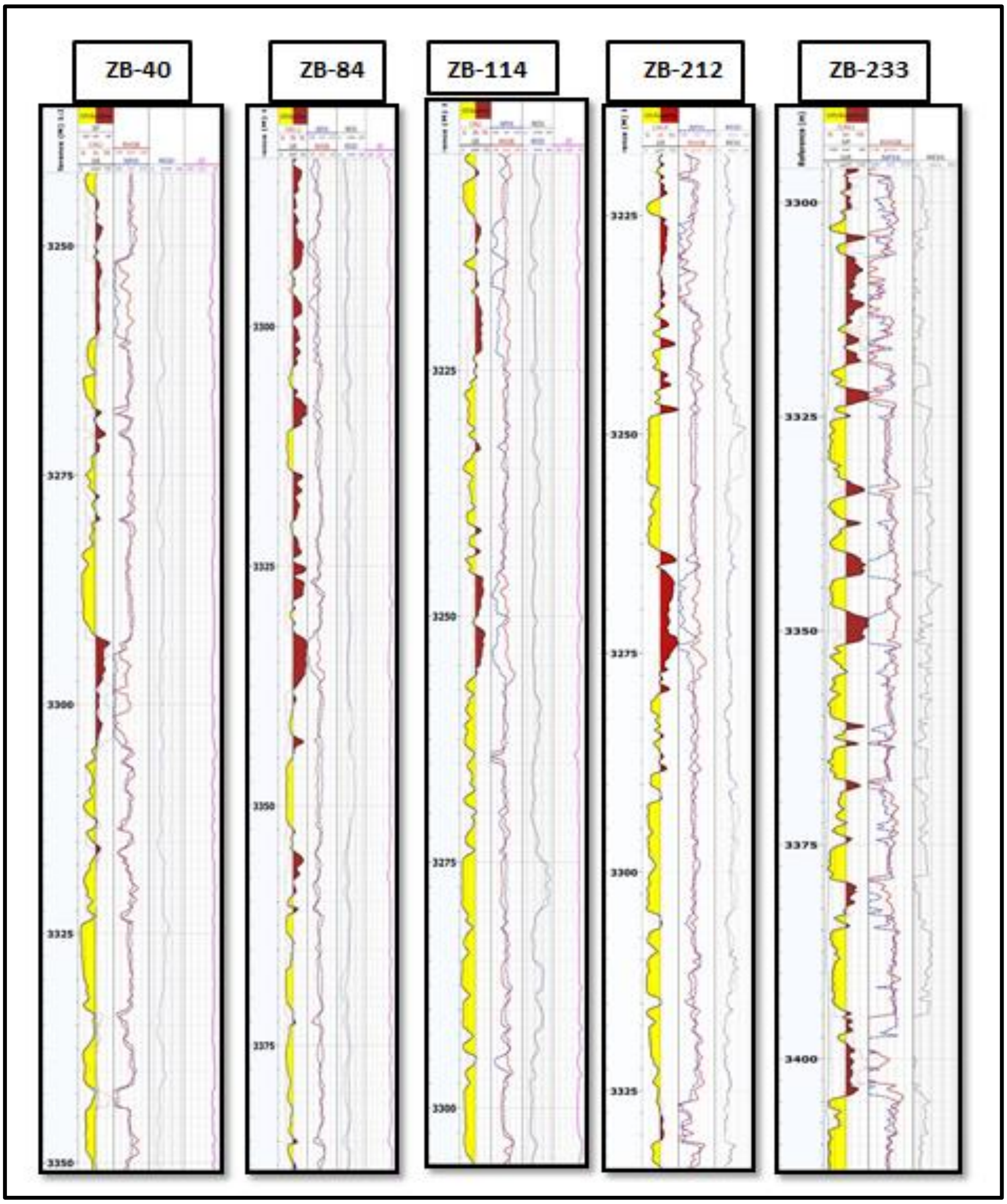

Fig. 3: well logs response from studied wells (ZB-40, ZB-84, ZB-114, ZB-212, ZB-233).

3- Results and discussion

1- Shale volume calculation (VSh)

Gamma ray log was used to calculate the volume of shale, for this rezone the following equation was used to calculate the radiation factor of gamma, which is the first step in determining the volume of the shale [15].

$$\mathbf{IGR} = \frac{(\boldsymbol{GR\ log} - \boldsymbol{GR\ min})}{(\boldsymbol{GR\ max} - \boldsymbol{GR\ min})} \qquad \textbf{(1)}$$

I_{GR}: gamma ray index. GR log : value of the gamma log at the desired depth to calculate the volume of the shale. GR_{min}: value the gamma log minimum . GR_{max}: value the gamma log Maximum.

The equation of Larionov1969 [16] was used to calculate the volume of shale (Vsh) of Zubair Formation.

$$V_{sh=0.33*\{2^{2*IGR}-1\}} \quad (2)$$

Depending on Vsh the separation between in clean zone (Vsh<%10) and shaly zone (Vsh>%10). The Vsh results are shown in (Table 4), un increases in the Vsh was detected in the well ZB-84 in all units, while there was decreasing was detected in the well ZB-114 in unites AB, and LN. Figure (4) and (5).

Table 4: The Volume of shale (Vsh) calculated for the reservoir units

Well	Unit AB	Unit DJ	Unit LN
ZB-40	0.34	0.25	0.16
ZB-84	0.64	0.59	0.35
ZB-114	0.18	0.27	0.13
ZB-212	0.38	0.28	0.24
ZB-233	0.25	0.27	0.16

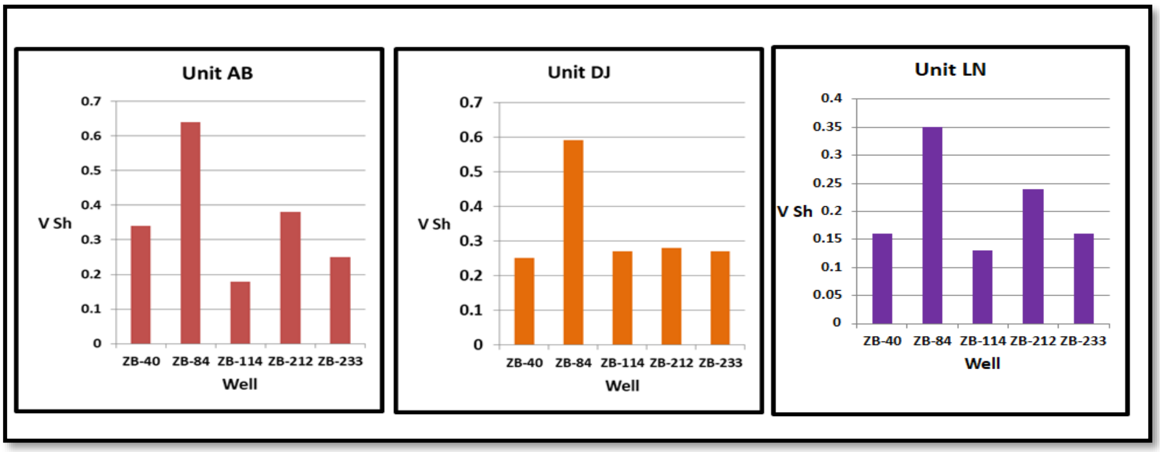

Fig.4: The Volume of shale (Vsh) calculated for the reservoir units wells of the study area

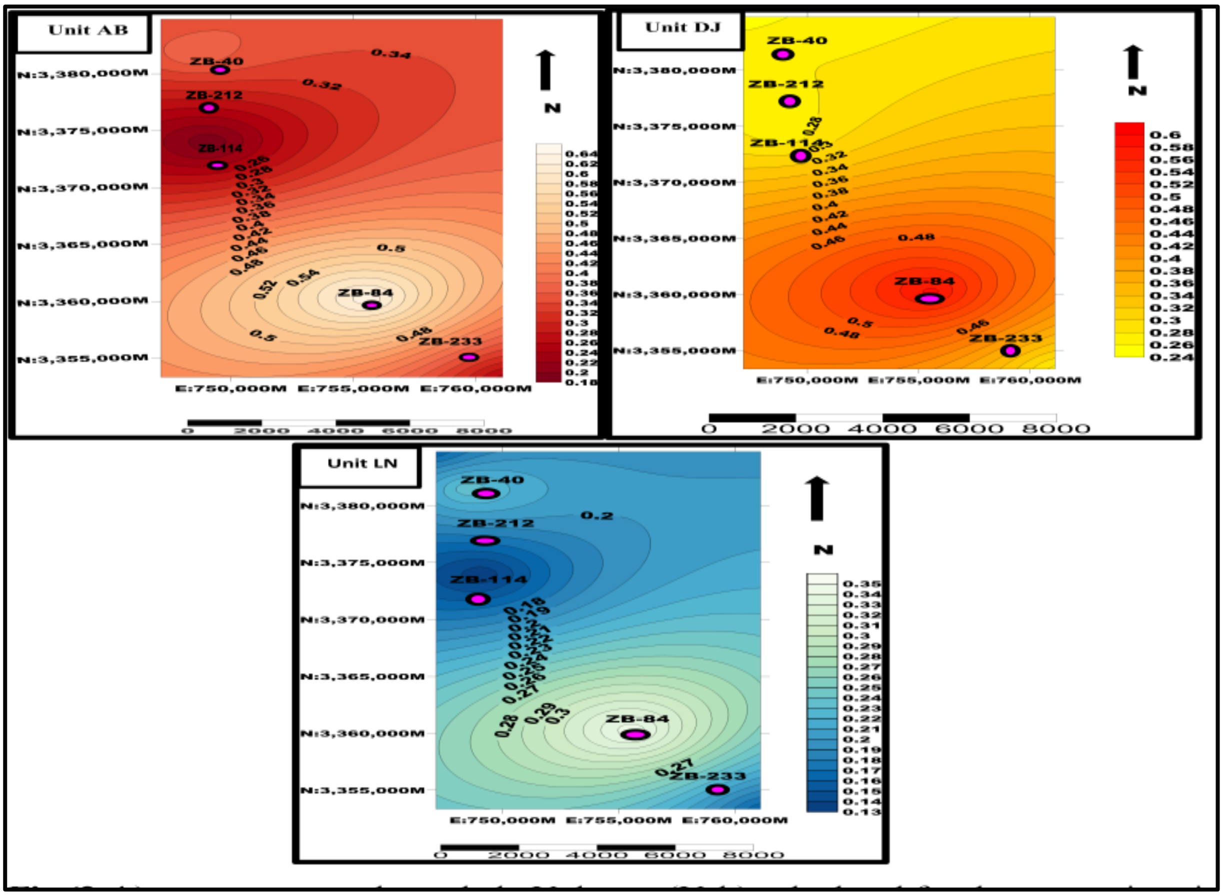

Fig. 5: contour maps show the distribution of Vsh in studied reservoir units of wells of the study area.

2-Porosity:The porosity is volume of voids to total rock volume as a percentage. The density log used to determining formation porosity using the Wylie equation in [17].

$$øD = \frac{\rho ma - \rho\, b}{\rho ma - \rho\, f} \tag{3}$$

φD: porosity % for clean depth intervals (Vsh < %10). To calculate the porosity for dirty intervals (Vsh > 0.1) used Dewan equation in [16].

$$ØD_e = \left[\frac{(\rho ma - \rho\, b)}{(\rho ma - \rho\, f)}\right] - \left[\left(\frac{(\rho ma - \rho\, sh)}{(\rho ma - \rho\, f)}\right) \times Vsh\right] \tag{4}$$

ρma = matrix density (2.65gm / cm3). ρb = formation bulk density (the log reading). ρfl = fluid density . ρsh = density of nearby shale. Vsh = shale volume shale.

The neutron log used to measure porosity directly in clean zone, while in while in dirty intervals the porosity corrected for shale effect by using Dewan equation in [16].

log **ØN= ØN-(ØNsh× Vsh)** **(5)**

ØN = neutron derived porosity. ØN = Shale-corrected density porosity. **Ø**N sh = neutron porosity of nearby shale. Vsh = shale volume.

3-Total (Effective) porosity: The total porosity or effective porosity calculated by using equation [18].

$$ØN.D = \frac{ØN+ØD}{2} \quad (6)$$

ØN.D=active or total porosity calculated from neutron and density log.

Table 5 showed there are increase of the average of effective porosity in well ZB-233 in all unit while the decrease was in well ZB-84 whithin the unites AB, and LN Figures (6)and (7).

Table 5: The Average of effective porosity calculated for the reservoir units

Well	Unit AB	Unit DJ	Unit LN
ZB-40	0.07	0.13	0.16
ZB-84	0.06	0.07	0.11
ZB-114	0.13	0.04	0.15
ZB-212	0.11	0.13	0.13
ZB-233	0.17	0.25	0.21

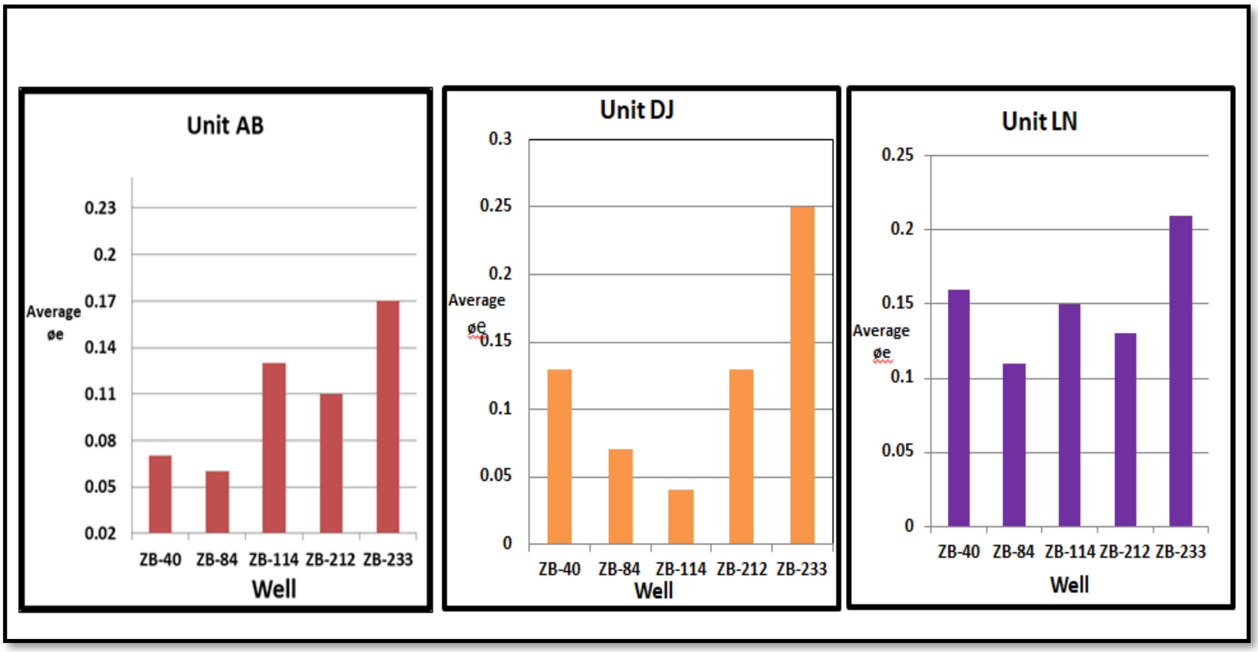

Fig. 6: The Average effective porosity calculated for the reservoir units of studied wells

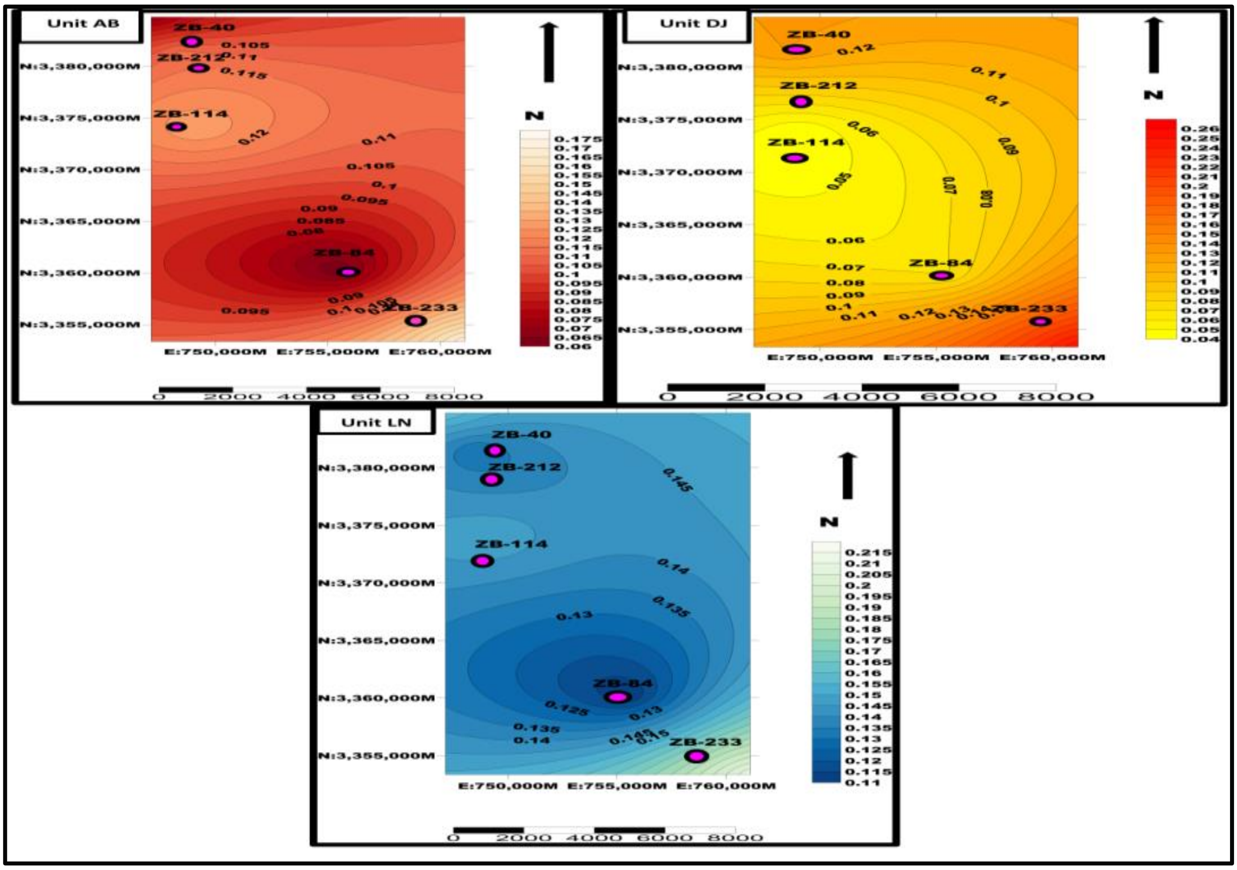

Fig.7: contour maps show the Average of effective porosity calculated for the studied reservoir units**.**

4-Formation Factor (F):

The formation factor could be related to the porosity by the following equation [19] in [20].

$$F = \frac{a}{\phi^m} \qquad (7)$$

The cementation exponent value (m) and tortuosity factor (a) are constants which they are determined empirically. The value of the cementation exponent (m) varies with tortuosity factor (a), and grain-size distribution [13].

5-Calculation of water and hydrocarbon Saturation

Water saturation (Sw) is defined percentage of volume of water-filled voids to total volume of pore space in the rock [21].

Hydrocarbon saturation(Sh) is the remainder of the volume of pore space unoccupied by water [22].

$$1 = Sw + Sh \qquad (8)$$

The value of water saturation is important in the well log analyzes to know the movement of hydrocarbons and residual In this study the water saturation was calculated for the invaded and uninvaded zones (Sxo and Sw) for depth intervals of shale volume (Vsh) less than 10 by using equations [19] :

$$S_w=(F\ R_w/R_t)^{1/n} \qquad (9)$$

$$S_{xo}=(F\ R_{mf}/R_{xo})^{1/n} \qquad (10)$$

While Water saturation in the uninvaded zone (Sw) for depth intervals of shale volume (Vsh) more than 10% was calculated by using Indonesia's equation [23].

$$S_w=\left(\frac{V_{sh}^{1-(V_{sh}*0.5)}}{\left(\frac{R_{sh}}{R_t}\right)^{0.5}}+\left(\frac{R_t}{R_o}\right)^{0.5}\right)^{\frac{-2}{n}} \qquad (11)$$

$$R_o=\frac{a*Rw}{\emptyset m} \qquad (12)$$

Water saturation in the flushed (Sxo) can be determined by the degree of flushing of mud filtrate [22].using the same method as to calculated water saturation (Indonesia's equation) in the uninvaded zone (Sw) with replacing the following terms:

Sw~Sxo = flushed saturation (v/v). Rw ~Rmf =mud filtrate resistivity (ohm.m). Rt ~Rxo =flushed zone resistivity (ohm.m)

The Indonesia equation in the flashed zone is as follows:

$$S_{xo}=\left(\frac{V_{sh}^{1-(V_{sh}*0.5)}}{\left(\frac{R_{sh}}{R_{xo}}\right)^{0.5}}+\left(\frac{R_{xo}}{\frac{a*R_{mf}}{\emptyset^m}}\right)^{0.5}\right)^{\frac{-2}{n}} \qquad (13)$$

The resistivity of the mud filtrate (Rmf) is corrected at formation temperature by Arp'formulas

$$R_2=\frac{R1(T1+21.5)}{(T2+21.5)} \qquad (14)$$

R2= resistivity at formation temperature. R1 = resistivity of mud filtrate at surface temperature T1 = surface temperature. T2 = formation temperature.

Table 6 show the increases of water saturation in well ZB-40 in unit AB while the decrease was in well ZB-84 in unite DJ Figures (8) and (9).

Table(6): The water saturation (SW) calculated for the reservoir units

Well	Unit AB	Unit DJ	Unit LN
ZB-40	0.39	0.37	0.36
ZB-84	0.33	0.26	0.30
ZB-114	0.34	0.33	0.35
ZB-212	0.36	0.37	0.33
ZB-233	0.33	0.38	0.37

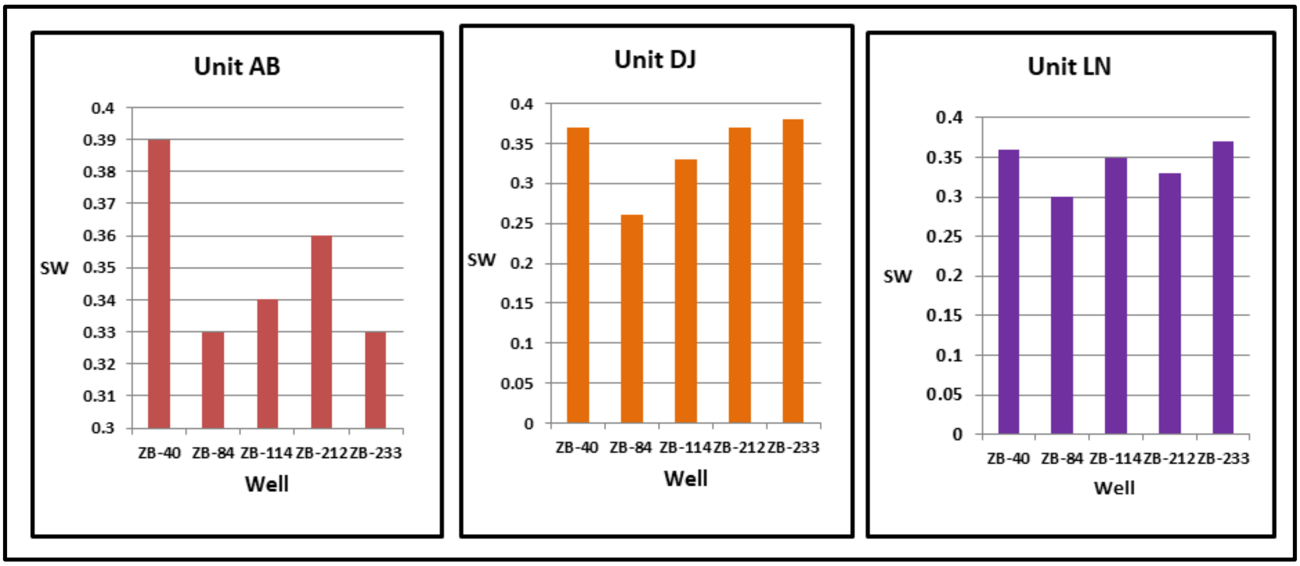

Fig.8: The water saturation (SW) for the reservoir units of studied wells

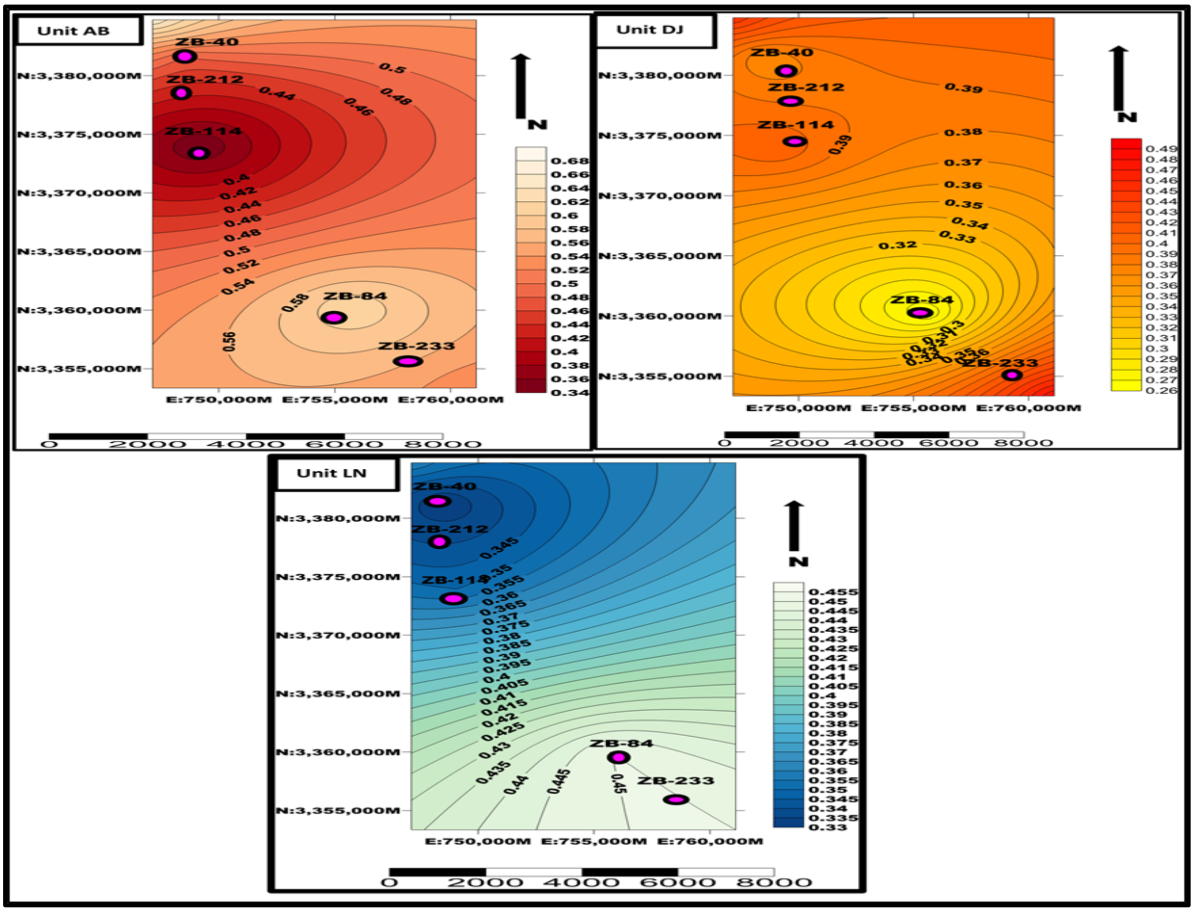

Fig.9: contour maps show the water saturation (SW) distribution with in the studied reservoir uinte

6-Calculation of bulk volume water and hydrocarbon movability

1- Bulk volume water (BVW): It calculated in the univaded zone and in the invaded zone by using the two equations as follows [24].

$$\mathbf{BV_w = SW\ \emptyset_{N.D}} \quad \textbf{(15)}$$

$$\mathbf{BV_{xo} = S_{xo}\ \emptyset_{N.D}} \quad \textbf{(16)}$$

Where: BVw = bulk volume water in the invaded zone.
BVxo = bulk volume water in the invaded zone.

When the values of the bulk volume water is constant or nearly constant in a given zone , this mean that zone is at irreducible water saturation and the water in the uninvaded zone cannot move, in addition to, hydrocarbon production should be water free [16].

Bulk volume hydrocarbon (BVh): It calculated from the following equation [23]

$$BVo=Sh\emptyset_{N.D} \quad \textbf{(17)}$$

BVo=Bulk volume hydrocarbon

3-Movable oil saturation (Mos): Its calculated from the flowing equation [24].

$$\mathbf{Mos=Sxo - Sw} \quad \textbf{(18)}$$

Mos: Movable oil saturation

4- Residual oil saturation (Ros): Its calculated from the flowing equation[25]

$$\mathbf{Ros=1-Sxo} \quad \mathbf{(19)}$$

petrophysical properties of studied wells showed in figures 10, 11, and 12

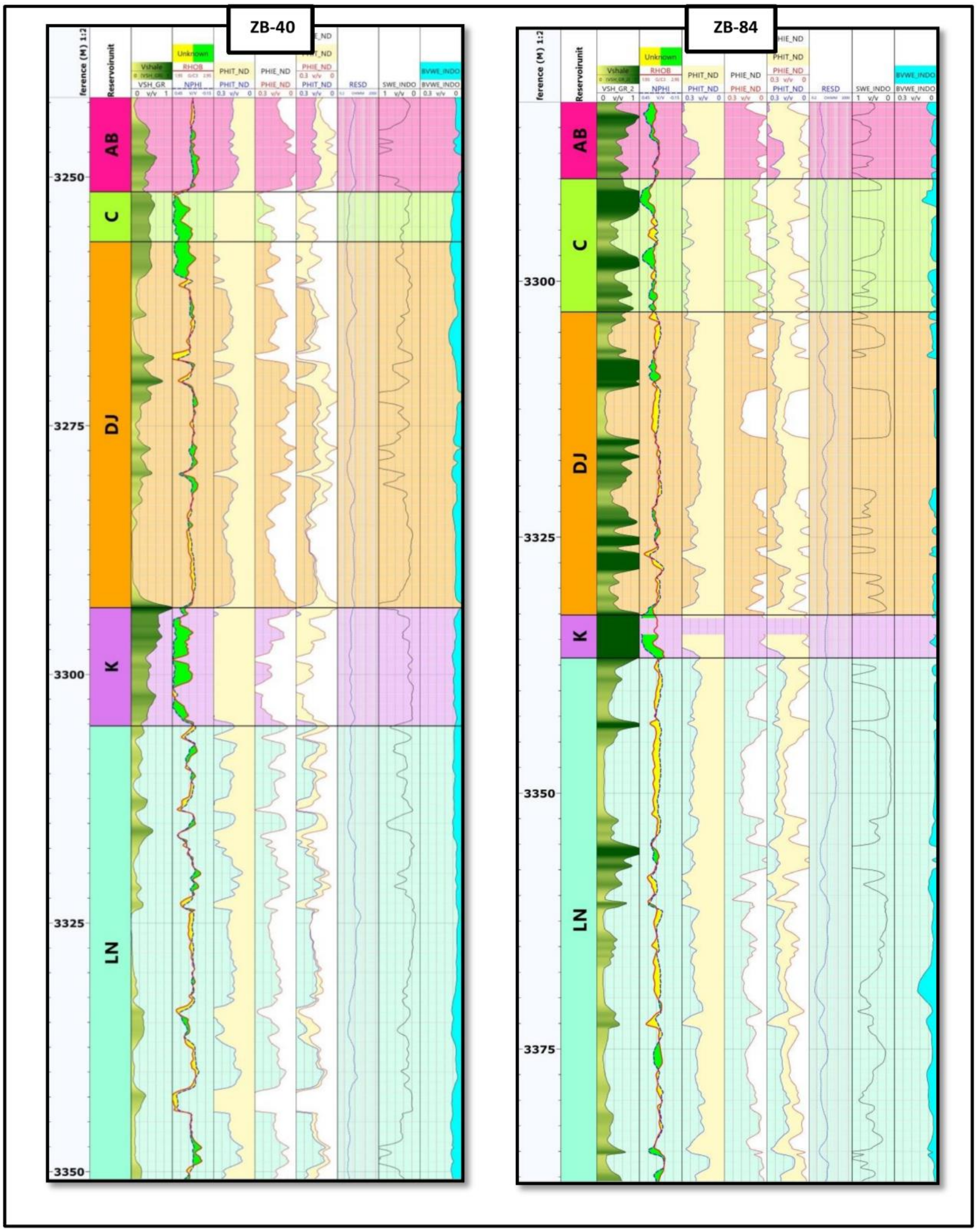

Fig. 10 perophsical properties distribution along the studied wells (ZB-40 and ZB -84).

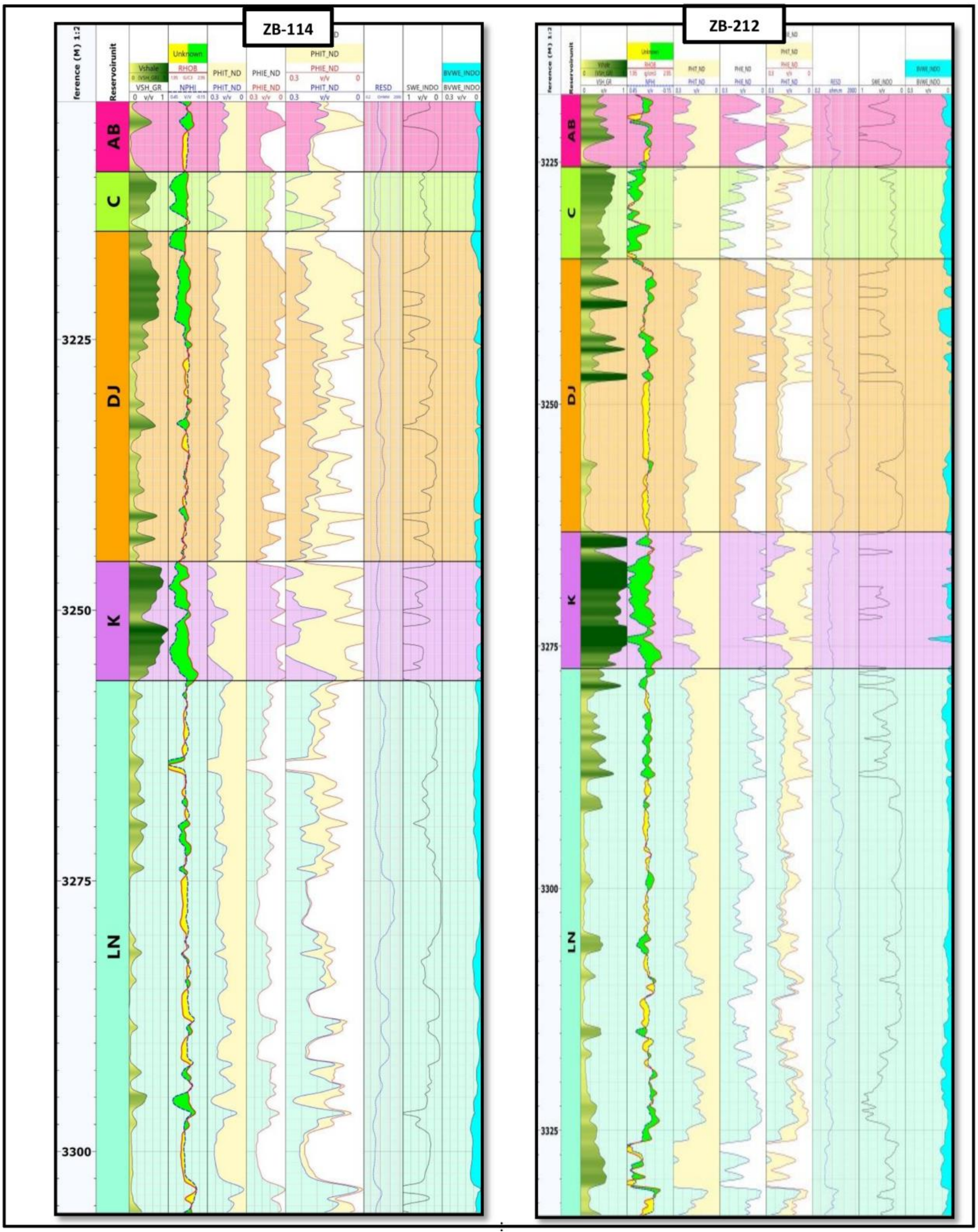

Fig. 11: perophsical properties distribution along the studied wells (ZB-114 and ZB-212).

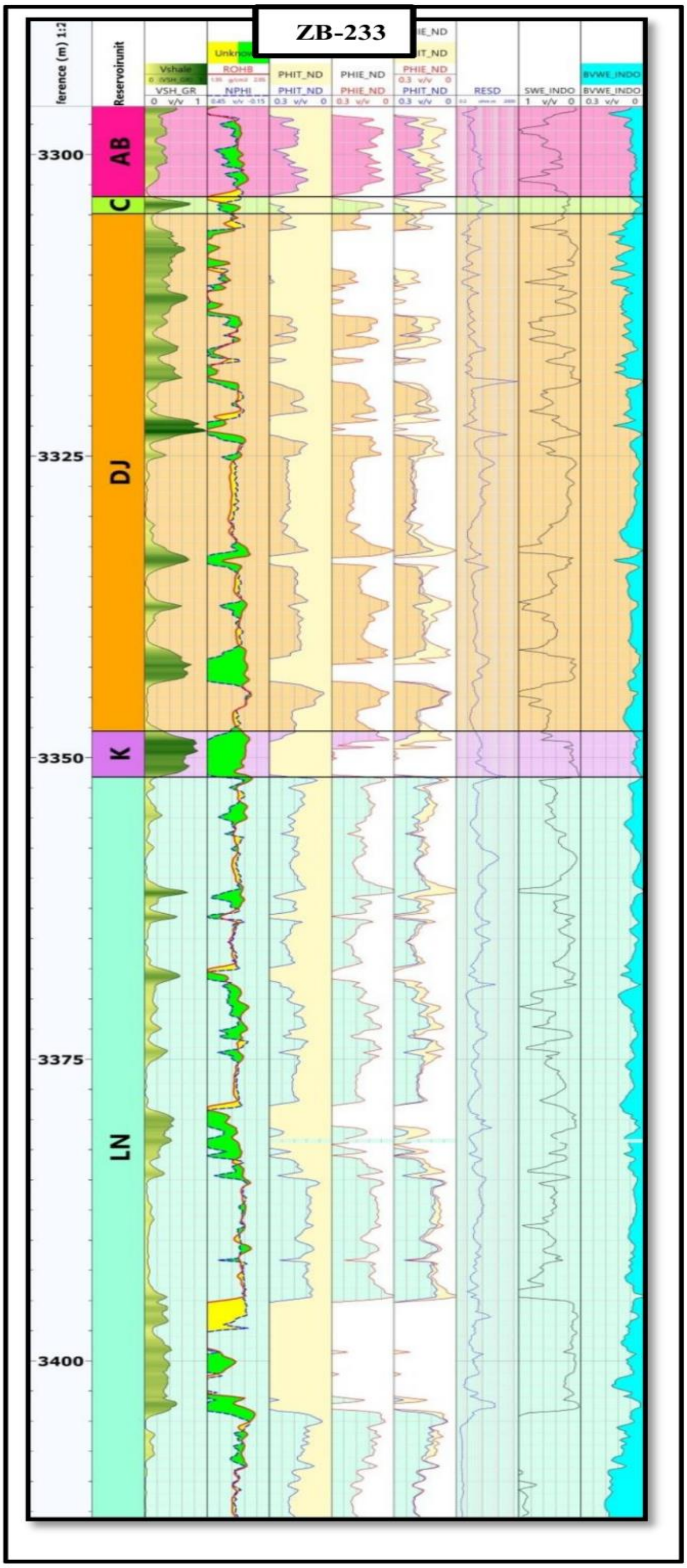

Fig. 12: perophsical properties distribution along the studied wells (ZB-233).

9-Permeability: is a measure of the rock`s ability to flow fluids (oil, gas, water) [26].or It is the ability of a rock to conduct fluids. Permeability gives an indication to the ability of porous medium to transmit fluids .The Permeability reservoir classification according to [27] is shown in table 7.

Table (7): Indicates reservoir permeability in general values [27].

Permeability	**Value**
Very low	> 1md
Low	1md < k < 10 md
Fair	10 md < k < 50 md
Average	50 md < k < 200 md
Good	200 md < k < 500 md Good
Excellent	> 500 md

The equation and chart of Wyllie and Rose were used for estimating permeability of the upper member sandstone of Zubair formation as follows:

$$\boldsymbol{K} = \left[\boldsymbol{C} * \left(\frac{\emptyset^3}{S_{wirr}}\right)\right]^2 \qquad \textbf{(20)}$$

Where: K = permeability, C = constant, its value equal 250 for medium oil and 79 for dry gas. Ø = porosity. , the equation and chart of Wyllie and Rose (1950) used for estimating permeability in all reservoir units for the studied wells except in unit (LN)in wells (ZB-114), (ZB -212) and (ZB-233) because unit LN in these well be under movable water saturation so cannot be applied the special equations to calculated permeability from logs . The results are shown in table 8 and Figures (13), (14), and (15).

Table 8: Indicates the range of the bulk volume water (BVW) and Permeability (K) in (md) for the studied wells.

Well No	**Unit**	**Bulk volume water(BVW)**	**Permeability (K) md**
ZB-40	AB	0.04-0.17	2.00 -50
	DJ	0.04-0.26	50-1000
	LN	0.02-0.16	50-5000
ZB-84	AB	0.10-0.31	1.00-30
	DJ	0.02-0.36	15.0 -3000
	LN	0.02-0.16	2.50 -500
ZB-114	AB	0.02-0.14	1.00-300
	DJ	0.03-0.22	1.50-200
ZB-212	AB	0.02-0.22	1-500
	DJ	0.01-0.22	10.0-5000
ZB-233	AB	0.04-0.20	5.0-1000
	DJ	0.01-0.25	5.0.-5000

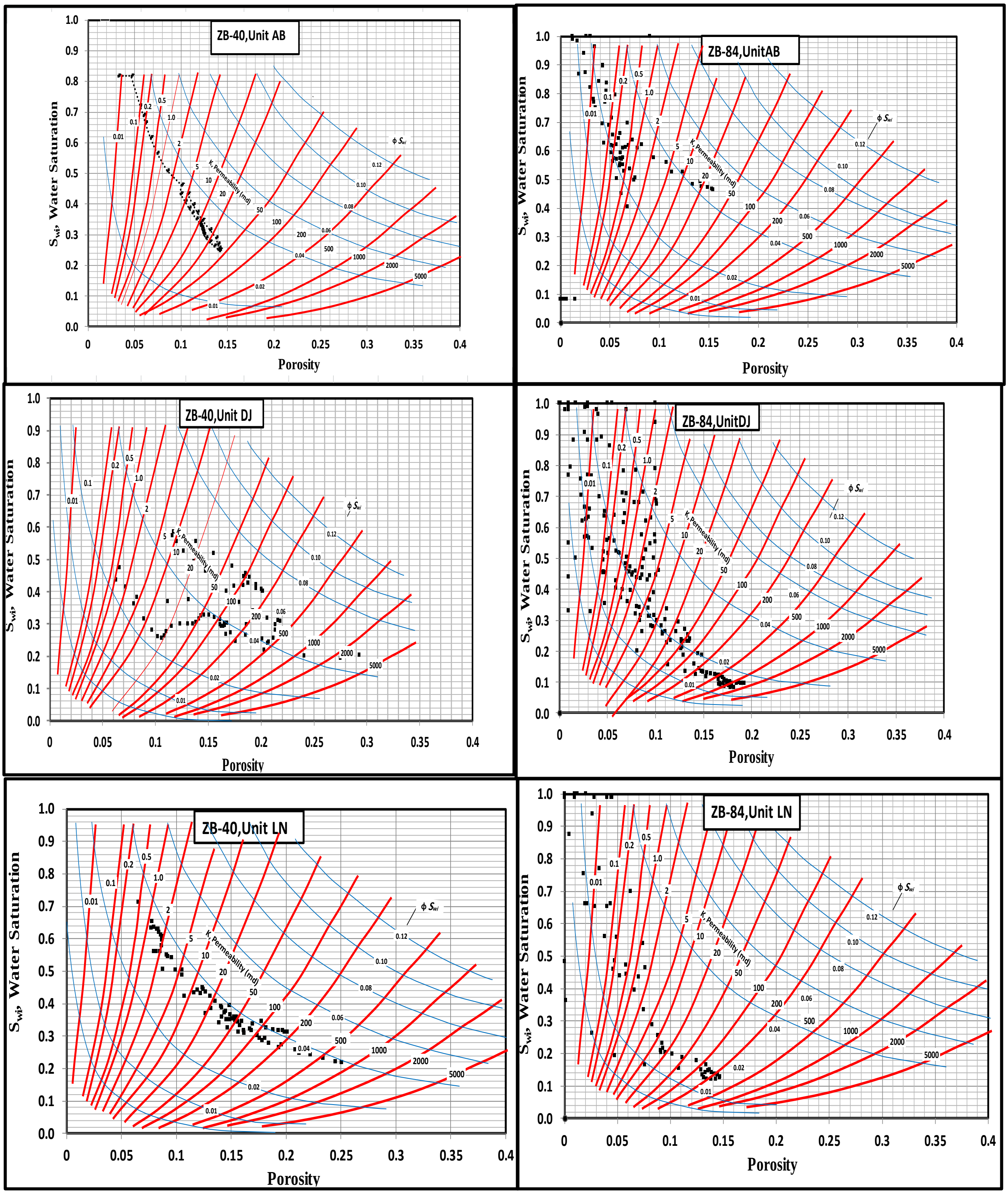

Fig. 13: Charts of (Ø) versus (Swirr) for estimating permeability and determining (BVW) for the studied reservoir units within the wells (ZB-40,ZB-84) .

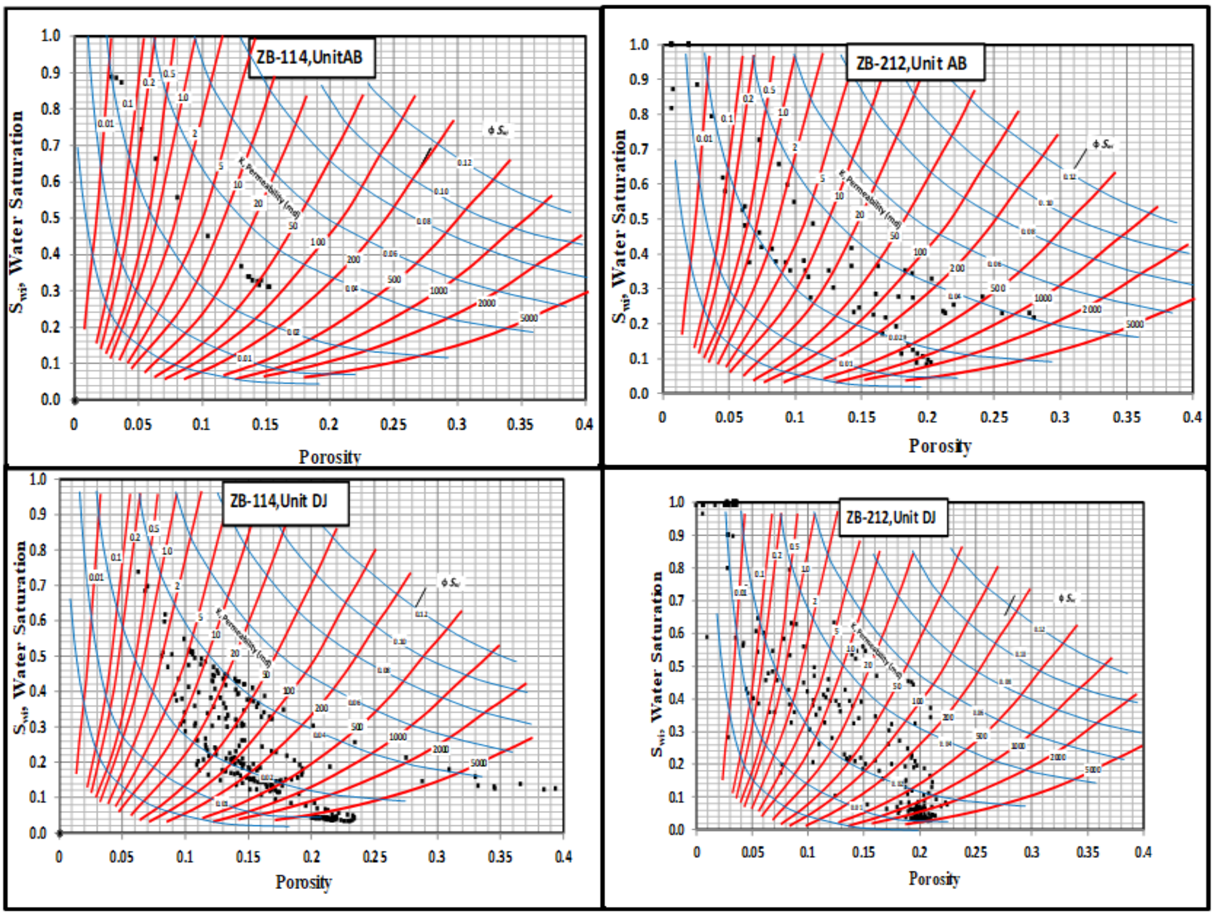

Fig. 14: Charts of (Ø) versus (Swirr) for estimating permeability and determining (BVW) for the studied reservoir units within the wells (ZB-114,ZB-212.

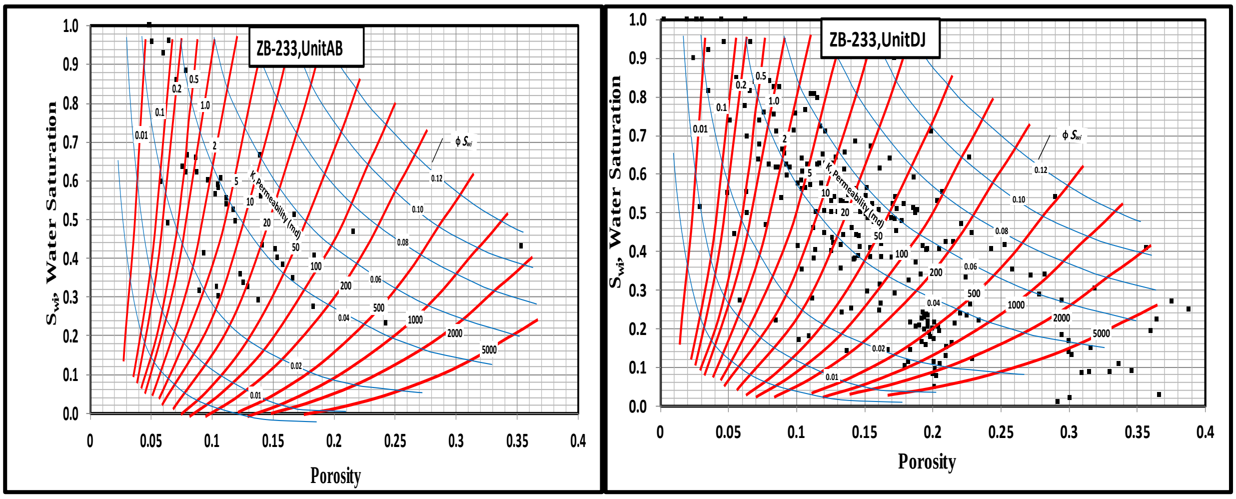

Fig. 15: Charts of (Ø) versus (Swirr) for estimating permeability and determining (BVW) for the studied reservoir units within the well ZB-233.

Where the values of Permeability (K) and bulk volume water (BVW) values of reservoir units from the studied wells have different ranges and the permeability value of the well ZB-40 was (low- fair) in unit (AB) and (average - excellent) for units (DJ) and (LN). In well ZB-84 the permeability values were (low-fair), (fair – excellent) , and (low-good) for the units (AB), (DJ), and (LN) respectively. The results of permeability of the well ZB-114 for units (AB and DJ) indicates low-good, whereas at well ZB-212 the permeability values for units (AB) and (DJ) were (low-good) and (low- excellent) respectively. For the well ZB-233 the permeability value for units (AB) indicates low - excellent ,and for units(DJ) indicates (low- excellent) .

10-Pore throat type :According to[28] pore throats are the mean radius of the pore throat related the pores as door through which the flow of fluids from one pore to another and we can probable by using either plug or from the relationship of porosity permeability under title of R35.According to [28] the porous system can be classified in terms(R-35) Table (9)**.**

Table 9: classification of pore throat R35

pore throat Type	size range
Mega	>10 Micron
Macro	2-10 Micron
Meso	0.5-2 Micron
Micro	0.1-0.5 Micron
Nano	<0.1 Micron

In the present study the Winland equation is used to estimate the value of Pore throat radius at 35% mercury saturation (R35) for the studied wells.

$$\textbf{Log R35=o.732+ o.588 log(Q)-0.864log(k)} \qquad \textbf{(21)}$$

Q=effective porosity, K=Permeability.

Table (10) shows the result of pore throat radius At well ZB-40, the pore throat radius at 35% mercury saturation (R35) shows meso pore– macro pore results within the at units AB with fair to very good flow unit and produce little oil with high water. In DJ and LN units the result shows macro pore– mega pore flow unit with good to very good and produce oil without water. For the well ZB-84, pore throat radius results of unit AB show micro pore with bad to fair flow unit which represent as a non-reservoir. Whereas, unit DJ result shows meso pore to macro pore with represent fair to very good flow units and produce high water only. At LN unit the pore throat radius results show meso pore–mega pore with good to very good flow units and produce high oil with little water. The pore throat radius results Ffor the well ZB-114 show meso pore– mega pore in units AB and DJ represents good to very good of flow units and produce high oil with little water. At ZB-212 well the pore throat radius results show micro pore– mega pore at AB unit and meso pore– mega pore at DJ unit which represent high oil with little water For the well

ZB-233 results show macro pore– mega pore in units AB and DJ, good to very good flow units and produce high oil with little water.

Table 10: results of Pore throat radius at 35% mercury saturation R35 estimated from studied wells

Well No	Unit	Pore throat radius at 35% (mercury saturation (R35)
ZB-40	AB	meso pore– macro pore
	DJ	macro pore– mega pore
	LN	macro pore– mega pore
ZB-84	AB	micro port
	DJ	meso pore– macro pore
	LN	meso pore– mega pore
ZB-114	AB	meso pore– mega pore
	DJ	meso pore– mega pore
ZB-212	AB	micro pore– mega pore
	DJ	meso pore– mega pore
ZB-233	AB	macro pore– mega pore
	DJ	macro pore– mega pore

Conclusions

-The petrophysical properties of the upper sandstone member from Zubair Formation results revealed improve towards the northern parts of the Zubair oil field mainly within well (ZB-40), while there are decreasing in its improvement in the middle of the field at well (ZB-84).

-The porosity and hydrocarbon saturation estimation results show improved towards the wells (ZB-40) and (ZB-233).

-Zubair formation is divided into five units (AB, C, DJ, K, and LN). AB, DJ, and LN are considered to be the best units as a good reservoir units, while the units C and K were represent a bad units.

-Pore throat radius results show range between macro -mega pore to meso - mega pore within studied wells indicating high oil with little water saturation to good to very good of flow units and produce high oil with little water quantity.

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تقييم الخصائص البتروفيزيائية باستخدام مجسات الآبار في الجزء العلوي من العضو الرملي لتكوين الزبير في حقل الزبير النفطي، جنوب العراق

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الخلاصة

تم في الدراسة الحالية حساب الخصائص البتروفيزيائية لعضو الرمل الاعلى من تكوين الزبير لحقل الزبير النفطي جنوب العراق باستخدام التفسير لعدد من المجسات البئرية المختلفة للآبار المفتوحة (Zb -40، Zb -84، Zb-114، Zb- 212 و Zb- 233) هذه الخصائص تشمل حجم السجيل (Vsh)، المسامية الفعالة (Øe) ، التشبع المائي (SW)، النفاذية (K) ونوع اعناق المسامات (R35) . تم رسم الخصائص البتروفيزيائية (Vsh) ، (Øe) و (SW) لكل وحدة مكمنية للتعرف على اتجاه التحسن في خصائص الخزان للابار المختارة. اعتمادًا على مجس أشعة كاما فان تكوين الزبير يقسم الى ثلاث وحدات مكمنية هي (AB، DJ و LN) ووحدتين غير مكمنية (C و k). الزيادة في حجم السجيل كانت في البئر Zb-84 وفي جميع الوحدات المكمنية بينما النقصان فيه كان في البئر Zb-114 في الوحدتين المكمنية AB و LN. معدل المســـامية الفعالة في البئر Zb-233 في جميع الوحدات كانت مرتفعة بينما كانت القيمة المنخفضة لها في الوحدتين AB و LN لبئر Zb-84. هناك زيادة في التشبع المائي في البئر Zb-40 في الوحدة AB بينما ينخفض التشبع المائي في الوحدة DJ في البئر Zb-84 . التحليل البتروفيزيائي اوضح تحسين بنوعية المسامية والتشبع الهيدروكربوني باتجاه الأجزاء الشمالية خاصة عند البئر Zb-40 بينما افضل الخصائص كانت في الوحدة المكمنية LN . النوع السائد لاعناق المسامات كانت بين مسام ماكرو- ميكا ومسام ميكا- ميزو.

الكلمات المفتاحية : مجسات الابار، الخصائص البتروفيزيائية، تكوين الزبير، العراق