Determination of the best reservoir units for Upper Shale Member of the Zubair Formation by using several petrophysical properties, Southern Iraq

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Abstract

The Zubair Formation is considered the main hydrocarbon reservoir in the center and the south of Iraq' oilfields. The formation has five members, namely, Upper Shale, Upper sand, Middle Shale, Lower sand and Lower shale Members. This work concentrates on the Upper Shale Member of the Zubair Formation in the X-field in the south area of Iraq.

Three wells (A, B, and C) were chosen to evaluate the petrophysical properties of the Upper Shale Member in the study area using the Geolog software. The analysis of the conventional well log behaviors (gamma-ray, sonic and resistivity logs) proved that this member can be subdivided into three reservoir units separated by shale beds. The thickness of the member in the study area ranges between 95-100 m. The petrophysical properties were calculated for the reservoir units. In all wells, reservoir unit 2 shows the best petrophysical properties. However, the best reservoir characteristics were found in the well B.

Key words: Zubair Formation, petrophysical characteristics, Upper Shale Member, reservoirs, Hauterivian - Early Aptian, Iraq

1. Introduction

Well logging has a significant role in petrophysical log interpretation and geological decision-making. It provides numerous information, such as pay zone correlation, lithology, calculating the petrophysical properties like the volume of shale, porosity, water saturation, permeability, and other important characteristics (Liu, 2017). It can simply tell us if there is a hydrocarbon accumulation, the type of hydrocarbon (oil or gas), delineate the permeable zone, finding the thickness of the target zone, and extra information (Cannon, 2015).

The Zubair Formation is the main producing formation in the middle and south of Iraq's hydrocarbon fields. It is treated as an important formation, because of its good reservoir petrophysical properties (Al-Jafar, 2019).

Al-Azzawi (2003) studied Zubair Formation in a selected field in the south area of Iraq and found that all the components of the petroleum system are available within the Zubair Formation. Idan et al. (2014) studied the hydrocarbon potential of Zubair Formation in the south area of Iraq, and from the total organic carbon, he found that the upper parts of

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Zubair Formation shale's layers are good to excellent source rocks. Whereas in the lower part of the Zubair Formation, the total carbon content has fair values. Al-Jaberi and Al-Myyahi (2018) studied the Upper Shale Member of Zubair Formation in Rumaila oilfield using Petrel and Techlog softwares to define the petrophysical properties as well as the electrofacies. Petrel software was used to make a porosity model for the field and Techlog to estimate the permeability. AL-Shahwan et al. (2018) studied the reservoir petrophysical properties for 1C unit in Upper Shale member of Zubair Formation in Luhais field. The log interpretation was used to estimate those properties. From reservoir characteristics and the longitudinal section, the researchers realized that the good reservoir properties are distributed in the top, eastern part and the west part of the structure.

This study will evaluate the sand units within the Upper Shale Member by interpreting the data from open-hole logs of three drilled wells in X-field southern Iraq, which is considered the first study that shed the light on the Upper Shale Member in the X-field. The Geolog software will be used to calculate the petrophysical characteristics by interpreting the open-hole logs to determine the reservoir units and find the best petrophysical properties and check the feasibility of exploiting the member.

2. Geological setting

The X-field is an anticline structure. The main axis direction of the studied field is NNW- SSE (Fig. 1). The structure of it located at Zubair subzone in the Southernmost part of the Mesopotamian zone (Jassim and Goff, 2006). Mesopotamian zone is located in the stable shelf of the Arabian platform according to Jassim and Goff (2006), whereas, Numan (1997) describe the Mesopotamia zone as sagged basin of the qusiplatform foreland. The tectonic phase of closing to the passive margin of Arabian plate is the most effective to the Mesopotamia oilfields (Al-Mutori and Al-asadi, 2008) The subsidence of the Mesopotamia basins is high to moderate at Upper Jurassic until Mid-Cretaceous, then tectonic subsidence was slow with distinctive uplift happened during the Miocene (Handhal and Mahdi, 2016).

The Zubair subzone has structures trending predominately N-S (Fig. 2), which are formed through the Nabitah orogeny time and reactivated at Permo-carboniferous period, and continuous during Mesozoic - Tertiary era (Jassim and Goff, 2006). The northern side of the subzone is bounded by the Takhadid-Qurna transversal fault, and the southern side is delineated by the Al-Batin fault or along a transversal fault in Kuwait (Jassim and Goff, 2006).

The lower Cretaceous Zubair formation is the lowermost formation of the Thamama group. It belongs to the Late Tithonian – Early Turonian mega sequence (AP8) (Jassim and Goff, 2006). The estimated age of the formation is lower cretaceous. According to the regional correlation and fossils, it is assumed to be Hauterivian - Early Aptian (Al-Tool, et.al., 2019), (Al-Rubaye, 2019). Douban and Medhadi (1999) Suggested the age of the formation in Kuwait is from late Hauterivian to early Aptian. However, Al-Meri and Batten (1997) extend the formation age to early Albian depending on the palynomorphs indexes.

The deposition system of the Zubair Formation is a fluvial-deltaic combination (Sadooni and Aqrawi, 2000).

Zubair Formation Covers the north of Saudi Arabia, Kuwait and a large area of

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south and center of Iraq (Aqrawi et al., 2010). The type section was classified into five members for reservoir description purposes, Upper Shale, Upper sand, Middle Shale, Lower sand and Lower shale Members. The sand members are the main producing members from the Zubair formation. The formation thickness range between 200 – 500 m in the south area of Iraq (Fig. 3) (Aqrawi et al., 2010).

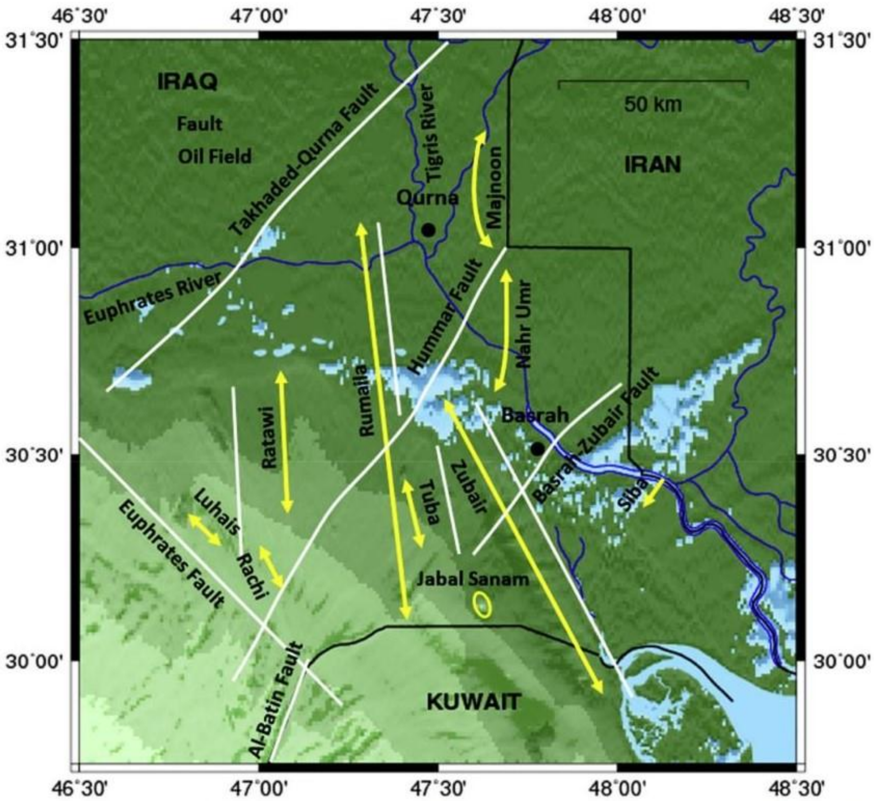

Fig. 2. The structure trend in the Zubair subzone, Mesopotamia Zone. The white lines represent the faults and the yellow arrows denote the oilfield structures in the study area (Abdulnaby, 2019).

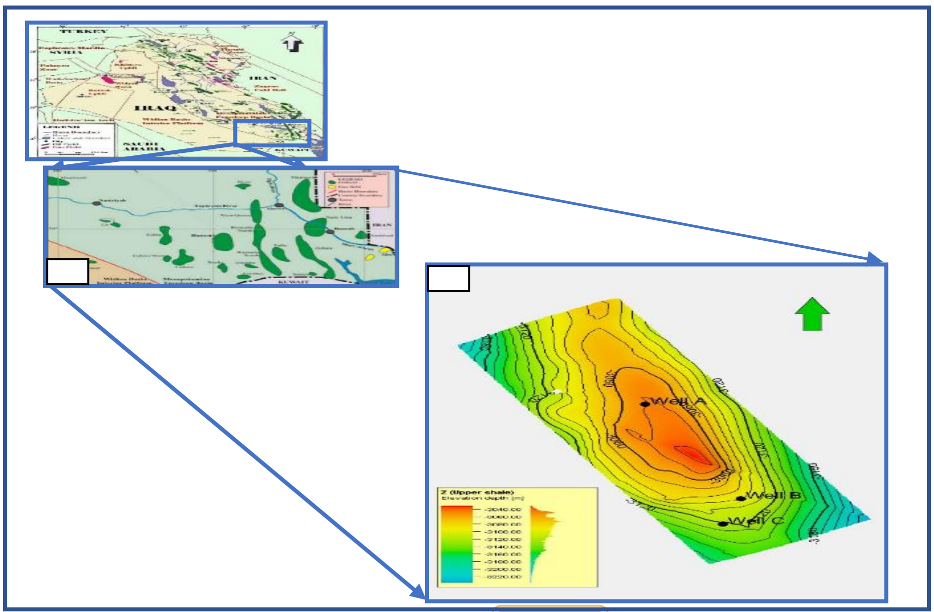

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Fig. 1. Location map of the studied wells 1.the main oil fields in the south of Iraq (Al- Meri & Batten, 1997), 2.countor map of the X-field with position of studied wells, southern Iraq.

The Formation comprises mainly clastic sequences. The formation comprises almost 100% of Shale near Dujaila in the center of Iraq. However, the Shale percentage in the formation rapidly decreases to the Southwest, and sand thickness reduced eastward (Aqrawi et al., 2010). It becomes Zero in the Salman zone (Jassim and Goff, 2006).

The stratigraphic column in the south of Iraq starts with the late Jurassic Gotnia Formation at the bottom. After that, the Cretaceous starts with Sulaiy, Yamama, Ratawi, Zubair, Shuaiba, Nahr Umr, Mauddud, Ahmadi, Rumaila, Mishrif, Khasib, Tanuma, Sadi, Hartha, Shiranish and Tayarat formations. Finally, the Tertiary formations, which are start with Um Er-Radhuma Formation then Rus, Dammam, Ghar, Lower Fars and Dibdibba Formations (Fig. 4).

The upper contact with the Shuaiba Formation is conformable, while the lower contact is unconformable with Ratawi Formation (Fig. 5). Shuaiba Formation overlies the Zubair Formation gradationally (Aqrawi et al., 2010). The appearance of *Hedbergella tunisiensis* Range Zone is well sign to the top of Shauaiba Formation (Al-Shawi, et.al, 2019). While Ratawi Formation passes both upwards and toward West to Zubair Formation (Jassim and Goff, 2006).

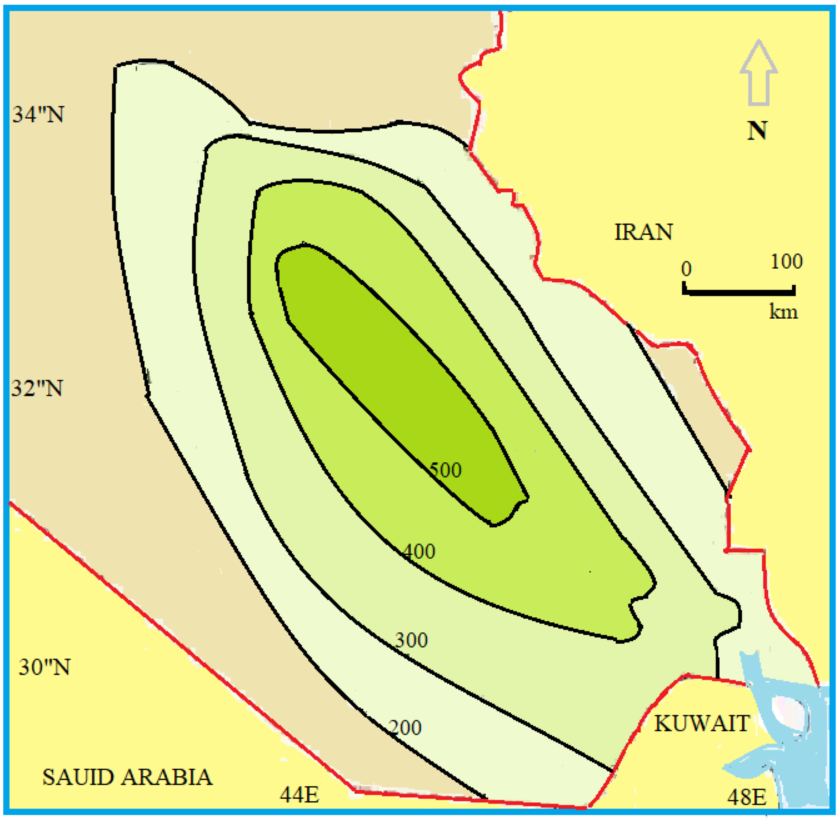

Fig. 3. Zubair Formation isopach map; thickness in meters showing the increase in the formation thickness towards Northeast Iraqi-Saudi border (Aqrawi, et al., 2010).

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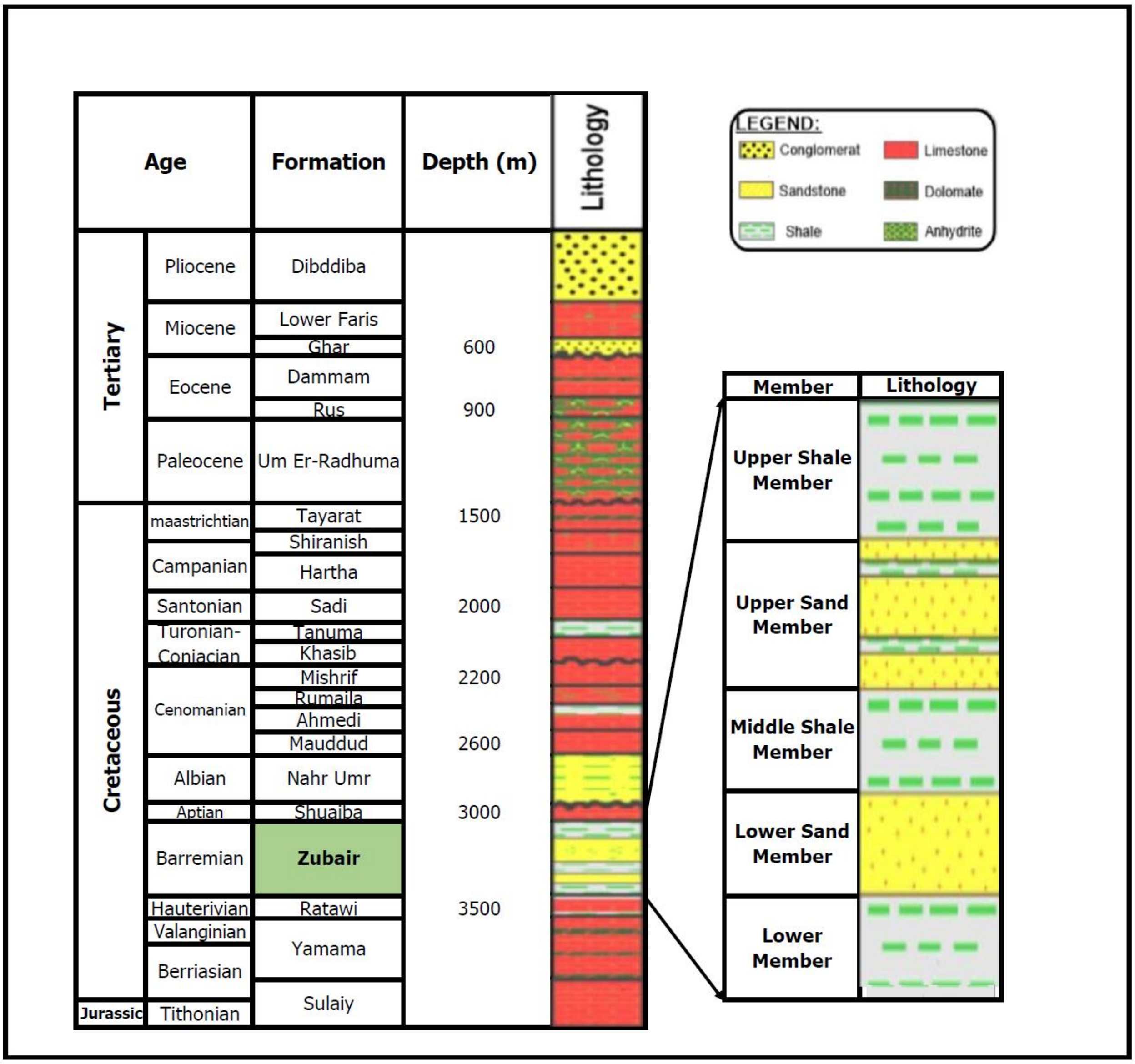

Fig. 4. Stratigraphic column of the study Area, illustrate the subdivision of Zubair Formation (modify after Handhal et al., 2019).

3. Material and Method

Three wells, namely A, B and C were used to study the Upper Shale Member in this study. The available logs in these wells include gamma-ray, Sonic and resistivity logs. Geolog software was used to evaluate these logs. The software was used to determine the formation boundaries of the studied members, identify the lithology, and estimate the petrophysical properties, such as volume of shale, porosity, water saturation, bulk volume of water and moveable hydrocarbon index.

The gamma-ray log was used to identify the formation boundaries and lithology, while the sonic log was used to estimate porosity. Finally, the resistivity logs were used to calculate the water saturation by using the Archei formula.

4. Lithology identification

Upper shale Member consist of sequences of Sandstone and shale. therefore, the gamma-ray log was used to identify the lithology, where the log has high gamma-ray readings in front of shale layers and low readings in front of sandstone layers (Figs. 5 to 7)

5. Zubair Formation boundary

The upper boundary of the Zubair Formation can be readily determined from the gamma-ray, resistivity and sonic logs. The change in lithology from the Shuaiba Formation which is composed of limestone to the top of Zubair Formation which is composed of shale will be easily detected from the sudden increase in gamma-ray and sonic values and the decrease in the resistivity logs values because of the presence of shale (Figs. 5 to 7). However, in this study, the bottom of the Zubair Formation cannot be detected because the total depth of the available wells does not exceed 20 meters inside the lower shale member of the Zubair Formation. The Zubair Formation is divided into five members (Aqrawi et al., 2010):

1- Lower shale member
2- Lower sand member
3- Middle shale member
4- Upper sand member
5- Upper shale member

The study is focused on Upper shale member, which contains several reservoir units (Table 4)

Table1. Zubair Formation tops in the studied wells

Well name	Zubair Formation tops (MD)
Well A	3198.5
Well B	3226.6
Well C	3248.9

Table 2. The tops and thicknesses of Zubair Formation units in the studied wells

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Well name	Formation / Unit	Depth	Thickness
Well A	Shuaiba	3140	58.5
	Upper shale	3198.5	104.8
	Upper sand	3303.3	135.4
	Middle shale	3438.7	49
	Lower sand	3487.7	97.2
	Lower shale	3584.9	\
Well B	Shuaiba	3172.2	54.4
	Upper shale	3226.6	98.9
	Upper sand	3325.5	124.3
	Middle shale	3449.8	46.1
	Lower sand	3495.9	79.3
	Lower shale	3575.2	\
Well C	Shuaiba	3193.1	55.8
	Upper shale	3248.9	95.8
	Upper sand	3344.7	121.2
	Middle shale	3465.9	51.6
	Lower sand	3517.5	74.6
	Lower shale	3592.1	\

6. Shale volume calculation

The volume of shale is used to correct the calculated porosity from the logs, like sonic or density as the first step in log analysis (Cannon, 2015). The estimation of shale volume can be done by one of three methods, Gamma-ray, spontaneous potential or density, and neutron logs (Tiab and Donaldson, 2015).

The relationship used to calculate shale volume using gamma-ray log is (Asquith and Krygowski, 2004):

$$IGR = \frac{GR\ log - GR\ min}{GR\ sh - GR\ min}$$

(1)

Where:

IGR = gamma-ray index

GR log= formation gamma-ray

GR min= clean formation gamma-ray

GR sh= shale gamma-ray value

The relationship can vary from one location to other and with depth, therefore several non-linear relationships have been produced, like Larionov, Steiber, and Clavier (Cannon, 2015).

Larionov's equation (Larionov, 1971) is used for rocks older than Tertiary to calculate shale volume (Asquith and Krygowski, 2004):

$$V_{sh} = 0.33 * (2^{2.1\ IGR} - 1)$$

(2)

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In this study the volume of shale was estimated by the calculation of gamma-ray index first then the Larionov equation for rocks older than Tertiary (figs. 5 to 7).

If the value of shale volume is less than 10%, the formation is considered clean of shale, and if the value is equal to or greater than 10% then the formation is considered unclean.

7. Porosity calculation

Porosity is the ability of a rock to retain fluids inside its pores, and it is the ratio of pore volume to the total volume of rock (Cannon, 2015).

Porosity can be classified into total porosity and effective porosity, relying on the presence of clay, where the effective porosity will be lower than the total porosity in shaly formation, whereas in shale free formation the total porosity will be equal to the effective porosity (Tiab and Donaldson, 2015). Total porosity also represents the amount of fluid hold inside the rock, whereas effective porosity represents the amount of connected pore space, that can transmit fluids (Asquith and Krygowski, 2004).

In this study, the porosity was calculated from density and sonic log (Figs. 5 to 7). And a 0.5 VSH cut-off was made to eliminate shale intervals, which does not have any contribution to hydrocarbon production. This cut-off value is considered a rational starting point to eliminate beds with high shale content (Cannon, 2015).

8. Sonic porosity

The Wyllie- time average equation was used to estimate sonic porosity, and it can be expressed in term of travel time as below (Wyllie et al., 1958):

$$\phi\ sonic = \frac{\Delta t\ log - \Delta t\ ma}{\Delta t\ fl - \Delta t\ ma} \quad (3)$$

Where:

ϕ sonic = sonic derived porosity

Δt log = sonic log reading

Δt fl = fluid interval transit time

Δt ma = matrix interval transit time

Hydrocarbon has an effect on sonic porosity. It causes an increase in sonic porosity. To remove its effect, Hilchie (1978) suggested the following equation:

$$\phi\ sonic\ Corr = \phi\ sonic * Bhc \quad (4)$$

Where:

ϕ sonic Corr = sonic corrected porosity

Bhc= Hydrocarbon effect coefficient (0.9 for oil)

9. Water and hydrocarbon saturation (S_w & S_h)

Hydrocarbon saturation can be defined as the ratio of the volume occupied by the hydrocarbon to the total volume of pores, and water saturation is the volume of water occupying the pores to the total pore volume (Cannon, 2015).

In order to calculate hydrocarbon saturation, water saturation must be determined first. The following equation can be used to calculate hydrocarbon saturation (Cannon, 2015):

$$S_h = 1 - S_w \quad (5)$$

Where: S_h = hydrocarbon saturation

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S_w = water saturation

Water saturation can be calculated directly by the Archie formula (Cannon, 2015):

$$S_w = (a * R_w / Rt * \phi^m)^{1/n} \quad (6)$$

Where: S_w = water saturation

R_w = formation water resistivity

R_t = true formation resistivity

a = tortuosity factor

ϕ = porosity

n = saturation exponent

m = cementation exponent

The water saturation of the flushed zone can be calculated by the Archie equation too by exchanging R_W and R_t by R_{mf} and R_{xo} respectively. As the water saturation of the uninvaded zone and flushed zone become available, it is possible to indicate the hydrocarbon moveability by moveable hydrocarbon index (MHI) (Cannon, 2015):

$$MHI = R_W / R_{xo} \quad (7)$$

Where: MHI= Moveable hydrocarbon index

R_W= Uninvaded zone water saturation

R_{xo}= Flushed zone water saturation

If the moveable hydrocarbon index value is 1 or higher, this means that the hydrocarbon did not move during the invasion. Whereas, if the value is less than 0.7 (for sandstone) that indicates the movement of hydrocarbon during invasion (Asquith and Krygowski, 2004).

10. Bulk volume of water (BVW)

The bulk volume of water is used to determine if a reservoir has reached its irreducible water saturation point. Consequently, it will flow free of water during production. (Tiab and Donaldson, 1996). When the values of the bulk volume of water remain constant throughout a zone, that indicates that the zone comprises one type of lithology and it is at irreducible water saturation. The bulk volume of water can be determined from the below equation (Asquith and Krygowski, 2004):

$$BVW = S_w * \phi \quad (8)$$

Where: BVW= Bulk volume of water

S_w= Water saturation

ϕ= Porosity

Also, the bulk volume of hydrocarbon can be found from bellow equation:

$$BVH = S_h * \phi \quad (9)$$

Where: BVH= Bulk volume of hydrocarbon

S_h= Hydrocarbon saturation

ϕ= Porosity

Table 3. Zubair upper shale tops, bottoms, thickness, Gross interval, net reservoir interval, net/gross, porosity and water saturation

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Well name	Top	Bottom	Gross interval	Net Reservoir unit	Net/Gross	PHI	SW
Well A	3198.5	3303.3	104.8	21	0.20	0.09	0.74
Well B	3225.5	3325.5	100	34.8	0.35	0.15	0.43
Well C	3248.9	3344.7	95.8	20.8	0.22	0.1	0.63

Table 4. The Reservoir units' petrophysical properties of the Upper shale members

Well name	Reservoir unit	Top	Bottom	Thickness	PHI	SW	Sh	Sxo	MHI	BVW	BVH	VSH
Well A	Reservoir unit 1	3201	3208.3	7.3	0.03	0.92	0.08	0.93	0.98	0.02	0.00	0.28
	Reservoir unit 2	3224.6	3235.2	10.6	0.14	0.32	0.68	0.34	0.93	0.04	0.09	0.16
	Reservoir unit 3	3247	3250	3	0.09	0.98	0.02	0.96	1.02	0.09	0.00	0.15
Well B	Reservoir unit 1	3229.7	3237	7.27	0.16	0.33	0.67	0.37	0.91	0.37	0.12	0.10
	Reservoir unit 2	3246.8	3261.3	14.44	0.15	0.29	0.71	0.41	0.70	0.43	0.11	0.16
	Reservoir unit 3	3268.2	3281.3	13.09	0.13	0.66	0.34	0.68	0.99	0.87	0.45	0.20
Well C	Reservoir unit 1	3252.4	3258	5.68	0.04	0.83	0.17	0.94	0.85	0.02	0.02	0.32
	Reservoir unit 2	3272.2	3282.1	9.92	0.13	0.27	0.73	0.38	0.7	0.04	0.09	0.24
	Reservoir unit 3	3290.4	3295.6	5.19	0.13	0.8	0.20	0.93	0.92	0.10	0.13	0.09

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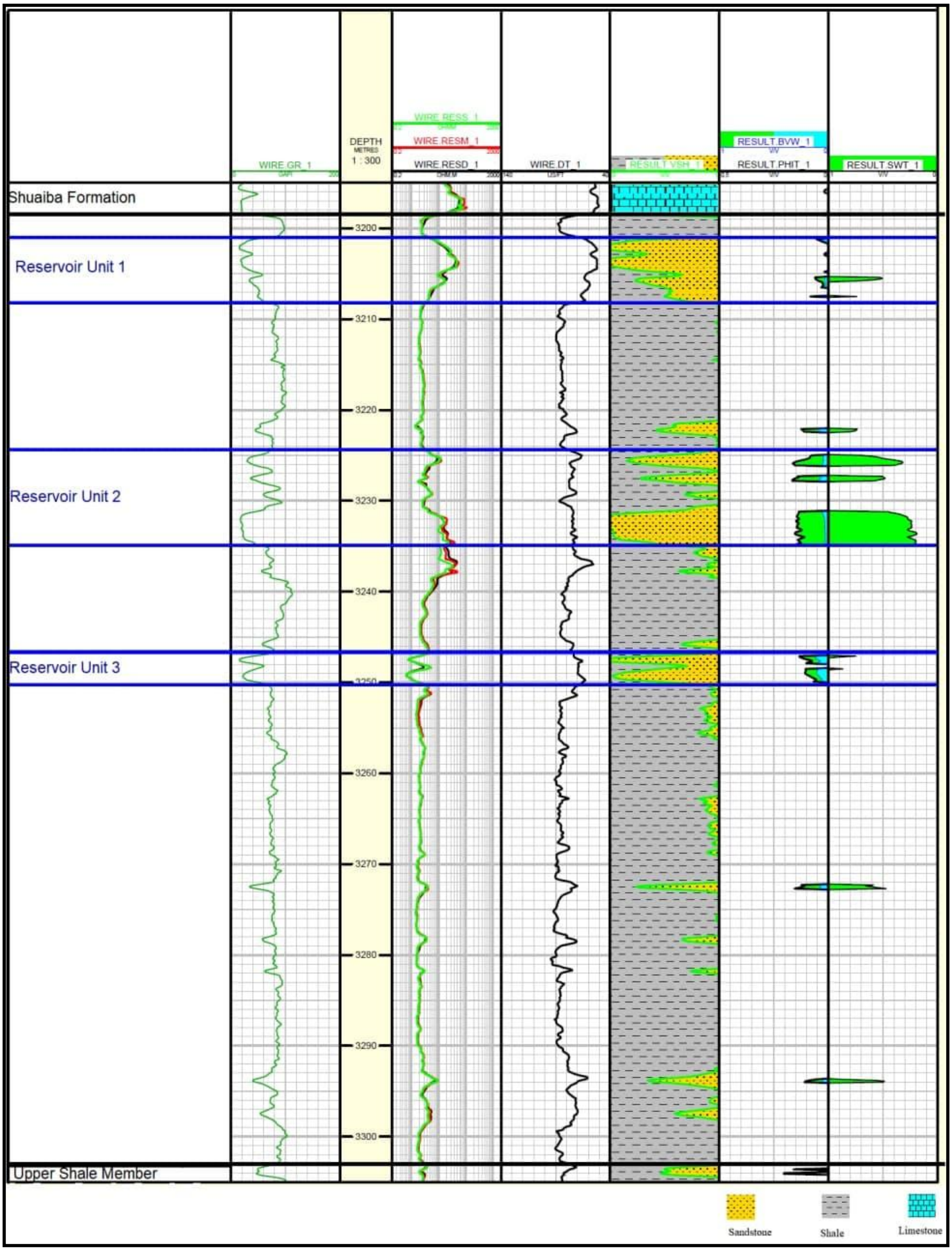

Fig. 5. Open-hole logs and CPI of the well A for the Upper Shale Member, Zubair Formation, Southern Iraq

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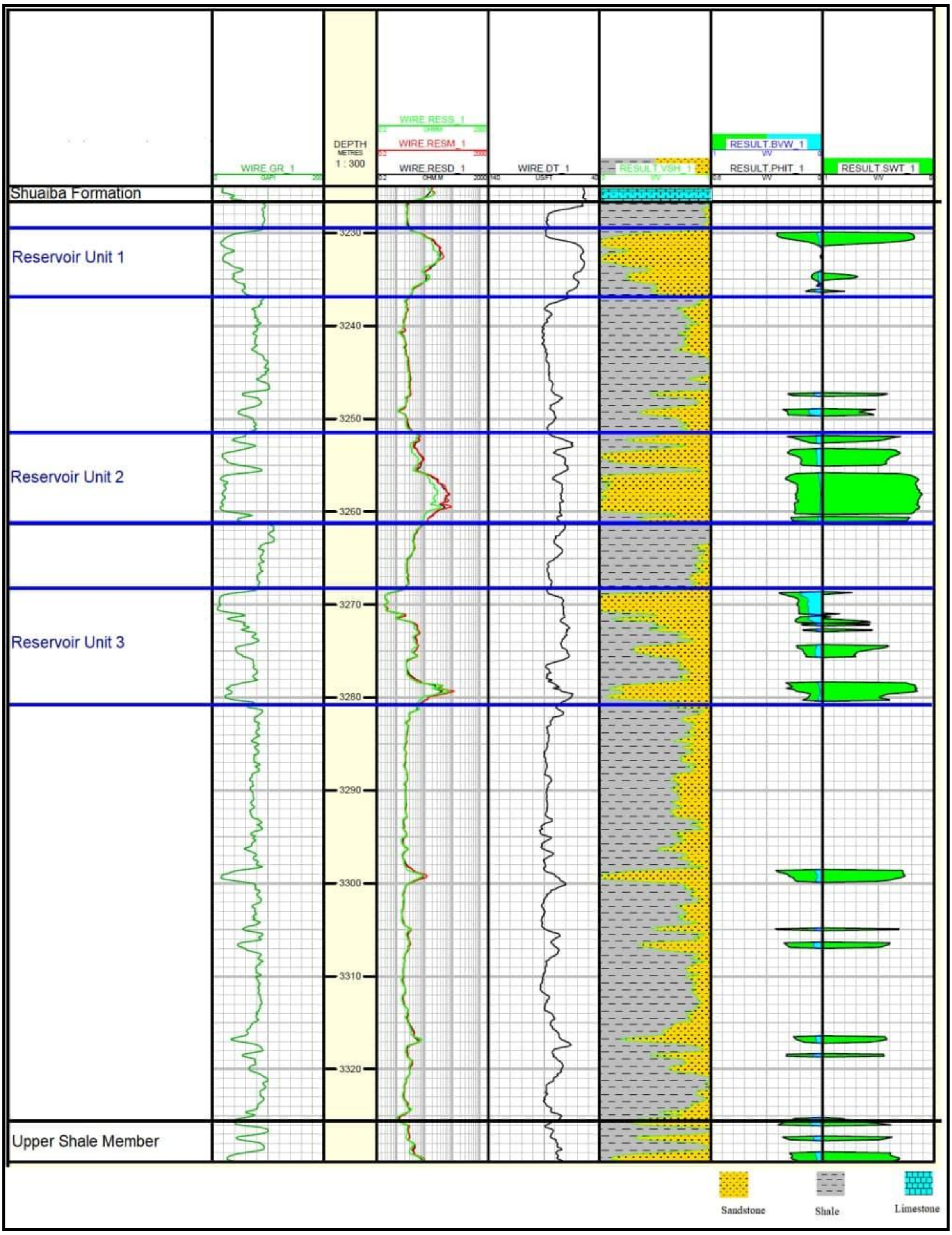

Fig. 6. Open-hole logs and CPI of the well B for the Upper Shale Member, Zubair Formation, Southern Iraq

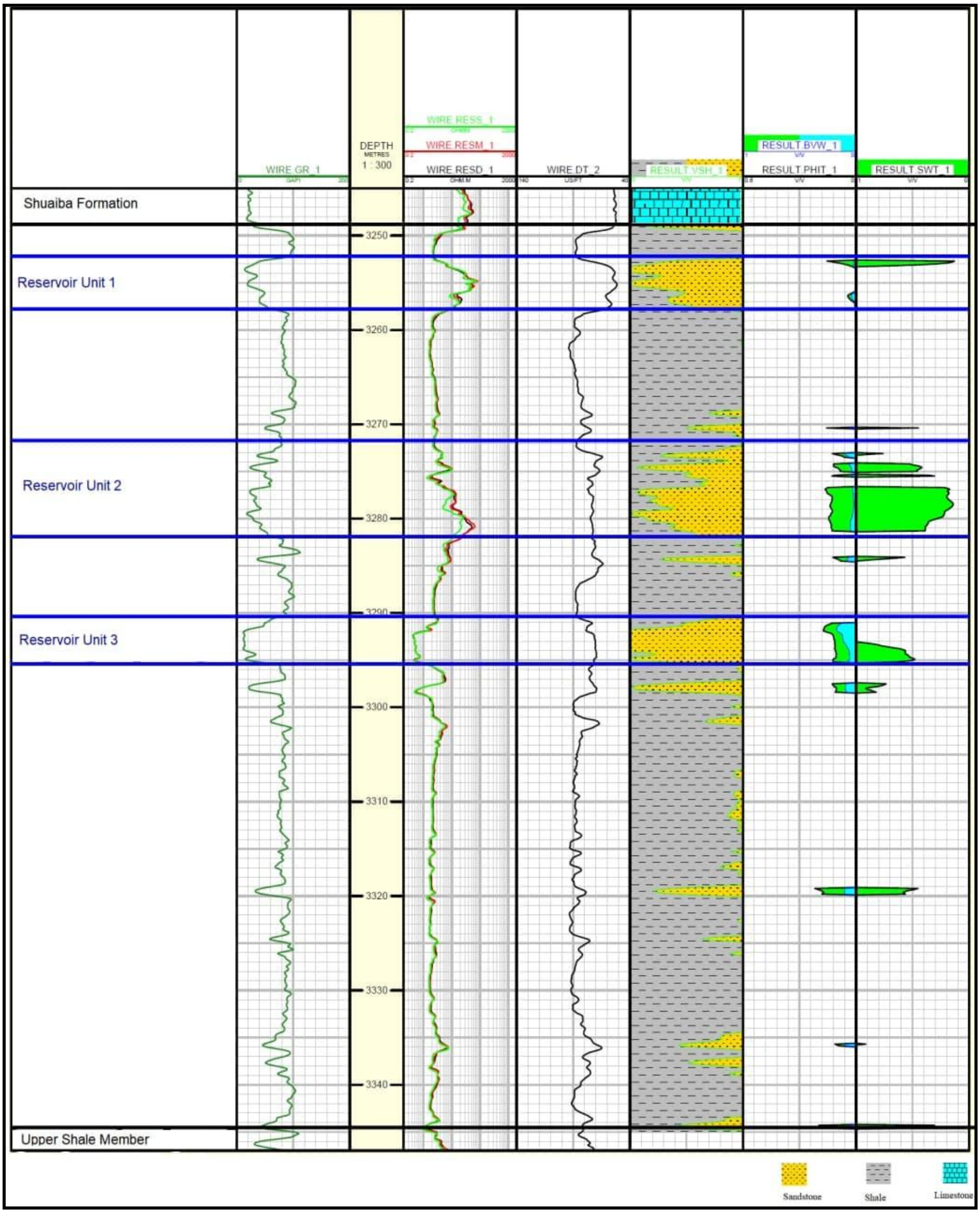

Fig. 7. Open-hole logs and CPI of the well C for the Upper Shale Member, Zubair Formation, Southern Iraq

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11 Results and Discussion

The well log interpretation confirmed that the lithology of the Upper shale units comprises alternation of sandstone and shale in the X field. There were three reservoir units identified in the Upper shale Members of the three studied wells. In all wells, reservoir unit 2 shows the best petrophysical properties. However, the best reservoir characteristics were found in the well B

11.1. Well A: The Upper shale Member top in this well was found at 3198.5m MD and the bottom at 3303.3m MD. The thickness of the Member is 104.8m, and it has three reservoir units:

- **Reservoir unit 1:** The top of the unit was found at 3201 m MD and the bottom at 3208m MD with a thickness of 7m. The VSH value (0.28) indicates that the unit comprises shaly sandstone. The unit has a negligible porosity with average porosity of 0.03. The hydrocarbon saturation in this unit is 0.08. This unit showed bad petrophysical properties, hence no production potential.
- **Reservoir unit 2:** The top of the unit was found at 3224.6 m MD and the bottom at 3235.2m MD with a thickness of 10.6m. The VSH value (0.16) indicates that the unit comprises shaly sandstone. The unit has a fair porosity with average porosity of 0.14. The hydrocarbon saturation in this unit is 0.68. Both of the constant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (93) indicate that the unit has immoveable hydrocarbon and the reservoir at its irreducible water saturation.
- **Reservoir unit 3:** The top of the unit was found at 3247 m MD and the bottom at 3253m MD with a thickness of 3m. The VSH value (0.16) indicates that the unit comprises clean sandstone. The unit has a poor porosity with average porosity of 0.09. The hydrocarbon saturation in this unit is 0.02. Both of the inconstant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (1.02) indicate that the unit has immoveable hydrocarbon and free reservoir water.

11.2. Well B: The Upper shale Member top in this well was found at 3225.5m MD and the bottom at 3325.5m MD. The thickness of the Member is 100m, and it has three reservoir units:

- **Reservoir unit 1:** The top of the unit was found at 3239.7 m MD and the bottom at 3237m MD with a thickness of 7.3m. The VSH value (0.1) indicates that the unit comprises shaly sandstone. The unit has a good porosity with average porosity of 0.16. The hydrocarbon saturation in this unit is 0.67. The inconstant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (0.91) indicate that the unit has immoveable hydrocarbon and free reservoir water.
- **Reservoir unit 2:** The top of the unit was found at 3246.8 m MD and the bottom at 3261.3m MD with a

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thickness of 14.5m. The VSH value (0.16) indicates that the unit comprises shaly sandstone. The unit has a good porosity with average porosity of 0.15. The hydrocarbon saturation in this unit is 0.71. Both of the constant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (0.7) indicate that the unit has moveable hydrocarbon and the reservoir in its irreducible water saturation.

- **Reservoir unit 3:** The top of the unit was found at 3268.2 m MD and the bottom at 3281m MD with a thickness of 13.9m. The VSH value (0.2) indicates that the unit comprises shaly sandstone. The unit has a fair porosity with average porosity of 0.13. The hydrocarbon saturation in this unit is 0.34. The inconstant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (0.99) show that the reservoir has immoveable hydrocarbon and free water, hence the unit will probably produce water.

11.3. Well C: The Upper shale Member top in this well was found at 3248.9m MD and the bottom at 3344.7m MD. The thickness of the Member is 95.8m, and it has three reservoir units:

- **Reservoir unit 1:** The top of the unit was found at 3252.4 m MD and the bottom at 3258m MD with a thickness of 5.68m. The VSH value (0.32) indicates that the unit comprises shaly sandstone. The unit has a negligible porosity with average porosity of 0.04. The hydrocarbon saturation in this unit is 0.17. This unit showed bad petrophysical properties, hence no production potential.
- **Reservoir unit 2:** The top of the unit was found at 3272.2 m MD and the bottom at 3282.1 m MD with a thickness of 9.9m. The VSH value (0.24) indicates that the unit comprises shaly sandstone. The unit has a fair porosity with average porosity of 0.13. The hydrocarbon saturation in this unit is 0.73. The inconstant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (0.7) indicate that the unit has moveable hydrocarbon and free reservoir water, hence the reservoir will produce oil with water.
- **Reservoir unit 3:** The top of the unit was found at 3290.4 m MD and the bottom at 3295.6 m MD with a thickness of 5.19 m. The VSH value (0.09) indicates that the unit comprises clean sandstone. The unit has a fair porosity with average porosity of 0.13. The hydrocarbon saturation in this unit is 0.20. The inconstant values of the bulk volume of water (BVW) throughout the unit and the moveable hydrocarbon index (MHI) value of (0.99) show that the reservoir has immoveable hydrocarbon and free water, hence the unit will probably produce water.

12. Conclusions

1- Upper Shale Member of the Zubair Formation consists of an alternation of sand and shale.

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2- The thickness of the member in the study area ranges between 95-100 m.
3- Upper Shale Member has three reservoir units, and the best petrophysical properties are found in reservoir unit 2, where the average porosity is 14% and the average hydrocarbon saturation is 70%. The average porosity in reservoir unit 1 is 5% and the average hydrocarbon saturation is 31%. While the average porosity and hydrocarbon saturation in the reservoir unit3 is 11% and 19% respectively.
4- The well B has the best petrophysical properties because it has the largest net reservoir units (35m), best average porosity (15%) and hydrocarbon saturation (53%).

References

Abdulnaby, W., 2019. Structural geology and neotectonics of Iraq, Northwest Zagros. In Developments in structural geology and tectonics, Vol. 3, pp. 53-73. Elsevier.

Al- Meri, T.K., & Batten, D.J., 1997. Palynomorph and palynofacies indication of age, depositional environment and source potential for hydrocarbon: Lower Cretaceous, Zubair Formation, southern Iraq, Cretaceous research:18, 789-797.

Al-Mutury, W., Al-Asadi, M., 2008. Tectonostratigraphic history of Mesopotamian passive margin during mesozoic and cenozoic, South Iraq. J Kirkuk Univ—Sci Stud 3(1):31–50.

Al-Azzawi, 2012. The Petroleum System of Zubair Formation in Selected Oil Fields-Southern Iraq. A Thesis Submitted to the College of Science, University of Baghdad, 197 P.

Al-Jaberi, M. H., & Al-Mayyahi, H. K, 2018. Wireline logging response and true core analysis of the Upper Shale Member of Zubair Formation, Rumaila Oilfield, Southern Iraq. The Iraqi Geological Journal: 51, 28-40.

Al-Jafar M. K. & Al-Jaberi M. H, 2019. Well logging and electrofacies of Zubair formation for Upper Sandstone Member in Zubair oil field, southern Iraq. Iraqi Geological Journal, 52, 101-124.

www.misan-jas.com (Arabic Impact Factor) - 1.1 ISSN (Paper)-1994-697X (Online)-2706-722X

Al-Rubaye H. H., Gayara A. D., & Al-Zaidy A. A, 2019. Facies Analysis and Stratigraphic Development of the Zubair Formation in the Mesopotamian Zone, Southern Iraq. Iraqi Journal of Science, 60, 290-307.

AL-Shahwan, M. F., AL-Yasiri, A. A., & Saqer, M. H, 2018. Petrophysical properties of the reservoir unit (1C) for Upper Shale Member from Zubair formation in Luhais field. Iraqi Journal of Science: 59, 1936-1949.

Al-Shawi, Z., Mahdi M., Mohammed A., 2019. New records of planktonic foraminifera in the Shuaiba Formation (Aptian Age), Mesopotamian plain, South of Iraq, Iraqi Journal of Science, Vol. 60, No.6, pp: 1322-1335.

Al-Tool, Z. M., Almallah, I. A., & Al-Najm, F. M., 2019. Petrophysical properties evaluation using well logging of the upper sand member of Zubair Formation in Zubair oil Field, Southern Iraq. Basrah Journal of Science,37, 456-480.

Aqrawi, A.A., Göff, J.C., Horbury, A.D., and Sadooni, F.N., 2010. The Petroleum Geology of Iraq. Scientific Press, 424.

Asquith, G. B., Krygowski, D., 2004. Basic well log analysis. Tulsa: American Association of Petroleum Geologists.

Cannon S., 2016. Petrophysics: A practical guide. Chichester: John Wiley & Sons, Ltd, 224 P.

Douban, A. F., & Medhadi, P, 1999. Sequence chronostratigraphy and petroleum systems of the Cretaceous Megasequences, Kuwait. AAPG international conference and exhibition,152-155.

Handhal A. M., Jawad S. M., Al-Abadi A. M. 2019. GIS-based machine learning models for mapping tar mat zones in upper part (DJ unit) of Zubair Formation in North Rumaila supergiant oil field, southern Iraq. Journal of Petroleum Science and Engineering, 178, 559–574.

Handhal A. M., and Mahdi M M., 2016. Basin modeling analysis and organic maturation for selected wells from different oil fields, Southern Iraq, Model. Earth Syst. Environ. 2:189.

Hilchie, D. W.,1978. Applied open hole log interpretation. Golden, Colorado, D. W. Hilchie Inc, 350 P.

Idan, R. M., Faisal, R. F., Nasser, M. E., Al-Ameri, T. K., & Al-Rawi, D. 2014. Hydrocarbon potential of Zubair Formation in the south of Iraq. Arabian Journal of Geosciences, 7, 4805-4817.

Jassim, S.Z., & Goff, J.C., 2006. *Geology of Iraq*. Dolin, Prague and Moravian Museum, Czech Republic, p 341.

Liu, H. 2017. Principles and applications of well logging. Berlin. Springer Mineralogy.

Numan, N.M.S.,1997. A plate tectonic scenario for the phanerozoic, succession in Iraq, Jour. Geol. Soc. Iraq, Vol. 30, PP.85-110.

Sadooni, F. N., & Aqrawi, A. A., 2000. Cretaceous sequence stratigraphy and petroleum potential of the Mesopotamian basin, Iraq, Special Publications of SEPM, 315-334.

Tiab, D., & Erle C. D. ,2015. Petrophysics: Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties. Gulf professional publishing.

Wyllie, M. R. J. Gregory, A. R., and Gardner H. F, 1958. An experimental investigation of the factors affecting elastic wave velocities in porous media. Geophysics, 23, 459-493.

تحديد أفضل الوحدات المكمنية للعضو السجيلي العلوي لمكمن الزبير من خلال بعض المواصفات البيتروفيزيائية جنوب العراق

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المستخلص

يعتبر تكوين الزبير المكمن الرئيسي للهيدروكربون في حقول المنطقة الوسطى والجنوبية للعراق. ويعد مكمن مهم جدا بسبب مواصفاته البتروفيزيائية الجيدة. يحتوي التكوين على خمسة أعضاء رئيسية وهي: العضو السجيلي العلوي والعضو الرملي العلوي والعضو السجيلي المتوسط والعضو الرملي السفلي والعضو السجيلي السفلي. يركز هذا العمل على العضو السجيلي العلوي لتوين الزبير في الحقل-X في جنوب العراق.

تم اختيار ثلاثة ابار وهي (A وB وC) لتقييم المواصفات البتروفيزيائية للعضو السجيلي العلوي في منطقة الدراسة. تم استخدام برنامج الـ Geolog لحساب تلك المواصفات. اثبتت التحليلات التي أجريت على سلوك المجسات (مجس اشعة كاما والمجس الصوتي ومجسات المقاومة) بان العضو السجيلي العلوي يقسم الى ثلاث وحدات مكمنيه معزولة بطبقات من السجيل. يتراوح سمك العضو في منطقة الدراسة بين ٩٥ – ١٠٠ متر. تم حساب المواصفات البتروفيزيائية كحجم السجيل والمسامية والتشبع المائي وحجم الماء للوحدات المكمنية حيث اظهرت الوحدة المكمنية (Reservoir unit 2) أفضل المواصفات وكانت أفضل المواصفات موجودة في البئر B.

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