Iraqi Geological Journal

Journal homepage: https://www.igj-iraq.org

Reservoir Evaluation for Mishrif Formation in R Oil Field, Southern Iraq

Miqat A. Al-Rawi[1*], Basim F. Al-kubaisi[1], and Fahad M Al-Najm[2]

1 Department of Applied Geology, College of Science, University of Anbar, Anbar, Iraq
2 Department of Geology, College of Science, University of Basra, Basra, Iraq
* **Correspondence**: miq23s4004@uoanbar.edu.iq

Received:
14 February 2026
Accepted:
14 May 2026
Published:
30 June 2026

Abstract

The Mishrif Formation is one of the major carbonate reservoirs at R Oil Field, southern Iraq. The current study sought to evaluate the petrophysical and reservoir properties of this formation. Resistivity, gamma-ray, spontaneous potential, sonic, density, neutron, and caliper logs from seven wells (M1, M2, M3, M4, M5, M6, and M7) have been used. Porosity has been calculated in its different types (primary, total, and secondary), as well as effective porosity. Other petrophysical parameters that were calculated include shale volume, water saturation, oil saturation, both movable and residual. The Mishrif Formation contains two major reservoirs, MA and MB. It is separated by a sealing unit (CR II). MB is the second reservoir unit, further divided into two subunits, MB1 and MB2, based on the main well logs using Techlog 2015.3. Unit MA has low shale volume. The percentage ranges between(0.04-0.16) gives moderate values for effective porosity(0.09-0.24), and results in favorable hydrocarbon saturation(0.59-.0.83). This indicates good reservoir quality, supported by high movable oil saturation and low residual oil saturation. The second reservoir unit, MB, exhibits good, variable reservoir characteristics. The MB1 subunit has low shale (0.02-0.12), good effective porosity (0.13-0.27), good oil saturation (0.48-0.68), high movable oil, and low residual oil saturation, except for well M4, which recorded 81% residual oil. The MB2 subunit is characterized by excellent effective porosity (0.18-0.26) and low shale content (0.05-0.16). However, the oil saturation is lower (0.44-0.66) than in the previous two units. Reservoir quality is best for MA, followed by MB1. The lower subunit MB2 has a lower-quality reservoir. The best reservoir is in well M1, which is near the crest of the structure. Well M2, located in the southern part of the field, has the worst reservoir among those wells studied.

Keywords: Mishrif Formation; Reservoir Evaluation; Petrophysical Properties; Well Log Interpretation; Carbonate Reservoir; Southern Iraq

1. Introduction

Petrophysics is a fundamental science for the appraisal of hydrocarbons and is particularly significant for reservoir characterization and understanding rock-fluid relationships (Tiab & Donaldson, 2024). Accurate characterization of subsurface reservoirs depends on petrophysical interpretation, an important tool for controlling reservoir behavior and understanding the distribution of its properties. Well log data provide full information about the entire section, including the physical properties of different layers and rock units, as reflected in resistivity, gamma-ray, and other supporting petrophysical indicators (Lai et al, 2022).

The Mishrif Formation is one of the richest hydrocarbon-bearing formations, articulating the special position that Cretaceous rocks occupy in Iraq (Al-Heeti et al., 2023). This has therefore attracted

much attention to studies of oil fields located in southern Iraq, particularly in the Basra, Amara, and Nasiriyah regions. Due to its economic importance, large oil reserves, and production levels, this formation is among the main reservoirs in southern Iraq, ranking second after the Zubair Formation (Al-Najm et al., 2013). Geological and petrophysical conditions were addressed by several studies for their significant role in regional oil production systems (Al-Heeti et al., 2023; Al-Kanaani, 2025; Radhi et al., 2025). The aims of this research are to evaluate the petrophysical and reservoir properties of the Mishrif Formation at the R Oil Field in southern Iraq.

1.1. Study Area

The R Oil Field is located in Basra Governorate (southern Iraq), approximately 70 km northwest of Basra city, adjacent to the North Rumaila Oil Field, and about 20 km west of it. The field extends between the coordinates (E 705,000.4 - 696,000.36 m) and (N 3,394,000.183 - 3,373,000.8 m), between latitudes (30.48°–30.67° North) and longitudes (47.33°–47.43° East) (Fig. 1). The field is approximately 27 km long and 13 km wide. The study area is concentrated in the central and northern parts of the field, where most of the current production wells are located. The site is characterized by relatively gentle topography and prominent Mishrif Formation reservoir layers, which constitute the primary focus of the reservoir studies in this research.

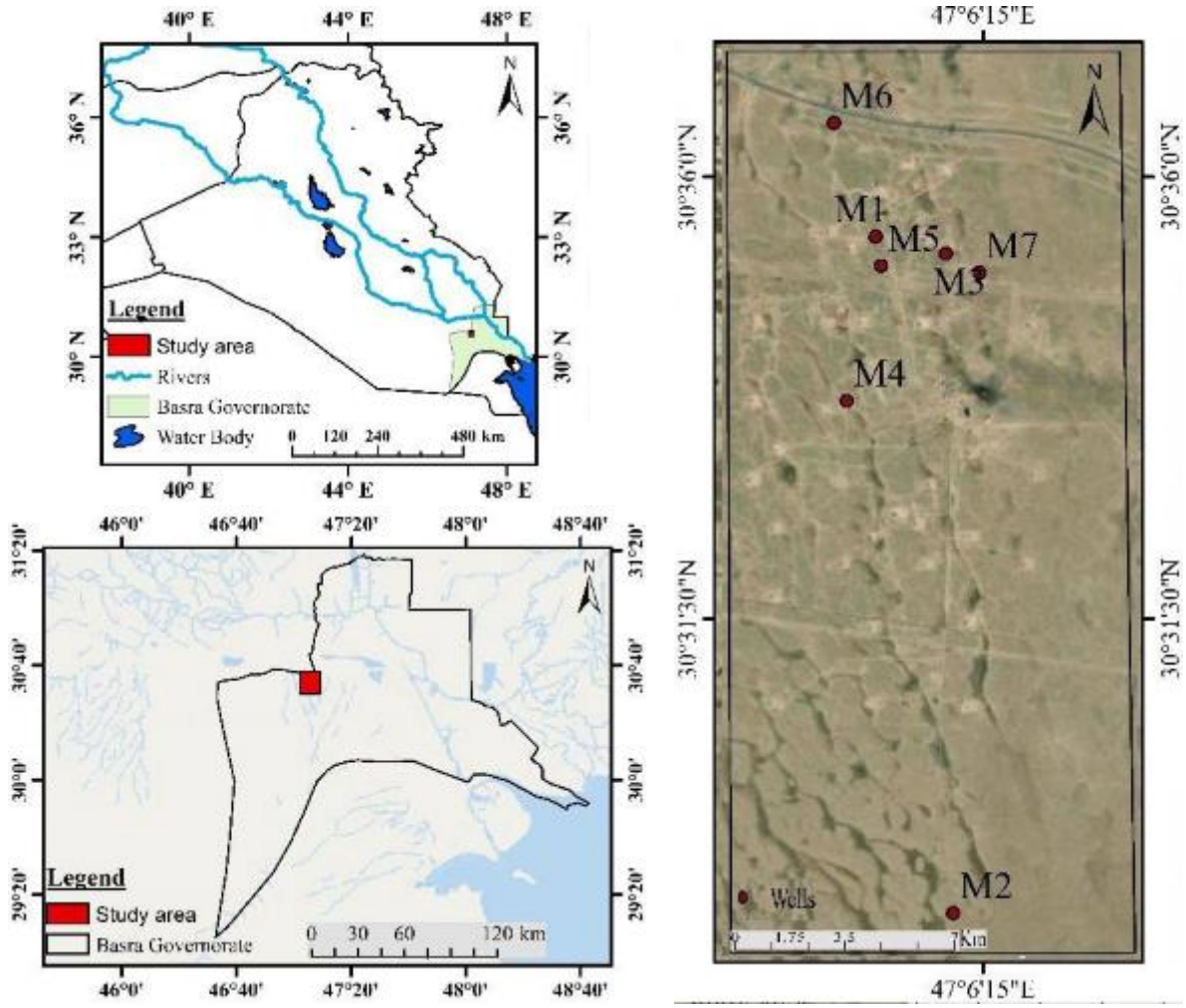
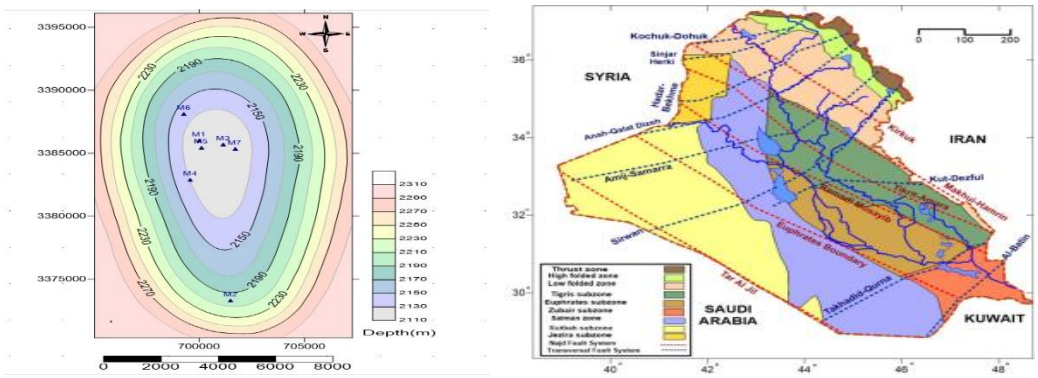


Fig.1. Location map of the study area and oil wells

1.2. Geological and Tectonic Setting

The R Oil Field is structurally located in the Zubair sub-zone on the Stable Shelf Unit in southern Iraq, within a north-south-trending anticlinal structure developed by successive tectonic phases. Stratigraphic succession (Jurassic to Triassic) has been encountered in this field, with the main reservoir being the Mishrif Formation, deposited in shallow marine to reefal environments. The Rumaila Formation lies conformably at its base, while it is unconformably overlain by the Khasib Formation (Jassim & Goff, 2006). A field develops under conditions of geological evolution, generating hydrocarbon potential as much as exploration and production activities do. It is structurally limited from the north and south by Takhadid Qurna and Al-Batin transversal faults, respectively, and belongs to the Basra Block. The general structure of this field appears very homogeneous, due to basement control over structural development. With depth, structures oriented north-south are uplifted, reaching about 300 m at Lower Cretaceous horizons (Fig. 2). Seismic survey results indicate that the field's structural configuration forms an elongated oval anticline trending north-south, with nearly symmetrical flanks showing increasing dip with depth. Based on available geological and geophysical data, structural effects associated with salt-related features from the Hormuz sequence of the Lower Precambrian are inferred. This reflects a complex geological and tectonic evolution that has enhanced the field's potential for hydrocarbon exploration and production (Jassim & Goff, 2006; Al-Kanaani, 2025).



a b

Fig. 2. a) Structural contour map of the top of the Mishrif Formation; b) tectonic map of Iraq showing the location of the study area, modified after Jassim and Goff (2006)

2. Materials and Methods

This study was conducted to evaluate the petrophysical and reservoir properties of the Mishrif Formation in the R Oil Field, southern Iraq. Seven oil wells were selected for this research (M1, M2, M3, M4, M5, M6, and M7) **(**Table 1**).** The acquired data were primarily processed in Microsoft Excel 2010 using specific mathematical equations for each logging tool type. After that, the data were exported to Techlog 2015 and used for elaborated petrophysical analysis and interpretation.

Resistivity, gamma-ray, spontaneous potential, sonic, density, neutron, and caliper logs from seven wells (M1, M2, M3, M4, M5, M6, and M7) have been used. Porosity has been calculated for the different types (primary, total, and secondary), as well as for effective porosity. Other petrophysical parameters that were calculated include shale volume, water saturation, oil saturation, both movable and residual.

The behavior of the various logging tools and their interrelationships was evaluated through qualitative interpretation. In parallel, quantitative interpretation was carried out to derive major petrophysical parameters, including shale volume, effective porosity, movable oil saturation (MOS) and residual oil saturation (ROS), and bulk hydrocarbon volume (BVh). Based on these results, the main

reservoir units within the field and the intervening barrier layers between them are identified and characterized, along with the directions of enhanced reservoir properties delineated.

Table 1. The top and bottom of the Mishrif Formation in the studied wells

Well No.	Top (m)	Bottom (m)	Thickness(m)
M1	2080	2236	154
M2	2195	2336	141
M3	2070	2259.5	189.5
M4	2094	2231.5	137.5
M5	2112	2256	144
M6	2100	2235	135
M7	2082	2265	185

3. Results and Discussion

3.1. Qualitative Interpretation

A cross-plot between porosity and bulk density was constructed, revealing that limestone is the dominant lithology in most wells of the Mishrif Formation. However, dolomite was observed in wells M1 and M5, indicating that dolomitization has affected parts of the reservoir. This can be attributed to diagenetic processes involving the circulation of magnesium-rich fluids through carbonate rocks, leading to the replacement of calcite by dolomite and the development of intercrystalline porosity, which, in turn, enhances reservoir properties in these wells.

The qualitative analysis of the relationship between the gamma-ray (GR) log and the bulk density (RHOB) log indicates that clean limestone is the dominant lithology of the Mishrif Formation in the studied field, as evidenced by the low gamma-ray responses. Some portions of the formation exhibit a shift toward more argillaceous limestone, reflecting an increase in clay content. This interpretation is supported by comparisons with other well log readings and petrophysical calculations, as illustrated in Figs. 3,4,5, and 6, which demonstrate a high degree of consistency between the qualitative interpretation and the petrophysical properties of the reservoir

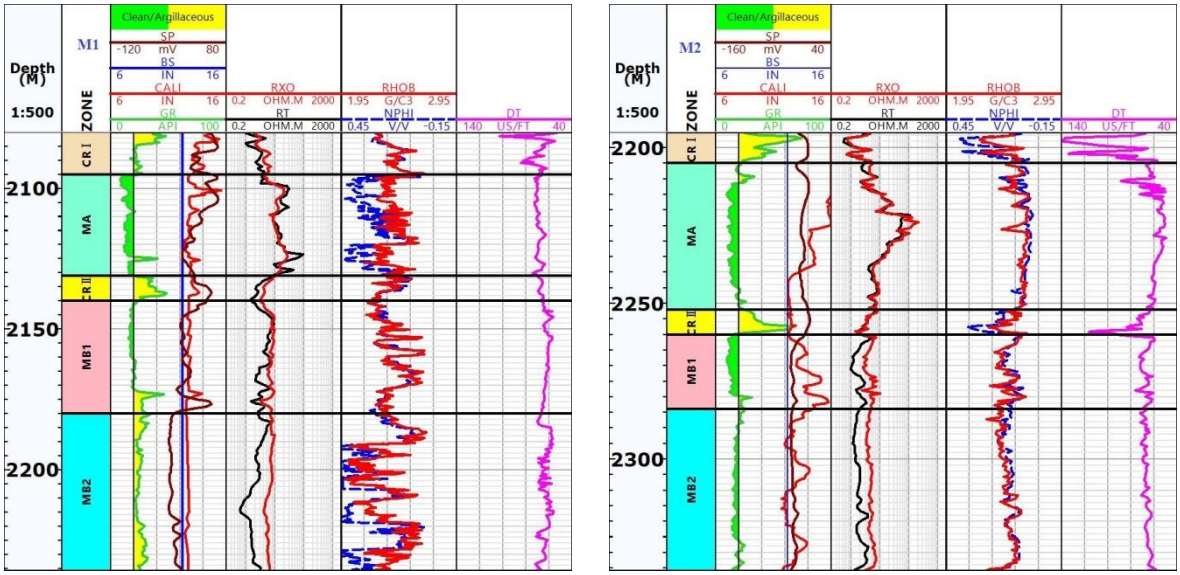


Fig.3. The behavior of oil well logs for the Mishrif Formation in the M1 and M2 wells

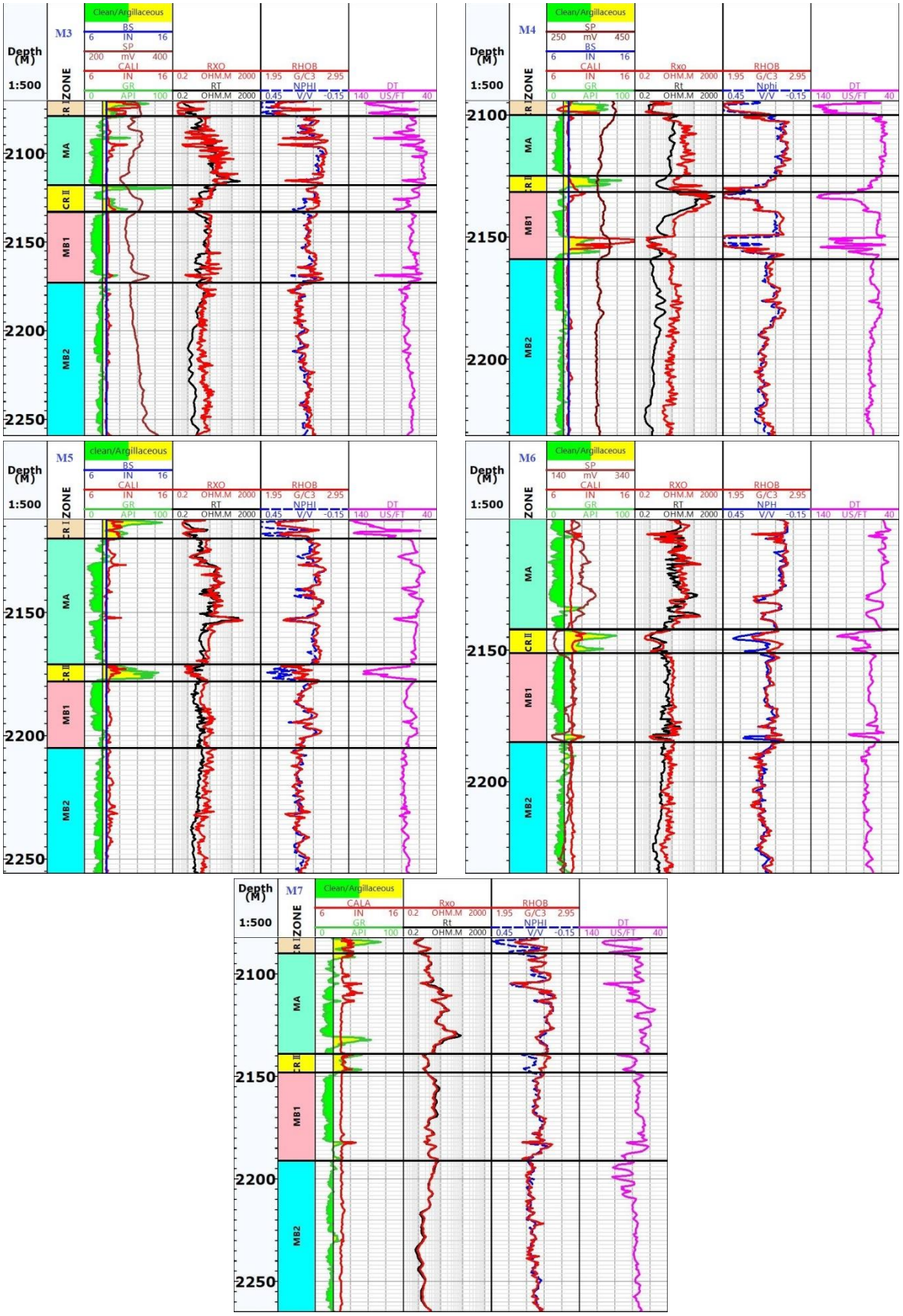


Fig. 4. The behavior of oil well logs for the Mishrif Formation in the M3, M4, M5, M6, and M7 wells

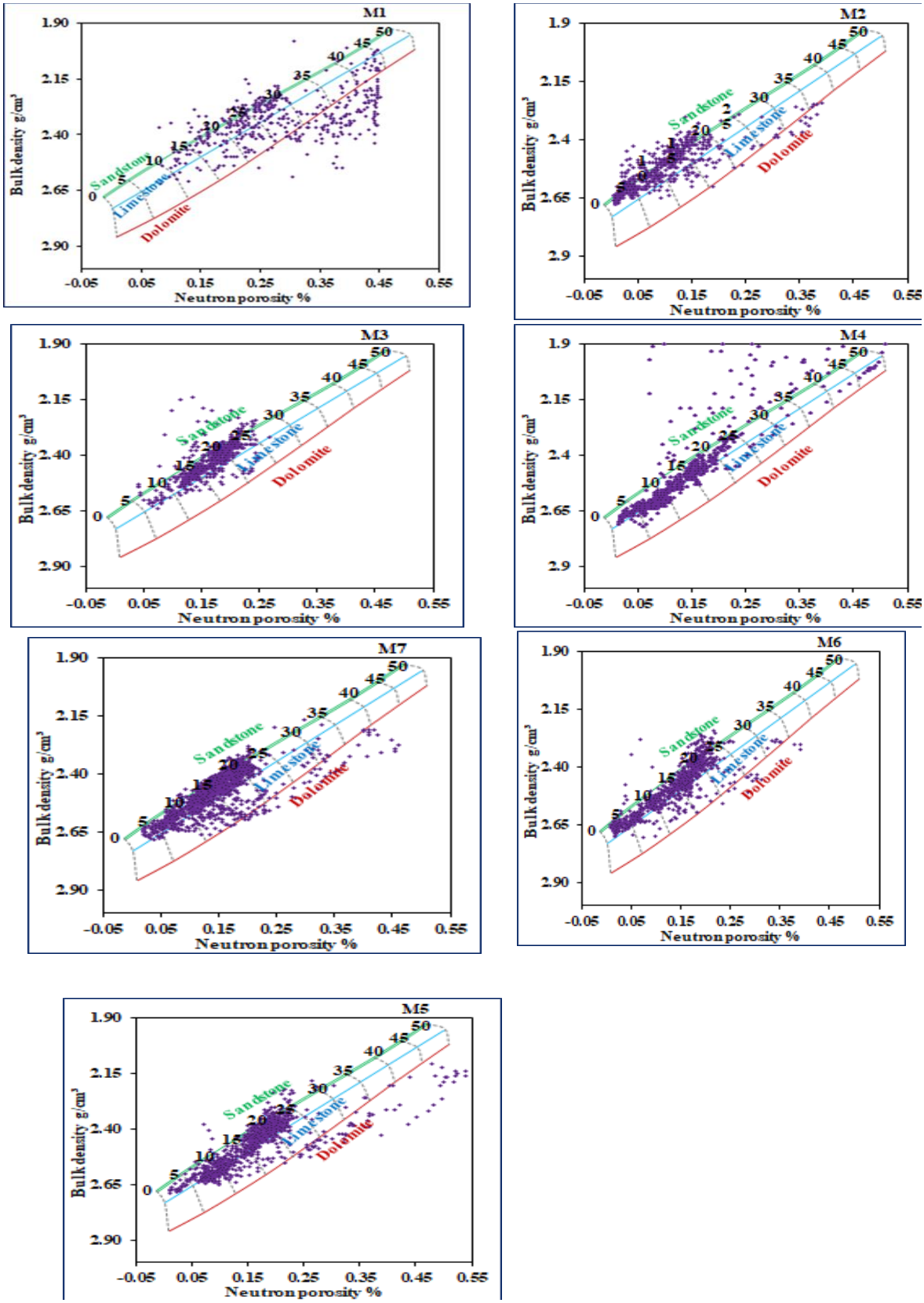


Fig. 5. Neutron-Density cross plot of the Mishrif Formation in wells M (1,2,3,4,5, 6, & 7)

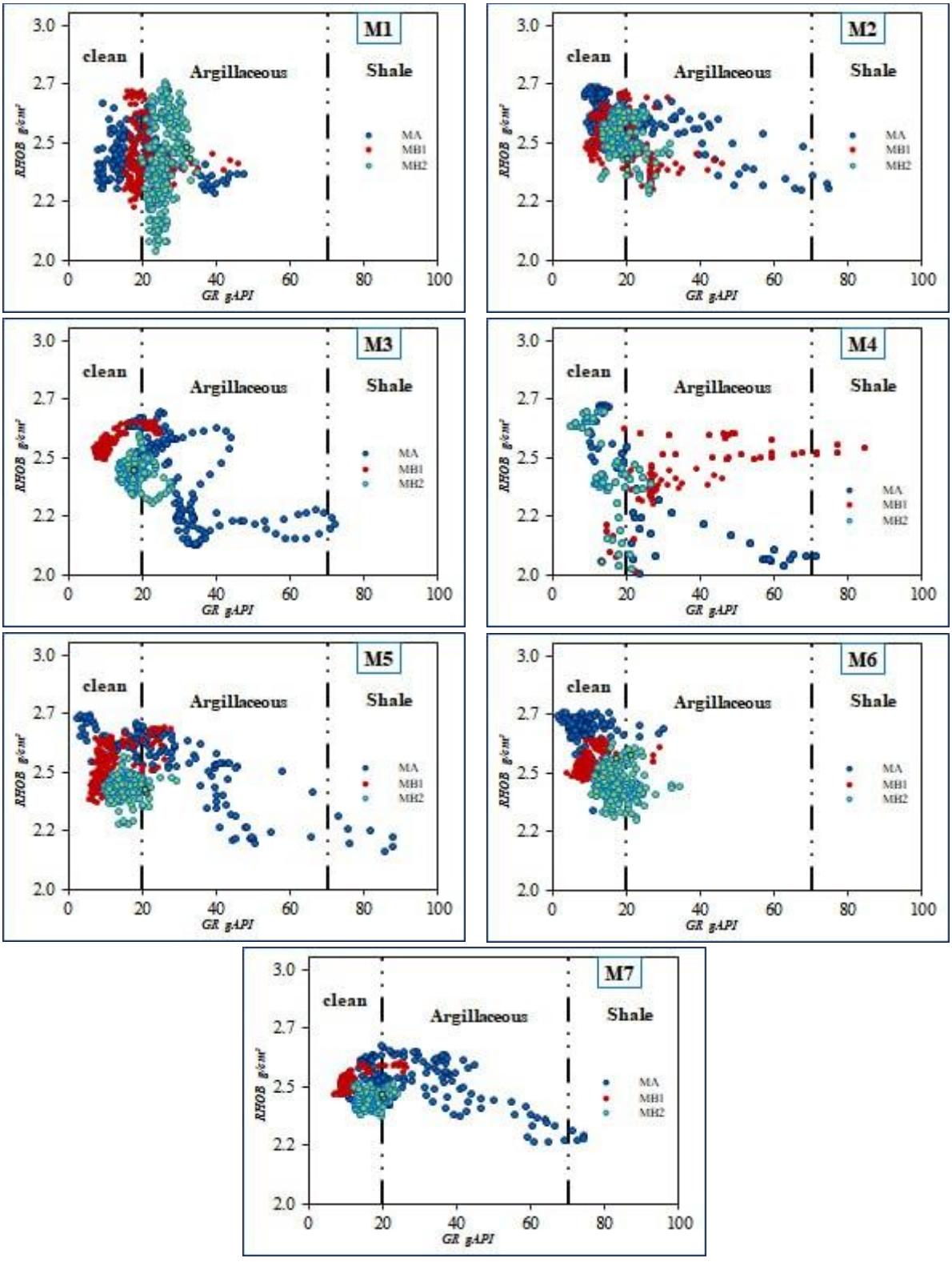


Fig. 6. Relationship between the density (RHOB) and the gamma ray (GR) logs for the M1, M2, M3, M4, M5, M6, and M7 wells

3.2. Quantitative Interpretation

The available data extracted from the well logs of the study area were entered into Excel (2010) to calculate the petrophysical properties of the Mishrif Formation. Subsequently, these data were

visualized and analyzed using Techlog (2015). The petrophysical properties determined for the studied wells in the R field included the following:

3.2.1. Shale volume (Vsh)

Several well logs can be used to estimate the amount of shale in a rock Formation. Specifically, this research used gamma-ray logs to determine shale volume (Asquith et al., 2004).

$$I_{GR} = \frac{GR_{log-}GR_{min}}{GR_{max-}GR_{min}} \quad (1)$$

$$V_{sh} = 0.33 \times \left[2^{(2\times IGR)} - 1.0\right] \quad (2)$$

Where IGR: the gamma ray index; GRlog: the actual gamma ray log reading from well log (in API units); GRmin: the minimum gamma ray value for clean sand (API); GRmax: the maximum gamma ray value for shale (API); Vsh: computed shale volume.

3.2.2. Porosity (Φ)

Porosity has long been considered the key parameter for defining a reservoir's (i.e., a geological Formation's) ability to contain fluids, both hydrocarbons and water. This study evaluated multiple porosity types, including primary porosity (ΦSonic), secondary porosity (SPI), total porosity (ΦT), and effective porosity (Φeff).

Primary (ΦSonic) and Secondary Porosity (SPI)

Secondary Porosity in the formation can be calculated from Sonic log data based on an estimate of Primary Porosity (Wyllie et al. 1958; Schlumberger 1997).

$$\Phi_{Sonic} = \frac{\Delta t_{log}-\Delta t_{ma}}{\Delta t_{f}-\Delta t_{ma}} \quad (3)$$

$$SPI = \Phi_{N-D} - \Phi_{Soinc} \quad (4)$$

Where: ΦSonic: sonic derived porosity; Δtlog: interval transit time of formation (μsec/ft); Δtma: interval transit time through the matrix (μsec/ft); Δtf: interval transit time through the fluid in μsec/ft (fresh mud=189, salt mud=185); SPI: secondary porosity index.

Total Porosity (ΦN-D) and Effective Porosity (Φeff)

Porosity is considered a fundamental rock property, as it reflects the capacity to store fluids and facilitate fluid flow (Tiab & Donaldson, 2024). The total porosity was calculated after removing the shale effect (Vsh ≥ 10%) using Schlumberger relationships (Schlumberger, 1997) :

$$\Phi_{Den.} = \frac{\rho_{ma}-\rho_{b}}{\rho_{ma}-\rho_{f}} \quad (5)$$

$$\Phi_{N-D} = \frac{\Phi_{N}-\Phi_{D}}{2} \quad (6)$$

$$\Phi_{eff.} = \Phi_{N-D} \times (1 - V_{sh}) \quad (7)$$

Where: ΦDen.: Density-derived Porosity; ρma: matrix density (2.71 g/cm³); ρb: Bulk density of the formation (g/cm³); ρf: density of fluid (1.1 g/cm³ for Salt Mud, 1.0 g/cm³ for Fresh Mud, and 0.7 g/cm³ for Gas); ΦN-D: Neutron Density Porosity; ΦN: Neutron Porosity; Φeff.: Effective porosity corrected for shale content.

3.2.3. Water saturation (Sw)

Archie's equations (Archie, 1942) were employed to estimate water saturation in the uninvaded zone (Sw) and the flushed zone (Sxo):

$$Sw = \sqrt{\frac{R_w \cdot F}{R_t}} \quad (8)$$

$$Sxo = \sqrt{\frac{R_{mf} \cdot F}{R_{xo}}} \quad (9)$$

Where: R: formation water resistivity, =0.019 It was obtained from the Basra Oil Company F: formation factor, R: deep resistivity (Ω·m), R : resistivity of the mud filtrate at formation temperature, R: resistivity in flushed zone.

$$F = \frac{a}{\varphi^m} \quad (10)$$

Where

a = tortuosity factor = (1) for Limestone rocks.

m = cementation factor = (2) for Limestone rocks.

3.2.4. Hydrocarbon Saturation (Sh) and Bulk Volumes of Water and Hydrocarbons (BVW, BVh)

Hydrocarbon saturation was calculated from its inverse relationship with water saturation (Al-Musawi et al., 2018)

$$Sh = 1 - Sw \quad (11)$$

$$BVW = Sw \cdot \Phi_t \quad (12)$$

$$BVh = Sh \cdot \Phi_t \quad (13)$$

Where: *Sh*: hydrocarbon saturation, *Sw*= water saturation, Φ= total porosity, *BVW*= bulk volume of water, *BVh*= bulk volume of hydrocarbons.

3.2.5. Movable Oil Saturation (MOS) and Residual Oil Saturation (ROS):

Schlumberger relationships and other empirical correlations were used to determine the movable and residual oil saturations (Yonus et al., 2022):

$$MOS = Sxo - Sw \quad (14)$$

$$ROS = 1 - Sxo \quad (15)$$

Where: MOS: movable oil saturation, ROS= residual oil saturation, Sw= water saturation in the uninvaded zone, Sxo= water saturation in the flushed zone.

3.3. Reservoir Units in the Mishrif Formation

Based on the petrophysical analysis of spatial properties derived from the well logs of the seven wells in the study area, the Mishrif Formation was subdivided into reservoir and non-reservoir (barrier) units. This classification was carried out using these properties in Techlog 2015, as illustrated in the accompanying Figs. 7, 8, and 9.

3.3.1. CRI unit.

This unit is a barrier layer composed of shaly rocks at the top of the Mishrif Formation. An unconformity exists between this unit and the overlying productive formation.

3.3.2. MA unit

The MA unit comprises the uppermost reservoir interval of the formation. The rocks in it have relatively low shale volume (Vsh) values between (0.04-0.16), with effective porosity (Φeff.) values from moderate to good between (0.11-0.24), except well M2, which recorded relatively low porosity

(0.09). This unit also reflects a favorable average hydrocarbon saturation, Sh, with values between (0.59-0.83), as shown in Table 2, showing its capability for hydrocarbon storage and productivity.

Table 2. Petrophysical properties of the MA reservoir unit

Well	Vsh	Φ eff.	Sh	MOS	ROS	Bvo
M 1	0.06	0.24	0.83	0.47	0.36	0.20
M 2	0.08	0.09	0.59	0.50	0.08	0.05
M 3	0.04	0.14	0.63	0.57	0.05	0.09
M 4	0.05	0.12	0.59	0.54	0.05	0.08
M 5	0.06	0.11	0.60	0.50	0.11	0.07
M 6	0.05	0.12	0.69	0.53	0.16	0.09
M 7	0.16	0.12	0.62	0.59	0.03	0.09

3.3.3. CRII unit

This unit represents a barrier layer composed of shaly rocks, as indicated in the logs, separating two potential units: the overlying MA unit and the underlying MB1 reservoir unit.

3.3.4. MB unit

The MB unit represents the lower reservoir interval within the formation and is further subdivided into two sub-units:

- MB1 Unit

This unit exhibits shale volume ranging from(0.02- 0.17), with effective porosity values ranging from moderate to good (0.13-0.27) and average hydrocarbon saturation between (0.48- 0.81) (Table 3).

Table 3. The petrophysical properties of the reservoir unit (MB1)

Well	V_{sh}	$\Phi_{eff.}$	S_h	MOS	ROS	Bvo
M 1	0.12	0.20	0.68	0.55	0.13	0.15
M 2	0.09	0.14	0.48	0.48	0	0.07
M 3	0.02	0.13	0.59	0.59	0	0.08
M 4	0.17	0.27	0.81	0.36	0.45	0.27
M 5	0.06	0.17	0.51	0.50	0.01	0.09
M 6	0.07	0.14	0.59	0.59	0	0.09
M 7	0.06	0.14	0.59	0.59	0	0.09

MB2 Unit

Representing the lower part of the reservoir, this unit is characterized by shale volume content ranging from 0.05 to 0.16, moderate to high porosity compared to other units (0.18 to 0.26), and average hydrocarbon saturation values ranging from 0.44 to 0.66 (Table 4).

Table 4. The petrophysical properties of the reservoir unit (MB2)

Well	V_{sh}	$\Phi_{eff.}$	S_h	MOS	ROS	Bvo
M 1	0.16	0.26	0.66	0.35	0.30	0.20
M 2	0.06	0.18	0.44	0.44	0.01	0.08
M 3	0.05	0.19	0.58	0.56	0.02	0.11
M 4	0.08	0.18	0.48	0.39	0.10	0.09
M 5	0.08	0.19	0.55	0.51	0.03	0.11
M 6	0.11	0.18	0.55	0.52	0.02	0.10
M 7	0.10	0.19	0.60	0.60	0	0.11

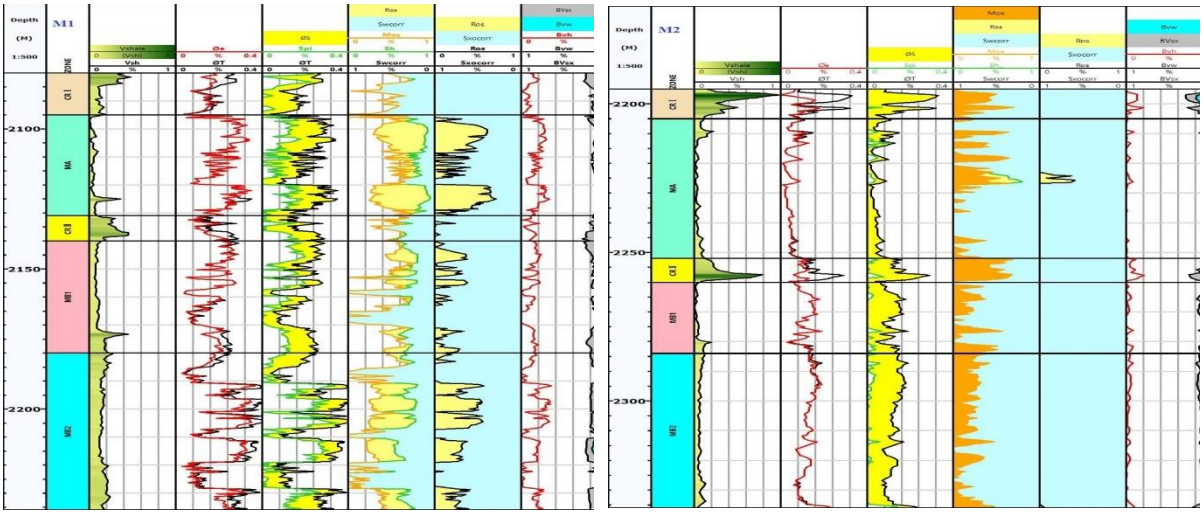


Fig.7. The petrophysical properties of the reservoir units for the Mishrif Formation in the M1 and M2 oil wells

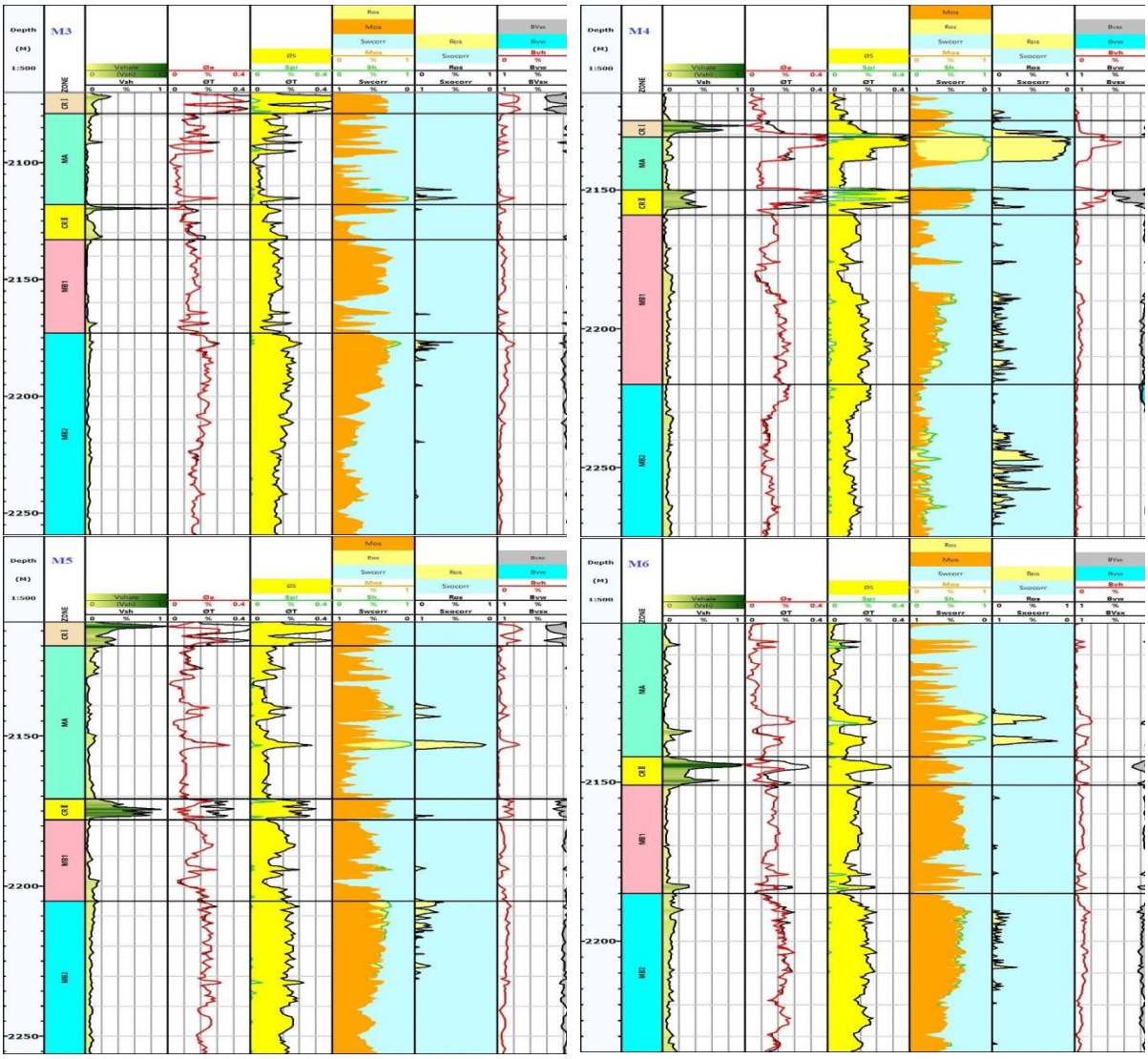


Fig.8. The petrophysical properties of the reservoir units for the Mishrif Formation in the M3, M4, M5 and M6 oil wells

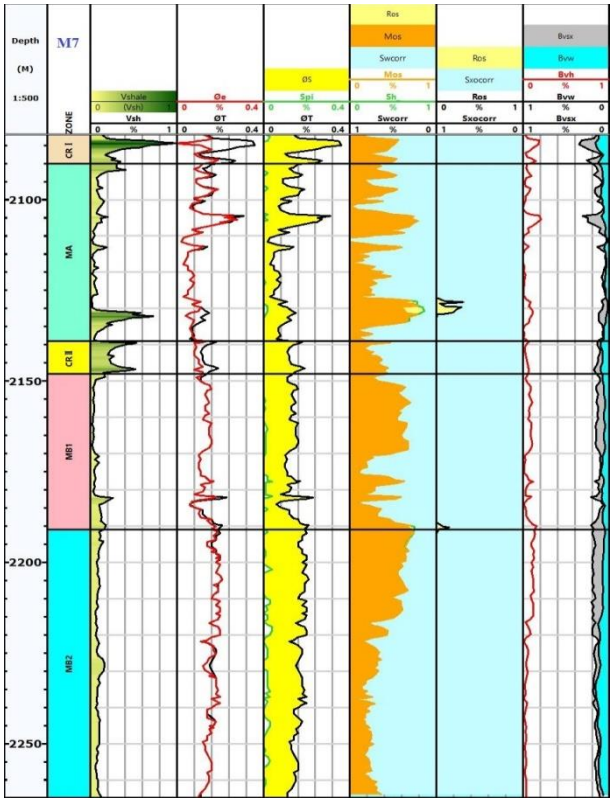


Fig.9. The petrophysical properties of the reservoir units for the Mishrif Formation in the M7 oil well

4. Conclusions

- The petrophysical and reservoir properties of the Mishrif Formation in the studied field were evaluated using data from seven wells (M1–M7) and a suite of well logs. The analysis included the calculation of different types of porosity, shale volume, and hydrocarbon saturation (movable and residual) to characterize the reservoir units. The evaluation of the MA, MB1, and MB2 units reveals significant variations in reservoir quality across the wells, reflecting heterogeneity controlled by both depositional environments and diagenetic processes.
- The MA unit is characterized by low shale content (0.04–0.16), moderate to good effective porosity (0.09–0.24), and high hydrocarbon saturation (0.59–0.83), supported by high movable oil and low residual oil saturation, indicating favorable reservoir conditions. Well M1 represents the best reservoir quality within this unit, exhibiting the highest porosity, hydrocarbon saturation, and bulk volume oil (Bvo), making it the most productive interval. In contrast, well M2 shows poor reservoir properties due to low porosity and hydrocarbon content, likely associated with cementation and compaction.
- The main reservoir units MA and MB are separated by an intervening sealing unit (CR II), while the MB unit is subdivided into MB1 and MB2. The MB1 unit exhibits considerable heterogeneity, with good porosity (13–27%) and low shale content (0.02–0.17), but variable reservoir performance. Well M4 shows the best reservoir quality within this unit, with high porosity, hydrocarbon saturation, and significant movable oil. However, several wells (M2, M3, M6, and M7) show negligible or zero movable oil, indicating the presence of immobile hydrocarbons due to microporosity, poor pore connectivity, or high water saturation, reflecting the strong influence of diagenetic processes.
- The MB2 unit shows relatively improved reservoir quality, with very good effective porosity (18–26%) and moderate shale content (5–16%), although it exhibits lower hydrocarbon saturation compared to the MA unit. Well M1 again demonstrates the best performance in this unit, indicating

good pore connectivity and high producibility. In contrast, well M2 exhibits lower hydrocarbon saturation and minimal movable oil, likely due to proximity to the water zone or reduced permeability.

- Petrophysical analysis indicates a decrease in secondary porosity and an increase in primary porosity, suggesting a limited impact of dissolution and replacement processes, with primary porosity being the dominant control on reservoir behavior. Overall, the reservoir units exhibit clear lateral and vertical heterogeneity governed by depositional and diagenetic processes such as cementation, dissolution, and recrystallization.
- Accordingly, the MA unit represents the best reservoir quality, followed by the variably performing MB1 unit, while the MB2 unit shows improved porosity but relatively lower hydrocarbon saturation. Wells M1 and M4 are identified as the most favorable locations for hydrocarbon production, whereas well M2 represents the poorest reservoir quality among the studied wells.

Author contributions: CRediT

- Conceptualization: The author developed the research idea and established the overall study framework for the Mishrif Formation in the R oilfield.
- Data Curation: The author collected, organized, and processed well log and petrophysical data required for the geological and reservoir modeling of the Mishrif Formation.
- Formal Analysis: The author performed the data analysis and applied the appropriate petrophysical equations. Basim and Fahad provided scientific guidance in selecting analytical methods, equations, and interpretation approaches.
- Funding Acquisition: Minimal; the research was primarily self-funded by the author.
- Investigation: The author conducted all research activities, including data interpretation, reservoir unit analysis, and evaluation of key reservoir properties such as porosity, permeability, and fluid saturation.
- Methodology: The author applied the adopted methodology for building the geological and reservoir model of the Mishrif Formation, while Basim and Fahad guided the overall research approach and methodology.
- Project Administration: Basim and Fahad supervised and managed the progress of the research.
- Resources: The data used in this study were obtained from petroleum-related sources and previous reports relevant to the R oilfield.
- Software: The author used Excel for data analysis and calculations, as well as specialized software for geological modeling, mapping, and figure preparation.
- Supervision: Basim and Fahad supervised all stages of the research, providing continuous guidance, evaluation, and scientific review.
- Validation: The results of this study were validated through comparison with previous studies on the Mishrif Formation and equivalent carbonate reservoirs in southern Iraq, demonstrating comparable trends in reservoir characteristics and petrophysical behavior.
- Visualization: The author prepared all figures, including structural maps, geological cross-sections, and graphical representations illustrating reservoir units and petrophysical relationships.
- Writing – Original Draft: The author prepared the original draft of the manuscript.
- Writing – Review & Editing: Basim and Fahad reviewed and edited the manuscript, and all authors contributed to refining the content and finalizing the submitted version.

Declaration of Competing Interest

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sector.

Data Availability

The data supporting the findings of this study are not publicly available due to confidentiality agreements with Basra Oil Company. Access to the data can be requested from the corresponding author under appropriate conditions.

References

Al-Heeti, A.M., Al-Fatlawi, O.F., Hossain, M.M., 2023. Evaluation of the Mishrif Formation using an advanced method of interpretation. Iraqi Journal of Chemical and Petroleum Engineering, 24(2), 41–51. https://doi.org/10.31699/IJCPE.2023.2.5

Al-Kanaani, N.A.T., 2025. Development Study for Ratawi Oilfield – Mishrif Formation. PhD thesis, University of Basrah, College of Science, Department of Geology, Basrah.

Al-Musawi, F.A., Idan, R.M., Salih, A.L.M., 2018. Reservoir properties and facies distribution of Mishrif Formation in Ratawi Oilfield, Southern Iraq. In: Rossetti, F. et al. (Eds.), The Structural Geology Contribution to the Africa-Eurasia Geology: Basement and Reservoir Structure, Ore Mineralisation and Tectonic Modelling. CAJG 2018. Advances in Science, Technology & Innovation. Springer, Cham, 101–104. https://doi.org/10.1007/978-3-030-01455-1_25

Al-Najm, F., Al-Shahwan, M., Al-Beyati, F., 2013. Petrophysical properties and reservoir modeling of Mishrif Formation at Tuba Field, Southern Iraq. Iraqi Journal of Science, 55(Oil_Conf), 80–95.

Archie, G.E., 1942. The electrical resistivity log as an aid in determining some reservoir characteristics. Journal of Petroleum Technology, 5, 54–62. https://doi.org/10.2118/942054-G

Asquith, G., Krygowski, D., Henderson, S., Hurley, N., 2004. Basic Well Log Analysis (2nd ed.). AAPG Methods in Exploration Series, No. 16. American Association of Petroleum Geologists, Tulsa. https://doi.org/10.1306/Mth16823C1

Jassim, S.Z., Goff, J.C., 2006. Geology of Iraq. Dolin, Prague, p. 341.

Lai, J., Wang, G., Fan, Q., Pang, X., Li, H., Zhao, F., Wang, Q., 2022. Geophysical well log evaluation in the era of unconventional hydrocarbon resources: a review on current status and prospects. Surveys in Geophysics, 43(3), 913–957. https://doi.org/10.1007/s10712-022-09705-4

Radhi, F.A., Al-Fatlawi, O., Kadkhodaie, A., 2025. Lithology and minerals identification from well logs for Mishrif Formation in Ratawi oilfield. Iraqi Journal of Chemical and Petroleum Engineering, 26(1), 129–138. https://doi.org/10.31699/IJCPE.2025.1.13

Schlumberger, 1997. Log Interpretation Charts. Schlumberger Wireline and Testing, Houston, p. 198.

Tiab, D., Donaldson, E.C., 2024. Petrophysics: Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties (5th ed.). Elsevier, Amsterdam. https://doi.org/10.1016/C2023-0-01203-1

Wyllie, M.R.J., Gregory, A.R., Gardner, G.H.F., 1958. An experimental investigation of factors affecting elastic wave velocities in porous media. Geophysics, 23(4), 459–493. https://doi.org/10.1190/1.1438493

Yonus, W.A., Fadhil, D.T., Theyab, M.A., 2022. The use of borehole logs to study the reservoir properties of Shiranish Formation in Qayarah field in Northern Iraq. In: AIP Conference Proceedings, 2660(1), 020013. AIP Publishing, New York. https://doi.org/10.1063/5.0109106