Iraqi Geological Journal

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

Reservoir Evaluation of the Sa'di and Khasib Formations in Q Field, Southern Iraq

Osama J. Mohammad[1*], Raafat A. Hamzah[2], and Ali S. Hameed[2]

[1] Department of Applied Geology, College of Science, University of Anbar, Ramadi, Iraq

[2] Department of Chemical and Petrochemical Engineering, College of Engineering, University of Anbar, Ramadi, Iraq

* **Correspondence**: msc.osamajm@uoanbar.edu.iq

Received:
12 July 2025
Accepted:
2 November 2025
Published:
31 January 2026

Abstract

The petrophysical characteristics of the Late Cretaceous Sa'di and Khasib formations were investigated in the Q oilfield, southern Iraq. Well log data from four wells across zones QA and QB were utilized in this study. The well log data were subsequently analyzed using the advanced Techlog Quanti module to interpret the well log data in terms of computer-processed interpretation and cross-plot analysis for studying rock types, porosity, permeability, and hydrocarbon saturation. The objectives were to identify zones with favorable petrophysical characteristics, measure their dispersion, and compare them well to well to improve reservoir management. The results showed a contrast between the two formations. The Khasib Formation, comprising limestone and dolomitic limestone, exhibits comparable characteristics across wells, including greater porosity (7-17%) and more continuous hydrocarbon zones than the Sa'di Formation. The Sa'di Formation is composed of a variety of rocks, including different shale percentages in the upper and lower portions, resulting in varied porosity (4-13%) and permeability. The bottom section of the Sa'di Formation, represented by wells QA1 and QA2, has a significant oil content and thickness. The statistical analysis revealed that the wells in the southwestern field (Group A) have superior reservoir attributes, notably the Sa'di Formation, which has little shale and high porosity. The results indicate that the Khasib Formation is a more dependable hydrocarbon source across the Q field, whereas the lower Sa'di Formation has a strong local production potential. The study of rock types, shale content, and properties helps in targeting exploration and better production strategies in the Q oilfield and similar areas of the Mesopotamian Basin.

Keywords: Reservoir characterizations; Sa'di and Khasib formations; Southern Iraq; Well logging; Hydrocarbon potential; Techlog; Pay thickness

1. Introduction

Through vertical and lateral stratigraphic investigations, reservoir assessment is a vital instrument for hydrocarbon field development, offering significant spatial understanding of reservoir architecture. Even in cases of limited data availability, recent technical developments have improved the accuracy of subsurface surveys using complex computer methods that draw precise interpretations of petrophysical properties from multidimensional well log data.

Within the petroleum resources and reserves of southern Iraq, the Cretaceous period-specifically the Cenomanian stage-emerges as a foundational epoch for substantial hydrocarbon accumulations (Verma et al., 2004). The Sa'di and Khasib formations represent prominent carbonate reservoir units

characteristic of Late Cretaceous depositional environments, extensively distributed throughout the Mesopotamian Basin's petroleum system. These geological formations constitute significant hydrocarbon-bearing stratigraphic intervals that have garnered considerable attention in regional exploration strategies (Aqrawi, 1996).

The systematic geological and engineering assessment of the Sa'di and Khasib reservoirs represents a critical investigative process in petroleum geoscience. Such comprehensive evaluations are instrumental in quantifying the hydrocarbon exploration potential of subsurface reservoir properties and informing strategic decisions in petroleum resource management.

The Khasib and Sa'di formations were selected for reservoir characterization using integrated well log data from the Q oil field in southern Iraq (Fig. 1). The dataset comprises well log measurements of four wells across two zones, QA and QB, based on their geographical distribution across the oil field. Stratigraphic evaluation segmented the reservoir into units based on detailed mud logs, predicated on an analysis of mudlogging reports, as summarized in Table 1, which details the wells, formations, and stratigraphic subdivisions. The CPI methodology quantifies water and hydrocarbon saturation by integrating geological and petrophysical variables, such as lithology, porosity, permeability, water and oil saturation, in addition to the net thickness. Additionally, cross-plot techniques characterize the lithological and mineralogical features of each formation, providing a comprehensive framework for reservoir assessment.

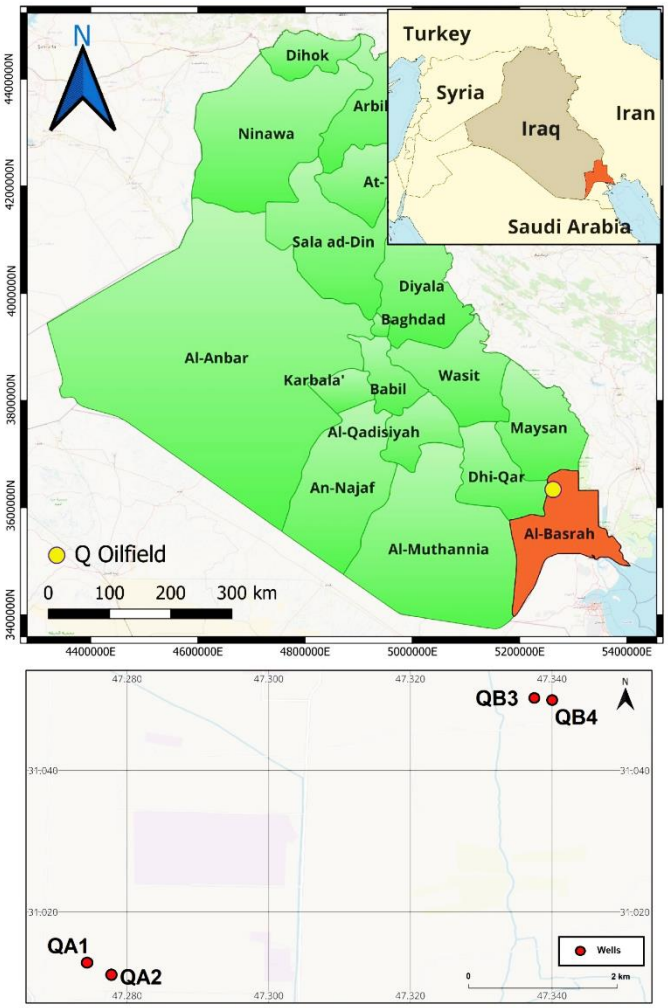


Fig. 1. Location map for the Q oilfield and studied wells positioned in southern Iraq

Table 1. Details about the studied wells

Well name	Formation	Top	Bottom	Thickness /m
QA1	Sa'di	2420	2459	39
QA1	Khasib	2539	2564	25
QA2	Sa'di	2830	2870	40
QA2	Khasib	2960	2995	35
QB3	Sa'di Upper	2318	2396	78
QB3	Sa'di Lower	2396	2420	24
QB3	Khasib	2513	2543	30
QB4	Sa'di Upper	2960	3058	98
QB4	Sa'di Lower	3058	3080	22
QB4	Khasib	3147	3215	68

The Turonian to Lower Campanian in the Mesopotamian Basin consists of the Khasib, Tanuma, and Sa'di formations, which are important oil reservoirs that consist of porous shale, marl, and porous carbonate units. The microfacies and lithostratigraphic analyses of the whole sequence revealed almost the same depositional environments, and the middle shelf was the main area for sediment deposits, with influences from the outer and inner shelves at different times (Aqrawi, 1996). The Khasib Formation, part of the deep inner shelf, and lagoonal facies sequence alongside the Tanuma and Sa'di formations in Iraq are significant for their reservoir units with high average porosity and permeability, which are crucial for oil reservoirs in many oilfields. The Sa'di Formation, the youngest and most widespread of the Late Turonian-Early Campanian Sequence, was first described by Owen and Nasr in 1958 from well Zubair-3. It comprises approximately 300 m of white, chalky, argillaceous, and globigerina limestones capped by a 60-meter-thick marl bed (Jassim and Goff, 2006).

The Sa'di Formation is the third-order depositional cycle with medium porosity and low to ultra-low permeability, consisting of four sublayers: Sa'di A (regressive tract) and Sa'di B1, B2, B3 (transgressive tracts). Inner ramp sediments have a micrite matrix with low permeability, while middle ramp sediments are rich in planktonic foraminifera packstones. Intraclastic shoal sediments are identified as favorable reservoirs, aiding in predicting oil production locations (Han et al., 2015).

In the area south of the eastern Baghdad oilfield, the Khasib Formation exhibits significant variations in porosity and water saturation among wells. This change was due to the heterogeneity of the formation (Jameel et al., 2020).

The Khasib Formation is defined by Owen Nasr (1958) in well Zubair 3 in southern Iraq. It is part of AP9, the Turonian–Danian mega-sequence. This formation is an important reservoir rock found in oil fields such as Tikrit, Balad, Samarra, and eastern Baghdad in central Iraq, and is composed mainly of bioturbated chalky limestone for marl shale (Al-Qayim, 2010). The dominant mineral matrix in the Khasib Formation is limestone, with a small proportion of sand and shale, while the well in the northern part of the East Baghdad Oil Field shows an apparent increase in secondary porosity, likely due to tectonic activity and faults. The Khasib Formation is characterized by a large vertical variation in the sub-reservoir zones, with coarse porosity and high permeability in the upper reservoir, while the lower reservoir is characterized by fine porosity and low permeability. The southeastern zone is characterized by a high asphaltene content, density, and viscosity, and immature oil is mainly found in early traps (Wang et al., 2022).

The reservoir units in the Khasib and Sa'di formations are distributed based on their petrophysical and surface properties. Khasib-A is divided into two layers, Khasib-B into three layers, Saadi-A into three layers, and Saadi-B into two layers. The Khasib Formation is characterized by relatively low porosity. The correlation well sections indicate improved petrophysical properties in the west-northeast direction within the Halfaya oil field (Fayadh and Mad'hat, 2018).

The reservoir units in the Khasib and Sa'di formations were classified based on their petrophysical properties and facies. Khasib-A Formation consists of two layers, Khasib-B consists of three layers, Sa'di-A consists of three layers, and Saadi-B consists of two layers. The Khasib Formation exhibits relatively low porosity. The correlation well sections indicate that the petrophysical properties improved in the west-northeast direction. (Wang et al., 2024).

The Sa'di Formation comprises four units: A, B1, B2, and B3. Unit A was excluded because of the absence of hydrocarbon accumulation (Jassam et al., 2023).

Cretaceous petroleum reservoirs in the Middle East exhibit distinct porosity and permeability patterns. The Arabian platform displays an inverse relationship between porosity and burial depth. In contrast, the Zagros Fold Belt has a low porosity without a depth relationship. Carbonate reservoirs have an irregular porosity-permeability relationship, whereas sandstones generally exhibit high permeability. These variations were due to differences in the maximum burial depth and subsequent geological processes (Ehrenberg et al., 2008).

The Q field contains a major oil accumulation and a substantial anticline along a north-south trend (Aqrawi et al., 2010. The reservoir evaluation is essential for the effective execution of an exploration program.(Ahmed and Al-kubaisi, 2024).

Reservoir characteristics directly affect field development plans and require further evaluation to adequately describe the continuity of the side reservoir.

This study examines the petrophysical characteristics of the Sa'di and Khasib reservoirs through a complete analysis of well logs from four wells inside the strategically substantial Q oil field. Advanced analytical methodologies have been employed to interpret gamma ray, density, neutron, and resistivity logs (both deep and shallow). The essential goals were to analyze the distribution and residences of rock types, porosity, and permeability within the reservoir, determine the extent of shale, take a look at water saturation to discover oil-bearing zones, investigate the internet manufacturing doable of the reservoir, estimate the volume of hydrocarbon current inside the formations, and conduct statistical comparisons to consider editions in petrophysical houses across the four studied wells. Collectively, these analyses supply a precise assessment of the petrophysical traits and production of the reservoirs. The findings of this investigation are anticipated to enhance our appreciation of the Sa'di and Khasib formations, particularly in analogous geological settings, and make a contribution to optimized reservoir management and manufacturing strategies.

2. Materials and Methods

The petrophysical evaluation employed a systematic methodology utilizing advanced equipment and strategies to comprehensively analyze the reservoir characteristics. The most important device utilized was the Techlog Quanti module by using Schlumberger, a state-of-the-art software platform designed for log nice monitoring and fluid property calculations, followed by means of designated petrophysical analysis. Data from four wells have been analyzed, incorporating more than a few logs, which include calipers, gamma rays, density, neutrons, and resistivity (deep and shallow). Shale quantity (Vsh) was once determined by using gamma-ray measurements (Schlumberger, 2013).

To improve the accuracy of the analyses, environmental corrections were applied to the gamma-ray, bulk density, and resistivity logs. These corrections accounted for variables such as the mud weight, borehole size, and tool positioning. For instance, GR logs had been adjusted for elements influencing mud weight and borehole dimensions, whereas formation density tools have been calibrated to mitigate borehole dimension effects on lithology density measurements. The resistivity logs have been corrected for borehole-induced effects and invasion influences, enabling accurate calculation of resistivity in both invaded and uninvaded zones, as well as estimation of the investigation depth.

Lithological assessments have been carried out using neutron-density logs, which are high-quality in distinguishing quartz, calcite, and dolomite. These logs have been used to measure the total porosity, as secondary porosity effects have been absent. Density-neutron cross-plots further facilitated lithological comparison through either single-well or multi-well comparisons. These cross-plots provided a two-dimensional representation of lithology and porosity versions at specific depths, assisting particular lithological characterization (Gimbe, 2015).

Water and hydrocarbon saturations were calculated using the Archie equation, and the Pickett plot technique was used to determine the water resistivity (Rw) and Archie parameters. This method relies on deep resistivity (Rt) logs to derive the Rw values. The bulk volume of water (BVW) is derived by multiplying the water saturation (Sw) by the porosity (ϕ). Oil saturation and movable oil portions have been estimated primarily based on the water saturation (Sw) and the water saturation of the flushed area (Sxo) (Asquith et al., 2004).

Porosity analysis encompassed total porosity (PHIT) and effective porosity (PHIE), each of which has been determined by using neutron-density porosity log plots (Schlumberger, 1989). Permeability, specifically governed by means of porosity, is influenced by grain size, pore size, sorting, throat size, cementation factors, and capillary pressure. Permeability (KmD) is used to calculate the Rose equation, which contains porosity and water content as key inputs (Wyllie and Rose, 1950).

The net pay thickness, an integral parameter for hydrocarbon evaluation, was determined by assessing water saturation, porosity, and shale volume. The net pay represents the internet productive thickness of the hydrocarbon-bearing formations relative to the complete formation thickness. (Worthington, 2010; Ellis and Singer, 2007).

This comprehensive workflow facilitated a comparison of the reservoir's petrophysical properties, ensuring unique characterization and improving the perception of the hydrocarbon within the studied formations. This complete workflow allows a strong evaluation of the petrophysical properties of the Sa'di and Khasib reservoirs in the study area, the studied wells were divided into two groups (A and B) according to the geographical distribution, the statistical assessment is used to determine the best productive reservoirs.

3. Results and Discussion

The evaluation of the Sa'di and Khasib formations utilized data from 4 well logs. The cross-sectional neutron density plots reveal the predominant rock types. Analysis of the reservoir interval data, illustrated in Fig. 2, highlights the fundamental lithological composition of the Khasib and Sa'di formations. These formations are predominantly composed of limestone and dolomitic limestone, interbedded with oil shale and scattered quartz. The neutron-density cross-plots successfully differentiate the lithology homes and petrophysical parameters of the reservoir sections penetrated by wells.

The four studied wells within the Q oilfield were categorized into two groups, A and B, based on their geographical distribution. Group A includes wells located in the southwestern part of the field, whereas Group B includes wells in the northeastern part. According to geological reports of the wells, the Sa'di Formation in wells of group B was further subdivided into two distinct units.

A computer-processed interpretation (CPI) was utilized to generate a virtual representation of the petrophysical properties of the study wells. Figs. 3, 4, 5, and 6 illustrate the distribution and characteristics of the petrophysical parameters within the studied formations, providing a comprehensive understanding of the lithological characteristics and reservoir quality of the Sa'di and Khasib formations within the studied wells.

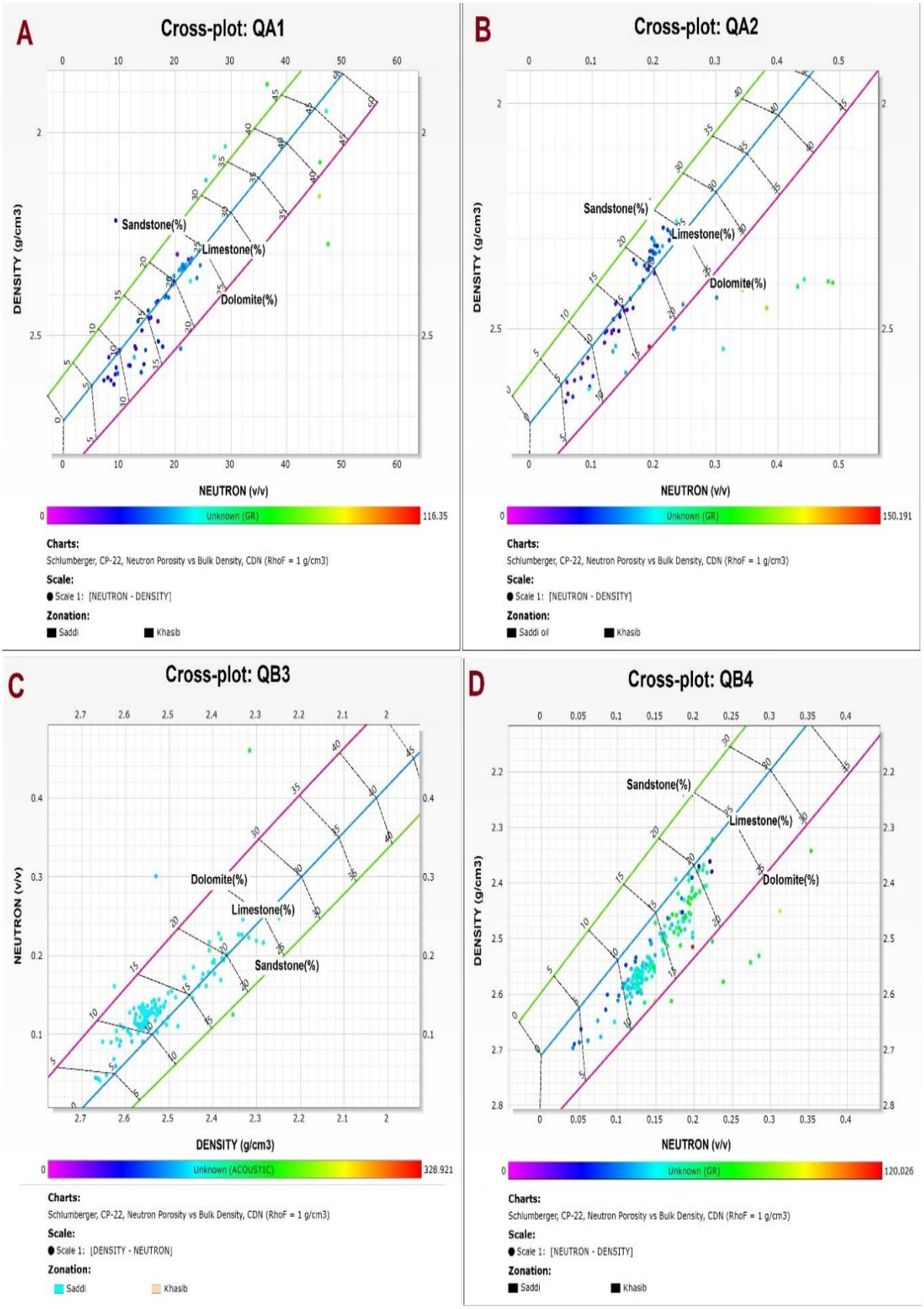


Fig. 2. The density-neutron cross plots for wells QA1, QA2, QB3, and QB4 are labelled as A, B, C, and D, respectively

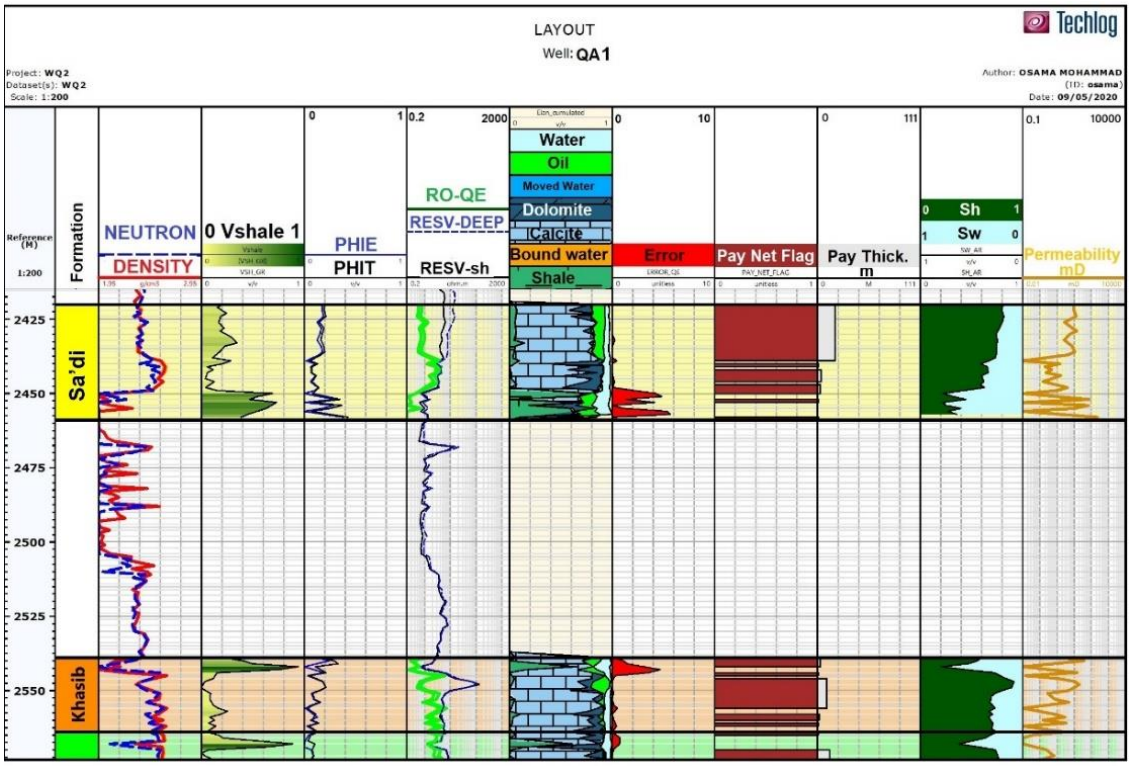


Fig. 3. The CPI of petrophysical parameters computed for the Sa'di and Khasib formations in well QA1

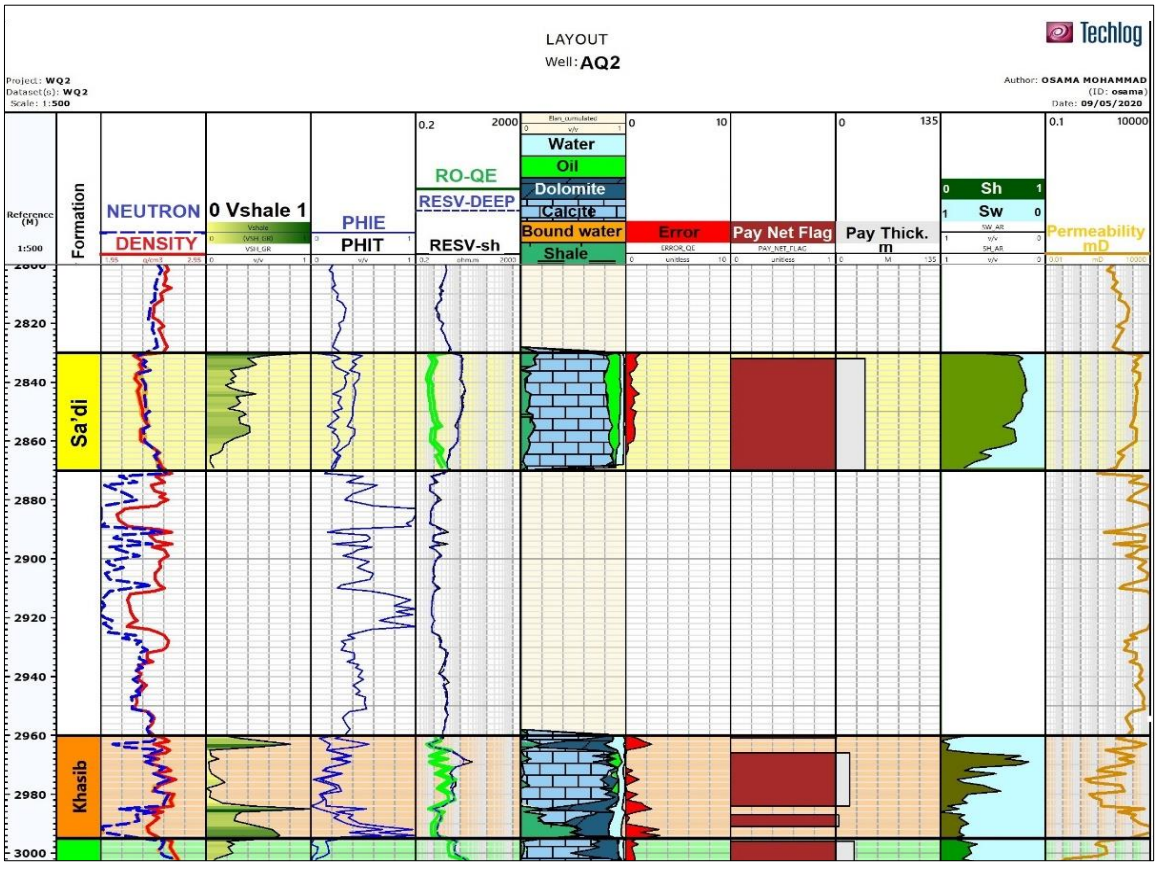


Fig. 4. The CPI of petrophysical parameters computed for the Sa'di and Khasib formations in well QA2

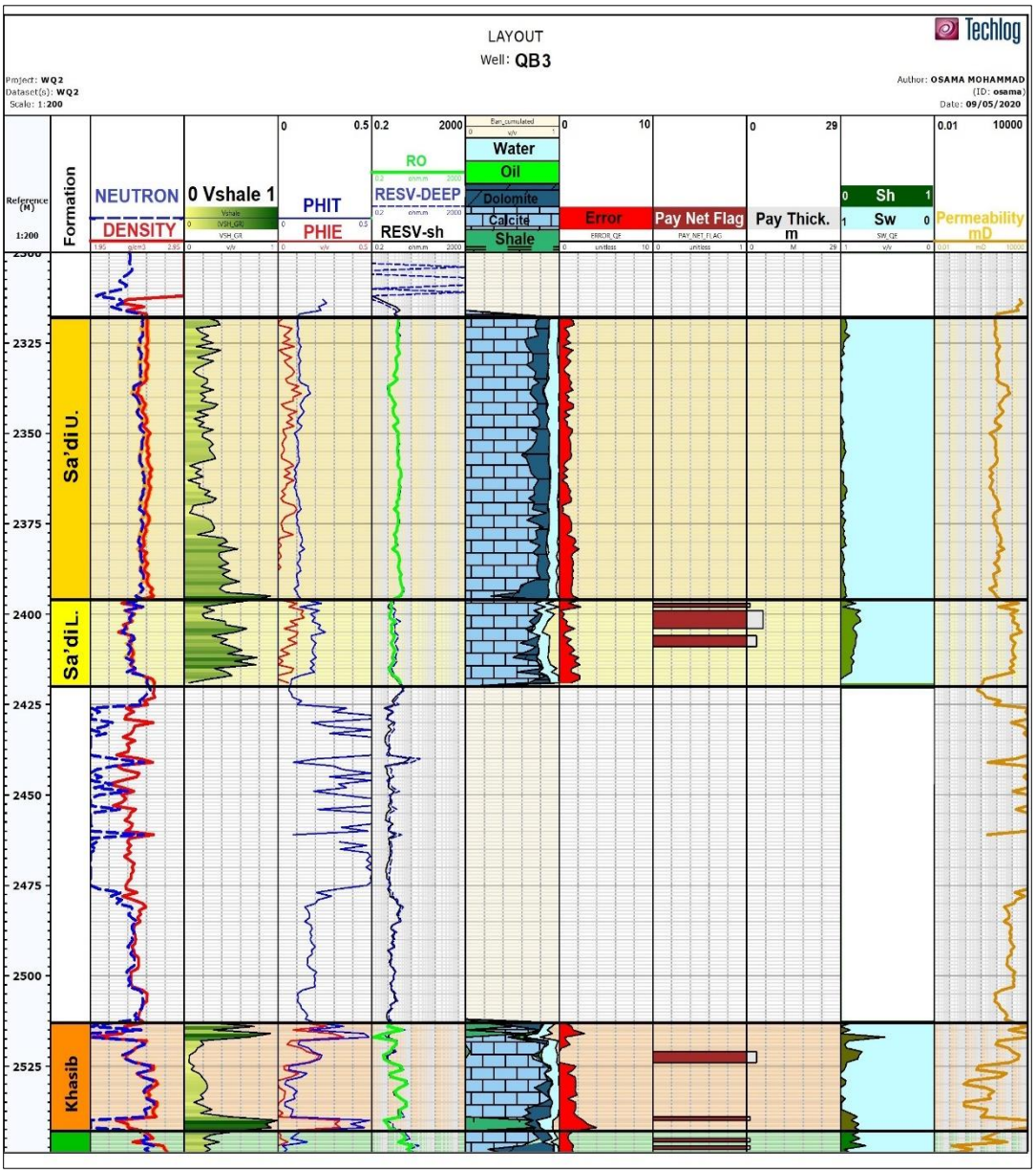


Fig. 5. The CPI of petrophysical parameters computed for the Sa'di and Khasib formations in well QB3

The initial and general views of the assessment results for the four wells (QA1, AQ2, QB3, and QB4) show a remarkable difference in reservoir properties. The Sa'di Formation exhibits better reservoir properties, with a greater net pay thickness, particularly in wells QA1 and QB4. It also showed consistent effective porosity and pronounced neutron density crossover patterns; however, specialized in the Khasib Formation, despite the limited net pay thickness, there were high hydrocarbon saturation values, indicating a better hydrocarbon material. Both formations show equal permeability, but there is slightly better continuity in the Sa'di Formation. The Khasib Formation is mainly made of carbonate, while Sa'di is more diverse. Overall, the Sa'di Formation has a better reservoir connection; however, the Khasib Formation can be a valuable reservoir for hydrocarbon production. The petrophysical properties of Khasib and Sa'di formations, as evaluated by the wells studied (Fig.7), provide a comprehensive basis for detailed reservoir characterization. These properties allow a systematic comparison of the quality and performance of the reservoirs across the different wells.

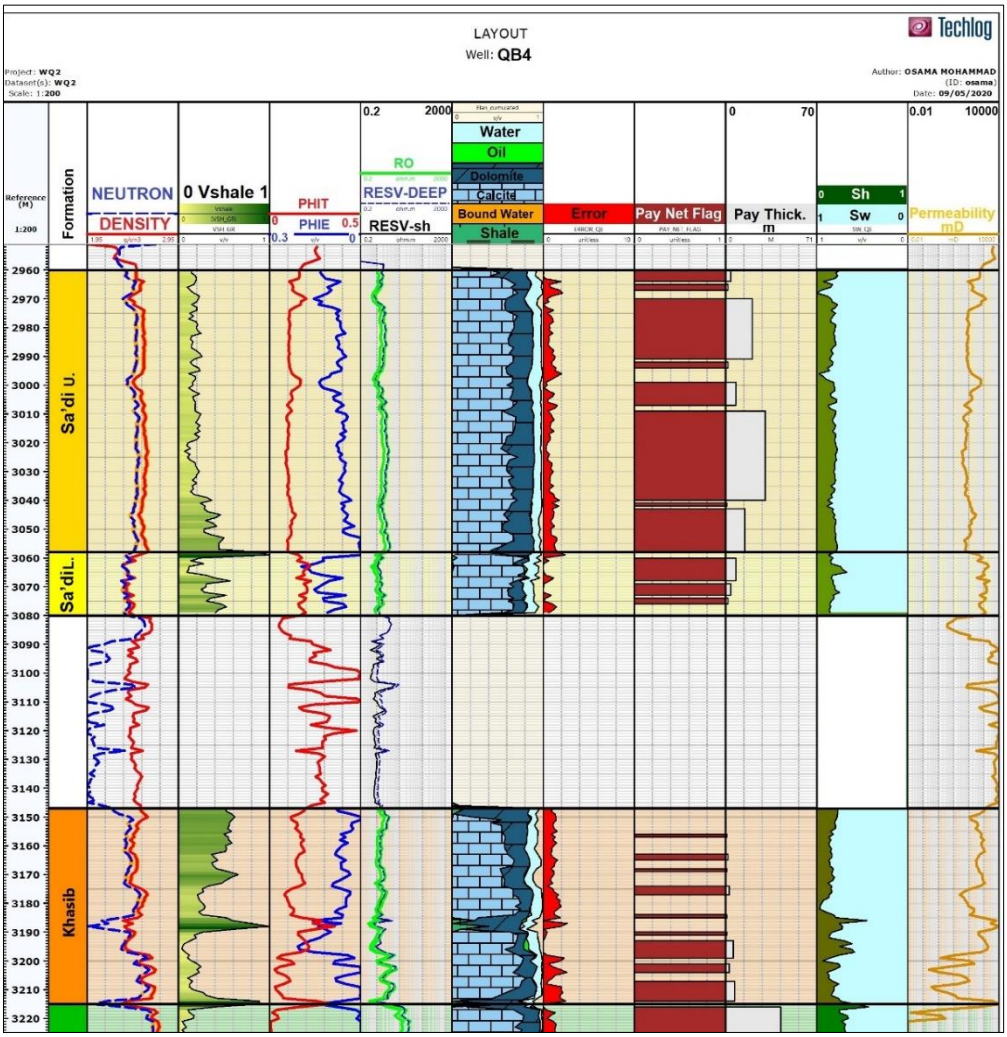
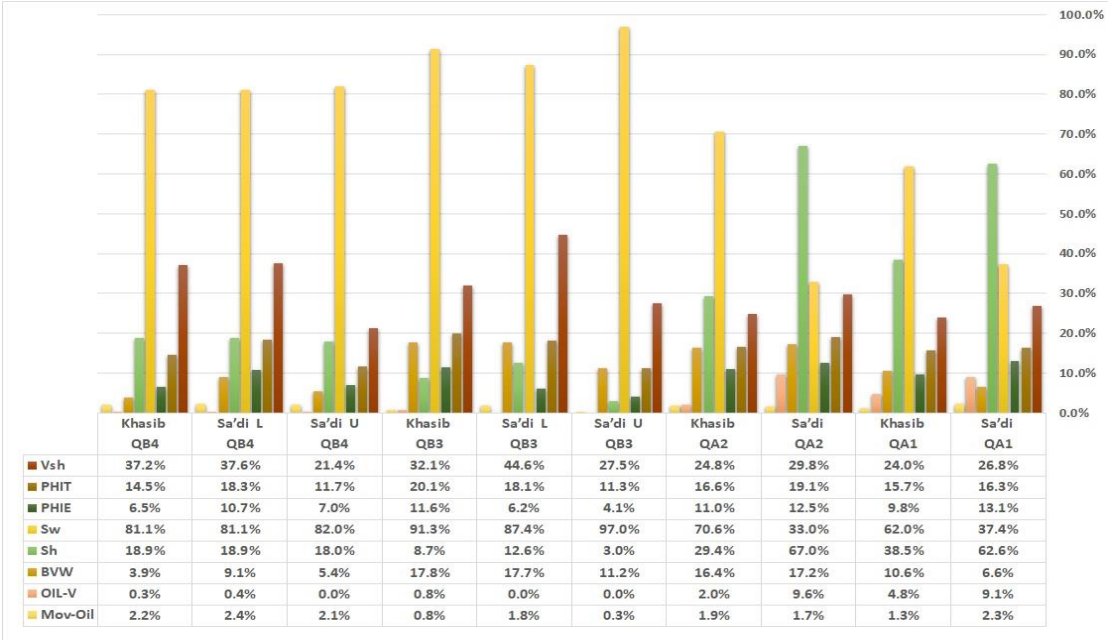


Fig. 6. The CPI of petrophysical parameters computed for the Sa'di and Khasib formations in well QB4



	Khasib QB4	Sa'di L QB4	Sa'di U QB4	Khasib QB3	Sa'di L QB3	Sa'di U QB3	Khasib QA2	Sa'di QA2	Khasib QA1	Sa'di QA1
Vsh	37.2%	37.6%	21.4%	32.1%	44.6%	27.5%	24.8%	29.8%	24.0%	26.8%
PHIT	14.5%	18.3%	11.7%	20.1%	18.1%	11.3%	16.6%	19.1%	15.7%	16.3%
PHIE	6.5%	10.7%	7.0%	11.6%	6.2%	4.1%	11.0%	12.5%	9.8%	13.1%
Sw	81.1%	81.1%	82.0%	91.3%	87.4%	97.0%	70.6%	33.0%	62.0%	37.4%
Sh	18.9%	18.9%	18.0%	8.7%	12.6%	3.0%	29.4%	67.0%	38.5%	62.6%
BVW	3.9%	9.1%	5.4%	17.8%	17.7%	11.2%	16.4%	17.2%	10.6%	6.6%
OIL-V	0.3%	0.4%	0.0%	0.8%	0.0%	0.0%	2.0%	9.6%	4.8%	9.1%
Mov-Oil	2.2%	2.4%	2.1%	0.8%	1.8%	0.3%	1.9%	1.7%	1.3%	2.3%

Fig. 7. Average petrophysical characteristics of the Khasib and Sa'di formations in the studied wells

3.1. Comparison of Sa'di and Khasib Formations

A detailed analysis of the Sa'di and Khasib formations reveals significant differences in many reservoir properties, which have played a crucial role in determining the productivity and quality of the reservoir in the two formations.

3.1.1. Lithology and shale volume

The Khasib Formation consists mainly of limestone and dolomite with medium shale content, whereas the Sa'di Formation shows lithological variation of alternating layers of limestone and shale, particularly within the lower section. This lithological range impacts the reservoir properties of the two formations.

The shale volume (Vsh) suggests significant variations between the two formations. In the Khasib Formation, the oil shale volume ranges from 24% to 37% throughout the four wells, whereas the Sa'di Formation shows remarkable variation between the higher and the lower sections. The higher segment of the Sa'di Formation exhibits a low shale content (21–28%), whereas the lower segment exhibits a high shale content (38–45%). The variation in oil shale volume suggests that the Khasib Formation was deposited in a more stable environment than the Sa'di Formation, which experienced changes in depositional conditions between the higher and the lower sections. In wells QA2 and QA1, the Sa'di Formation contains significantly less clay, which has a notable impact on reservoir residence and increases the reservoir volume. In wells QB4 and QB3, the clay content (Vsh) increased, which reduced the effective porosity (PHIE) and permeability, thereby limiting fluid flow efficiency. Wells QA2 and QA1 are preferred because their limestone is less contaminated with clay, making them more efficient reservoirs. In wells QB4 and QB3, clay penetration decreased the oil productivity and effective porosity while water saturation increased. Wells QA1 and QB3 incorporated higher percentages of calcite and pure limestone in the Khasib Formation, resulting in superior reservoir properties. Conversely, wells QA2 and QB4 show greater shale influence, particularly in the lower formation layers, which probably reduces the reservoir permeability in certain zones.

3.1.2. Porosity properties

Porosity is a key reservoir characteristic that determines the ability of rocks to store fluid. The results show that the Khasib Formation has an entire porosity (PHIT) ranging from 15% to 20%, which is higher than that of the Sa'di Formation, in which the total porosity ranges from 4% to 12% in the top segment and 10% to 18% in the lower phase. The effective porosity (PHIE) was similar, with the Khasib Formation displaying values ranging from 7% to 17%, whereas the Sa'di Formation ranged from 4% to 7% in the upper segment and from 6% to 13% in the lower phase. This distinction in porosity between the two formations was attributed to variations in lithology and sedimentary history. The better porosity in the Khasib Formation suggests better fluid storage capability, making it a suitable candidate for hydrocarbon reservoirs.

In the Sa'di Formation, well QA1 shows high porosity (PHIE: 13. 1%) despite moderate shale. QA2 has the most shale and poor reservoir properties. QB3 and QB4 show differences between the upper and the lower Sa' di. In the Khassib Formation, well B3 has the least shale (8. 7%), highest porosity (PHIE: 11. 6%, PHIT: 20. 1%), and good permeability. QA1 has moderate shale (38. 5%) and decent porosity (PHIE: 9. 8%, PHIT: 15. 7%). QA2 and QB4 have less favorable values.

3.1.3. Permeability

Permeability is an important reservoir property that determines the ability of rocks to transmit fluids. The Khasib Formation exhibits relatively higher and more constant permeability than the Sa'di

Formation. The permeability values in the Sa'di Formation are various, with generally lower values in the upper section and higher values in certain intervals in the lower section. This difference in permeability between the two formations is related to differences in porosity and rock composition. Better permeability in the Khasib Formation indicates higher oil production potential, while certain intervals in the lower section of the Sa'di Formation may also exhibit good production potential where the permeability is higher. Higher permeability zones correlate with calcite-rich intervals and lower shale contents. Wells QA1 and QB3 show better permeability profiles, especially within the Khasib Formation. Permeability decreased extensively in the shale-rich sections of QA2 and QB4.

3.1.4. Oil and water saturation

Oil saturation (Sh) and water saturation (Sw) reflect the hydrocarbon content and production potential of the formations. The results indicate a large variation in oil saturation across wells and formations. In the Khasib Formation, oil saturation ranged from 19% to 39% in all four wells, indicating relative stability in the hydrocarbon content. In contrast, the Sa'di Formation showed greater variation, with oil saturation in the upper section ranging from 3% to 18%, and in the lower phase from 13% to 63%. Conversely, water saturation (Sw) indicated the opposite pattern, ranging from 62% to 81% in the Khasib Formation, from 82% to 97% in the upper section of the Sa'di Formation, and from 37% to 87% in the lower section. This variation in saturation values highlights the differences in hydrocarbon distribution between the two formations, with the lower part of the Sa'di Formation containing periods of high oil saturation, particularly in wells QA1 and QA2.

3.1.5. Net pay thickness

Analysis of the pay zone indicators (Pay Net Flag) and net pay thickness (Table 2) revealed that the Khasib Formation exhibited a more continuous and consistent pay zone across the four wells, whereas the Sa'di Formation showed variation in pay thickness between the upper and the lower sections. The lower section of the Sa'di Formation performs better in terms of pay zone characteristics than the upper section, which is consistent with the observed porosity and oil saturation properties. This variability in the pay zone suggests that the Khasib Formation represents a more stable and consistent production target, while certain intervals in the lower section of the Sa'di Formation may also exhibit high production potential at specific locations. Wells QA1 and QA2 show good thickness in the Sa'di Formation, whereas the Khasib is relatively thin. The QB3 and QB4 wells have different thicknesses between the two formations, especially in high-quality reservoir areas in the upper Sa᾽di.

Table 2. Net pay thicknesses alongside the thickness of each unit in the studied oil well

Well name	Formation	Thickness	Net pay thickness /m
QA1	Sa'di	39	9.97
QA1	Khasib	25	15.48
QA2	Sa'di	40	34.23
QA2	Khasib	35	1.34
QB3	Sa'di Upper	78	0.00
QB3	Sa'di Lower	24	0.13
QB3	Khasib	30	0.37
QB4	Sa'di Upper	98	0.00
QB4	Sa'di Lower	22	0.50
QB4	Khasib	68	0.12

4. Conclusions

The Sa'di and Khasib formations possess contrasting reservoir properties that influence the production quality in the four studied wells. The two formations have different reservoir properties that can influence production quality. The Khasib Formation is a rock composed of pure limestone. Owing to its homogeneous rock, this formation exhibits higher effective porosity and permeability. This makes production more efficient in wells QA1 and QB3. In contrast, the reservoir properties of the Sa'di Formation exhibit greater variations owing to the presence of shale. This diminishes the reservoir quality in some areas, Such as the QA Wells group, which is in the southwestern part of the oil field. On the other hand, the reservoir properties in the QA well group in the southwestern part of the oilfield are relatively better in the Sa'di Formation. The correlation between wells shows that there are differences in the quality of the reservoir, indicating the processes that were involved with the sediments and geology. QA1 is the best with respect to reservoir properties in both formations, followed by QA2. Furthermore, QB4 and QB3 are the least efficient wells because they have a high shale. This study suggests that it is necessary to understand the lithological and reservoir differences between the two formations to discover the best productive zones and maximize reservoir development strategies.

Acknowledgements

The authors thank the Iraqi Ministry of Oil for their cooperation in providing this information, which enabled the completion of this study.

Author contributions

The first author, conceptualization and research idea development, data organization and structuring, well data analysis, reservoir properties extraction using Techlog software, writing-original draft preparation, review, and editing.

The second author, results analysis and interpretation, comparative analysis between the four wells used in the study, contribution to conclusions, and review and editing

The third author, results analysis, and interpretation, comparative analysis between wells and their locations, contribution to the development, and final review

Declaration of Competing Interest

The authors declare that they have no competing financial interests or personal relationships that could influence the work reported in this study.

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 used in this study were obtained from a third party and are not publicly available. Access to these data may be obtained from the data owner, subject to their restrictions.

References

Ahmed, H.W., Al-kubaisi, B.F., 2024. Reservoir evaluation model of the Khasib Formation in Halfaya oil field, Mesan governorate, southern Iraq. IOP Conference Series: Earth and Environmental Science, 1300, 012041. https://doi.org/10.1088/1755-1315/1300/1/012041

Al-Qayim, B., 2010. Sequence stratigraphy and reservoir characteristics of the Turonian-Coniacian Khasib formation in central Iraq. Journal of Petroleum Geology, 33, 387–403. https://doi.org/10.1111/j.1747-5457.2010.00486.x

Aqrawi, A.A.M., 1996. Carbonate-siliciclastic sediments of the Upper Cretaceous (Khasib, Tanuma, and Sa'di Formations) of the Mesopotamian Basin. Marine and Petroleum Geology, 13(7), 781–790. https://doi.org/10.1016/0264-8172(96)00022-0

Aqrawi, A.A.M., 2010. The Petroleum Geology of Iraq. Scientific Press.

Asquith, G., Krygowski, D.., Henderson, S., Hurley, N., 2004. Basic Well Log Analysis. Second Edition, American Association of Petroleum Geologists. Tulsa, Oklahoma.

Ehrenberg, S.N., Aqrawi, A.A.M., Nadeau, P.H., 2008. An overview of reservoir quality in producing Cretaceous strata of the Middle East. Petroleum Geoscience, 14, 307–318. https://doi.org/10.1144/1354-079308-783

Ellis, D.V, Singer, J.M., 2007. Well Logging for Earth Scientists. Springer Dordrecht.

Fayadh, A.H., Mad'hat, E.N., 2018. 3D Geological model for Khasib, Tanuma, and Sa'di formations of Halfaya oil field in Missan governorate, southern Iraq. Iraqi Journal of Science, 59(2B). 875-885.

Gimbe, M.P.S., 2015. Formation Evaluation and Uncertainty Analysis of the Ormen Lange Field, Norwegian Sea offshore Norway. MSc thesis, Norwegian Sea offshore Norway.

Han, H.., Zhao, L., Xu, X., Lu, W., 2015. Characteristics and genesis of low to ultra-low permeability carbonate rocks: a case study in Late Cretaceous Sadi formation in H Oilfield, southeast of Iraq, Society of Petroleum Engineers Reservoir Characterisation and Simulation Conference and Exhibition, Abu Dhabi, UAE. https://doi.org/10.2118/175658-MS

Jameel, L.A., Kadhim, F.S., Al-Sudani, H., 2020. Petrophysical properties of Khasib Formation in east Baghdad oil field, southern area. Iraqi Journal of Chemical and Petroleum Engineering, 21, 41–48. https://doi.org/10.31699/IJCPE.2020.4.5

Jassam, S.A., AL-Fatlawi, O., Canbaz, C.H., 2023. Petrophysical analysis based on well logging data for tight carbonate reservoir: The Sadi formation case in Halfaya oil field. Iraqi Journal of Chemical and Petroleum Engineering, 24, 55–68. https://doi.org/10.31699/IJCPE.2023.3.6

Jassim, S.Z., Goff, J.C., 2006. Geology of Iraq. 2nd ed., Dolin, Prague and Moravian Museum, Brno.

Owen, R.M.S., Nasr, S.N., 1958. Stratigraphy of the Kuwait-Basra area. Habitat of Oil, American Association Petroleum Geologist Memoir, 1, 1252-1278.

Schlumberger, 1989. Log Interpretation, Principles and Application. Schlumberger Wireline and Testing, Houston.

Schlumberger, 2013. Techlog Fundamentals: Workflow/solutions Training. NExT.

Verma, M.K., Ahlbrandt, T.S., Al-Gailani, M., 2004. Petroleum reserves and undiscovered resources in the total petroleum systems of Iraq: reserve growth and production implications. GeoArabia, 9, 51–74. https://doi.org/10.2113/geoarabia090351

Wang, Q., Wen, T., Li, H., Zeng, X., Wang, X., Xin, J., Sun, L., Wang, C., Zhou, Y., 2022. Influence of heterogeneity on fluid property variations in carbonate reservoirs with multistage hydrocarbon accumulation: A case study of the Khasib formation, Cretaceous, AB oilfield, southern Iraq. Open Geosciences, 14, 663–674. https://doi.org/10.1515/geo-2022-0363

Wang, J., Xu, Z., Liu, Y., Li, W., 2024. Carbonate sedimentary facies and sedimentary model of the Sadi Formation in W Oilfield. 94–103. https://doi.org/10.1007/978-981-97-0464-4_8

Worthington, P.F., 2010. Net Pay — What Is It? What Does It Do? How Do We Quantify It? How Do We Use It?. SPE Reservoir Evaluation and Engineering, 13, 812–822. https://doi.org/10.2118/123561-PA

Wyllie, M.R.J., Rose, W.D., 1950. Some theoretical considerations related to the quantitative evaluation of the physical characteristics of reservoir rock from electrical log data. Journal of Petroleum Technology, 2, 105–118. https://doi.org/10.2118/950105-G