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Reservoir Characterization and Stratigraphic Relationships of Mishrif Formation in Gharraf Oil Field

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Abstract

Mishrif Formation (Cenomanian-Early Turonian) is considered a main reservoir in the Gharraf oil field, south of Iraq. Three wells, namely Ga-1, Ga-2, and Ga-3, are selected to study the reservoir properties and stratigraphic relationships for the Mishrif succession. Six main microfacies are identified, which are lime mudstone, bioclastic wackestone, bioclastic packstone-wackestone, bioclastic wackestone-mudstone, pelagic mudstone-wackestone, and bioclastic packstone-grainstone microfacies in addition to their associated depositional environment. The diagenesis process has affected the Mishrif rocks and played a role in deteriorating reservoir porosity in well Ga-2 and enhancing it in wells Ga-1 and Ga-3. These processes include cementation, micritization, recrystallization, dissolution, compaction pressure solution, and dolomitization. The formation is subdivided into three main lithological units separated by an impermeable unit depending on the log's response. Middle Mishrif has been divided into MB1, MB2, and MB4 in Ga-1 and Ga-3, and MB3 and MB4 in Ga-2 according to log data and microfacies analysis. Reservoir properties are determined by using different well logs. Porosity is calculated via (sonic, neutron, and density) logs, and its value is compared with porosity derived from core analysis. The primary porosity represents the main porosity in the formation, while the secondary is rare. The log response shows that the Mishrif Formation has different oil contacts. In Ga-1 and Ga-3, it occurs at 2360 m, while in Ga-2, it is at 2344 m. The results of water and hydrocarbon saturation show it also has different quantities of water, residual oil, and mobile oil. The main hydrocarbon accumulation is found in well Ga-3, then Ga-1, and less accumulation appears in Ga-2. The microfacies analysis shows that the Mishrif Formation forms a shallowing upwards succession starting with a deep shelf environment and ending with a restricted environment and consists of two third-order. Two maximum flooding surfaces are determined within the formation. The seismic section shows the downlap termination that forms the stratigraphic trap in the western side of the field, dividing the field into two sectors: an eastern sector where Ga1 and Ga3 are located and a western sector where Ga-2 is located.

Keywords

Mishrif Formation, Gharraf Oil Field, Mudstone, Wackestone, Packstone

1. Introduction

The Cretaceous succession has been extensively studied because it contains abundant reservoir intervals. It is the most productive interval in Iraq and contains about 80% of the country's oil reserves. The Mishrif Formation is the most important carbonate reservoir in southeast Iraq, and it contains oil in 32 structures. The largest accumulation is in the Rumaila North, Rumaila South, West Qurna, Zubair, Majnoon, and Halfaiya fields, located on a large-scale north-south trending anticline. At least 15 other commercial oil accumulations in the Mishrif Formation have been discovered in southeast Iraq: Abu Ghirab, Ahdab, Amara, Buzurgan, Dujaila, Jabel Fauqi, Gharraf, Hawaiza, etc., (Aqrawi et al., 2010).

The earliest study of the Mishrif Formation started in 1952 by Rabanit, who described the formation in Zubair area (Zu-3) of southern Iraq, (Buday, 1980).

1.1. Geological Setting

The Gharraf oil field is located south of Iraq in Thi Qar province, about 85 km to the north of Nassriya city. The Gharraf oil field is a northwest-southeast trending anticline with an area of 24 km length and 5 km width. Three wells, Ga-1, Ga-2, and Ga-3, have been chosen to study the Mishrif Formation. The main oil accumulation zones in the field are the Mishrif and Yamama Formations. The second accumulation zones are found in the Ratawi and Zubair Formation **Figure 1**.

The Zagros Suture Zone and the Arabian Shelf (Stable and Unstable Shelf) are Iraq's two fundamental tectonic components, (Jassim & Goff, 2006). The Euphrates Subzone, which is regarded as a component of the Mesopotamian Foredeep Basin, is where the study area is located inside the Mesopotamian Zone.

The largest and wealthiest petroleum province in Iraq is located in the Mesopotamian Zone, which is the easternmost unit of the Stable Shelf and is dominated by Cretaceous plays (Aqrawi et al., 2010). This zone likely experienced an uplift during the Hercynian deformation, but it began to subside in the Late Permian. To the east, the Mesopotamian Zone's sedimentary column thickens. It includes Upper Cretaceous 700 - 1400 meters. Beneath the Quaternary layer, the Mesopotamian Zone has buried faulted structures that are divided by wide synclines. In the eastern portion of the zone, the fold structures mostly follow the Gharraf structure's northwest-south-east pattern. To the west of the Mesopotamian Zone

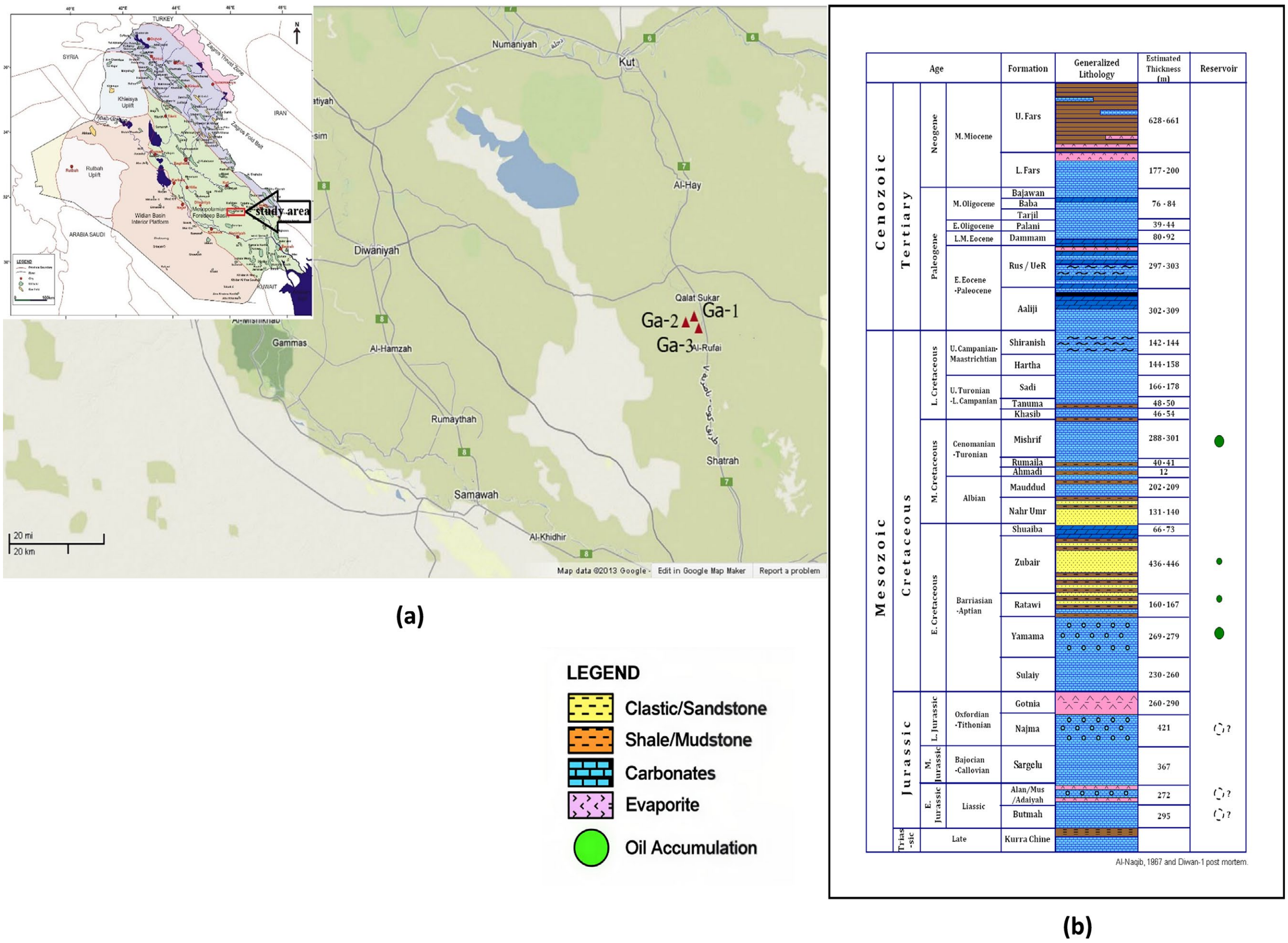

Figure 1. (a) General map of Iraq showing major tectonic units and oil/gas field location (Al-Ameri et al., 2011), the box shows the location of the study area. (b) Stratigraphic Column of the Gharraf Oil Field in well Ga-1 modified after Al-Naqib (1967).

is the Euphrates Subzone. It is a monocline with structural noses and short anticlines (less than 10 km) that dip northeast. Some longer anticlines (20 - 30 km long) that are oriented northwest-southeast are located close to and parallel to the Euphrates Boundary Fault. Typically, the basement is 7 - 6 km deep, (Jassim & Goff, 2006).

The Gharraf structure forms one of a series of anticlinal structures developed on the southern flank of the Zagros Mountain front flexure. The trend of the anticline is parallel to the main Zagros trend.

1.2. Stratigraphy

The Mishrif Formation (Cenomanian-Early Turonian) is a heterogeneous deposit that was first identified as organic detrital limestones with limonitic freshwater limestones on top, (Bellen et al., 1959, in Aqrawi et al., 2010).

The lower contact of the formation is conformable with the underlying unit Rumaila Formation. The upper contact of the Mishrif Formation is unconformable with Khasib Formation.

The Mishrif Formation was deposited through the Late Tithonian-Early Turonian Megasequence AP8, according to Sharland et al. (2001), within the Albian-Early Turonian Sequence (Wasi'a Group). The Mishrif Formation is thickest in the Rumaila and Zubair fields (270 m); in the Nahr Umr and Majnoon fields along the Iraq-Iran border, it becomes 435 m thick, and in Abo Amud field between Kut and Amara, it is 380 m thick. Other isolated occurrences lie near Kifl (255 m) and Samarra (250 m) (Jassim and Goff, 2006). The thickness of the formation in Gharraf oil field reaches 301 m.

1.3. Paleogeography and Equivalent Formation

According to Jassim and Goff (2006), longitudinal ridges and transversal blocks like the Kirkuk Embayment and the Mosul High were reactivated as a result of deformation along the Arabian Plate's northeast Tethyan margin during the Cenomanian-Early Turonian period. The Cenomanian Sea transgressed onto the Rutba and Mosul Highs, which had re-emerged during the Early Turonian.

In the Balambo-Tanjero Zone, pelagic Balambo Formation deposition continued. A few north-west-southeast trending ridges on the shelf (aside from the main Rutba and Mosul Highs) have split the basin into smaller basins, resulting in facies variations. The following are the main facies belts of the Cenomanian-Early Turonian Sequences:

1) A western clastic-carbonate inner shelf: where the Rutba Formation's clastics were deposited, followed by the M'sad's coastal and supratidal carbonates.

2) A deep inner-middle shelf sea: where the Rumila Formation's marls and limestones from deeper water were deposited.

3) A belt of shoals and rudist patch reefs of the Mishrif Formation: which developed in the Rumaila basin over activity-growing structures.

4) A deep-water basin: formed in the Balambo-Tanjero Zone, the plate margin where the Upper Balambo Formation's basinal limestones were deposited. This basin moved southwestward, encroaching on the Foothill Zone in the Kirkuk Embayment.

5) An isolated deep basin: was formed between the Rumaila basin in the southwest and the Balambo basin in the NE. It covered the Foothill Zone, particularly the Kirkuk Embayment, where the basinal oligosteginal limestones of the Dokan Formation and the euxinic shales of the Gulneri Formation were deposited.

6) The lagoonal inner shelf: The Mesopotamian Zone is where the desiccation basin of the Kifl Formation, the youngest unit of the sequence, formed.

The carbonates of the Gir Bir and Mergi formations were formed in a comparatively narrow basin in northwest Iraq, primarily in the Sinjar region; these facies are now part of the Mishrif Formation. In the direction of the Rutba Subzone, the Mishrif Formation passes into the M'sad Formation.

The formation is equivalent to the Mardin Formation in southeast Türkiye, the Sarvak Formation in the Zagros, the Mishrif Formation and the upper part of the Magwa Formation in Kuwait, and the lower part of the Judea Formation in central and northeast Syria (Jassim & Goff, 2006).

2. Microfacies Analysis

The microfacies classification of Mishrif Formation has been identified according to Dunham classification (1962) (**Figure 2**). This classification is easy to apply and depends on the texture of the rock. The environment of the formation is determined in addition to the diagenetic processes and their effects on reservoir properties.

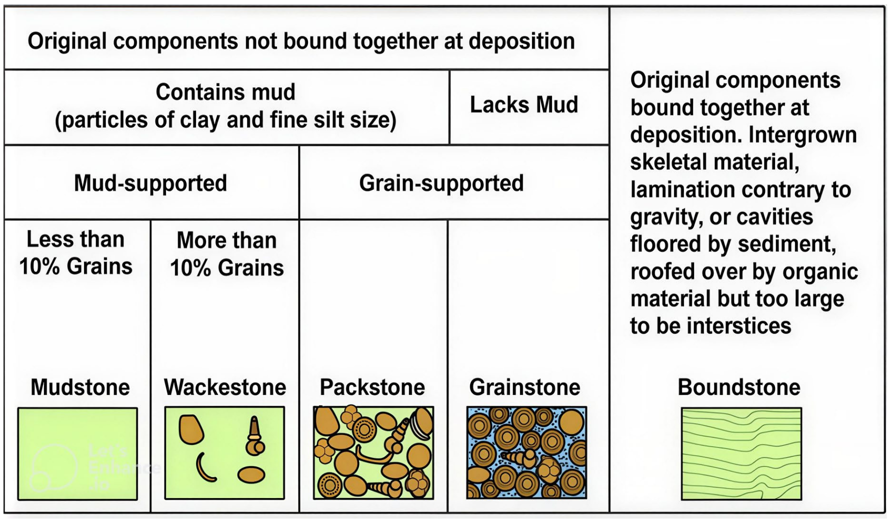

Figure 2. Dunham classification (Dunham, 1962).

2.1. Microfacies and Marine Depositional Environments

The microfacies study offers a comprehensive inventory of carbonate rock properties that can be linked to depositional conditions, such as carbonate grain types, fossil types and growth forms, grain size and shape, micrite type, cement, and particle fabrics (Boggs, 2009).

Seventy-three thin sections have been examined to determine the microfacies and depositional environments of the Mishrif Formation according to standard microfacies types (**Figure 3**).

1) Restricted platform interior environment (FZ8): the microfacies association with this environment is lime mudstone microfacies, mainly composed of homogeneous unfossiliferous (pure micrite). Some parts of these facies have been dolomitized. The standard microfacies (SMF), which is similar to SMF (23). This microfacies type was found in wells Ga-1 and Ga-2.

2) Open marine platform interior environment (FZ7): consists of two types of facies

- Bioclastic wackstone microfacies: included shell fragments, echinoderm fragments, and some benethic foraminifera. It's similar to SMF(9). This microfacies has been recognized in the three wells Ga-1, Ga-2, and Ga-3.
- Bioclastic packstone-wackstone microfacies: dominated by shell fragments, some of these shells related to Pelecypods . And some foraminifera cored with micrite envelops also found. It is similar to SMF (10) and recognized in well Ga-3.

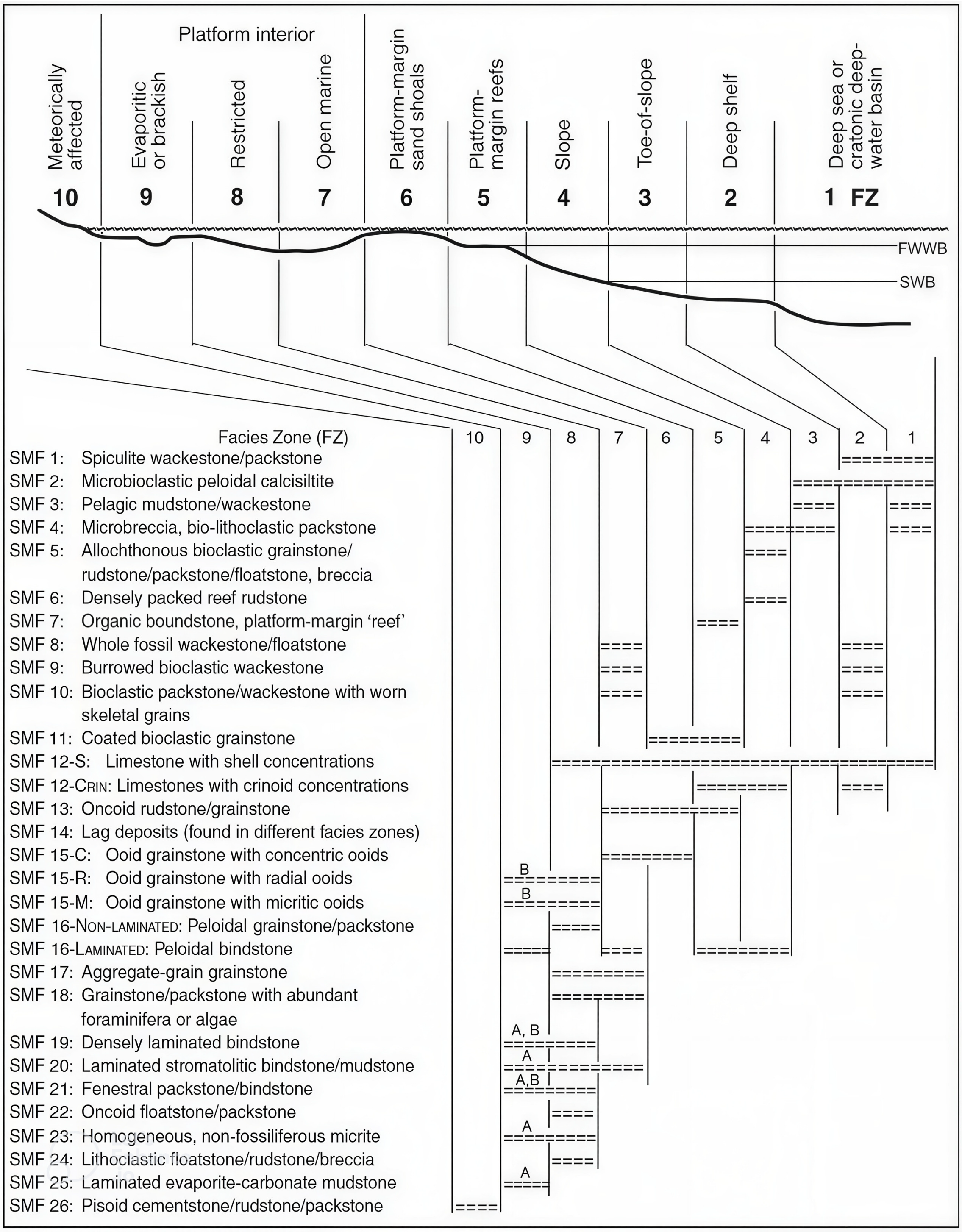

Figure 3. Distribution of SMF Types in the Facies Zone (FZ) of the rimmed carbonate platform model (Flügel & Munnecke, 2010).

3) Deep shelf environment (FZ2): the microfacies that represents this environment is bioclastic wackstone-mudstone microfacies. Allochems of this microfacies are characterized by small shell fragments and some types of planktonic foraminifera. This microfacies is similar to SMF (9) and distinguished in the well Ga-2

only because there are no available samples in the other wells (**Figure 6(c)**).

4) Toe-of-slope environment (FZ3): pelagic mudstone-wackstone microfacies represents this environment, which consists of planktonic foraminifera and calcispheres that dominate in this microfacies. It's similar to SMF (3). It is recognized in the three wells (**Figure 5(a)**, **Figure 5(d)-(f)**, **Figure 6(b)**, **Figure 6(d)-(f)**).

5) Platform margin reefs environment (FZ5): The microfacies representing this environment is bioclastic packstone-grainstone microfacies. The major component is rudist. Rudist fragments range from small to large sizes, rare to common mollusk fragments. This microfacies is similar to SMF (7). This facies represents the main reservoir unit, and it has been recognized only in wells Ga-1 and Ga-3 (**Figure 5(b)**, **Figure 5(c)**).

2.2. Diagenesis Process

Physical, chemical, and biological processes are all referred to as diagenesis. Compared to most silicate minerals, carbonate minerals are generally more prone to diagenetic processes such dissolution, recrystallization, and replacement, (Boggs, 2009). The diagenetic processes that affect the Mishrif rocks are:

1) Cementation: this process has a negative effect on the porosity and permeability of the formation in the study area. Several types of calcite cement have been recognized in the Mishrif rocks; these types are bladed, drusy, dogtooth and blocky (**Figure 6(a)**, **Figure 6(b)**).

2) Micritization: most fossils' skeleton grains have been destroyed as a result of this process, which has had a significant impact on the Mishrif rocks in the study area (**Figures 5**, **Figures 6**).

3) Recrystallization: this process affected some parts of the formations characterized by the transformation of micrite to microsparite.

4) Dissolution: the Mishrif formation is clearly and favorably impacted by this process, which increases porosity and improves permeability.

5) Compaction and pressure solution (stylolization): There are several styles and types of stylolite; some of them have been recognized in the formation (**Figure 6(c)**).

6) Dolomitization: The formation in the studied area is less affected by this process. Carbonate rocks have a variety of dolomite textures. The Mishrif formation has three distinct forms of dolomite texture: planar-euhedral, planar-void-filling, and planar-porphyrotopic (**Figure 5(f)**, **Figure 6(d)**).

In addition to the presence of authigenic pyrite, which has been recognized at different depths in the formation. The cubic form of pyrite and pyrite inside foraminifera chambers has been noticed (**Figure 6(e)**).

2.3. Porosity Types

Several types of porosity are recognized in thin sections derived from core and classified according to Choquette and Pray 1970 in (Flügel, 2004), **Figure 4**, which are:

Fabric-selective pores: interparticle (intergranular) porosity, intraparticle (intragranular) porosity, fenestral porosity, intercrystalline porosity, and moldic porosity (**Figure 5(c)**, **Figure 6(f)**).

Non-fabric selective pores: channel porosity, vuggy porosity, and cavern porosity (**Figures 5(b)-(e)**, **Figure 6(a)**, **Figure 6(b)**).

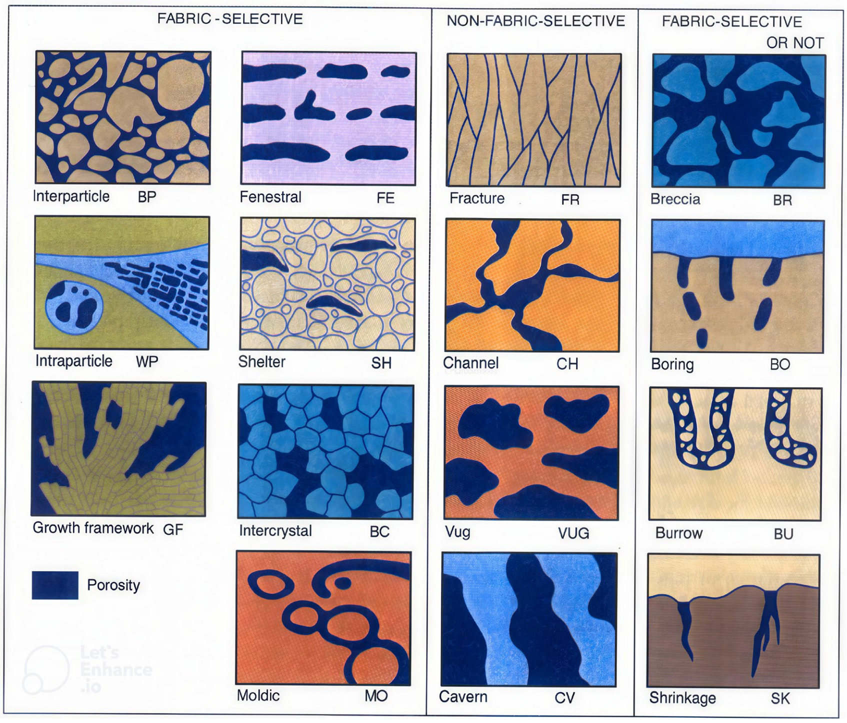

Figure 4. Pore types and porosity classification Choquette and Pary, 1970 in (Flügel, 2004).

3. Reservoir Characterization

Well logs can be used to record a wide range of rock characteristics, including radioactivity, density, sonic velocity, and formation resistivity. The lithology and porosity of the penetrated formation, as well as the kind and quality of fluids (oil, gas, or water) inside pores, can subsequently be ascertained by interpreting the recoded data (Selley, 1998).

3.1. Determination of Lithology

The lithology of the Mishrif Formation has been determined using two types of cross plots: the neutron-density lithology plot, which indicates that the main lithology of the formation is limestone (**Figure 7(a)**), and the neutron-sonic lithology plot, which shows that the main lithology of the formation is limestone in wells Ga-1 and Ga-2 and dolomitic limestone in well Ga-3 (**Figure 7(b)**).

A comparison of the two cross plots shows that the neutron-sonic plot indicates a much more dolomitic lithology compared to the neutron-density plot. This difference is due to the presence of vuggy porosity.

The nuclear logs (neutron and density) assess overall porosity, while the sonic log solely measures matrix porosity (intergranular and intercrystalline). Consequently, sonic porosity is lower than total (neutron-density) porosity when vuggy porosity is present, and the data cluster is lower on the neutron-sonic plot, i.e., more dolomitic (Asquith & Krygowski, 2004).

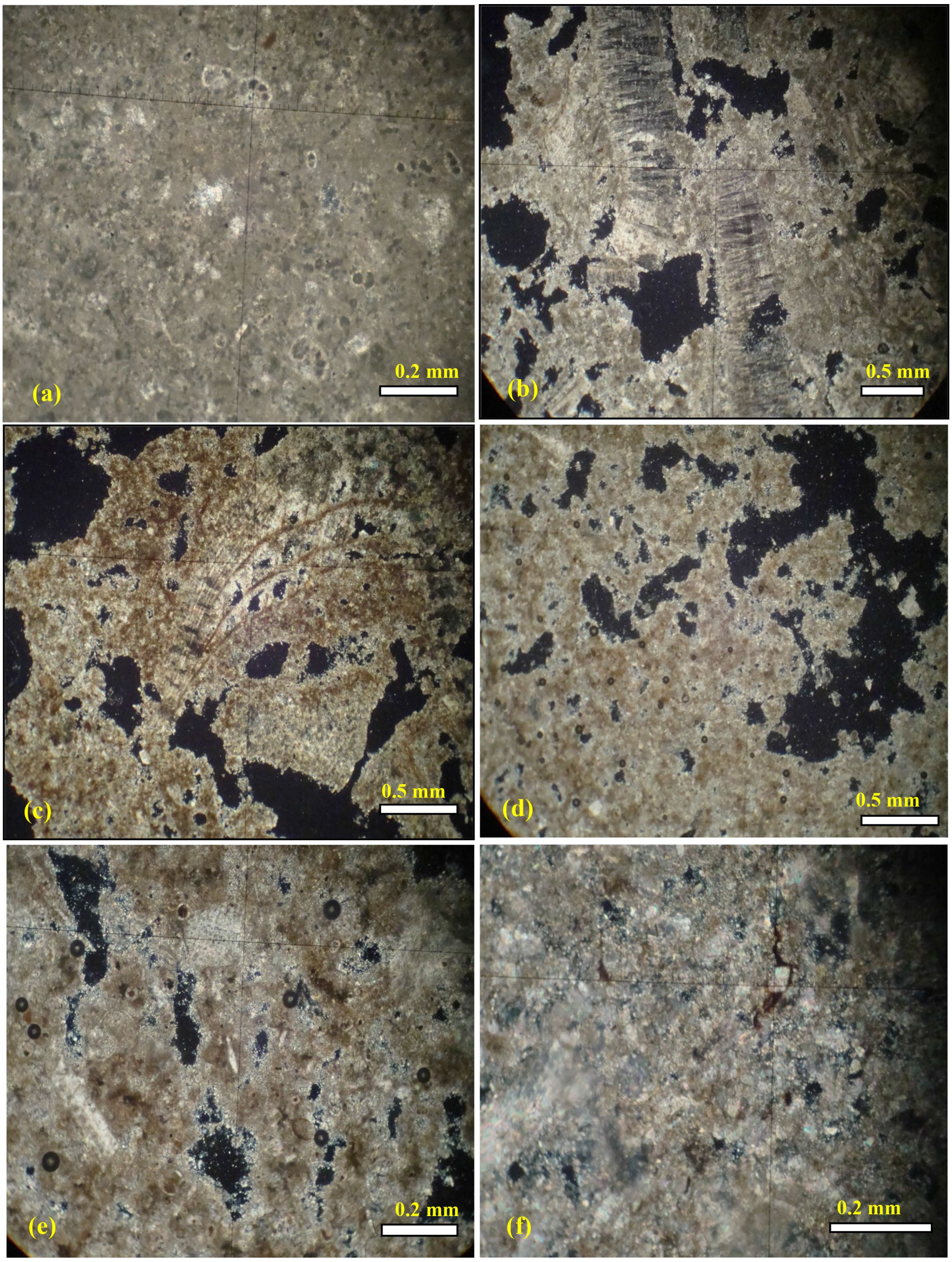

Figure 5. (a) Pelagic wackestone-mudstone microfacies, micritization process, Ga-2, 2404 m (100×). (b) Rudist in bioclastic packstone grainstone microfacies, micritization process ,vuggy and cavern porosity, Ga-3 C.3, 2339.50 m, (40×). (c) Rudist in bioclastic packstone microfacies, micritization process, vuggy and intragranular porosity, Ga-3, C.2, 2337 m (40×). (d) Pelagic mudstone-wackestone microfacies, micritization process, cavern porosity, Ga-1, C5, 2400 m (40×). (e) Pelagic mudstone wackestone microfacies, micritization process, vuggy porosity, Ga-1, C. 5, 2400 m (100×). (f) Pelagic mudstone wackstone microfacies, micritization process, dolomitization process (planar void-filling). Ga-3, C.4, 2361 m (100×).

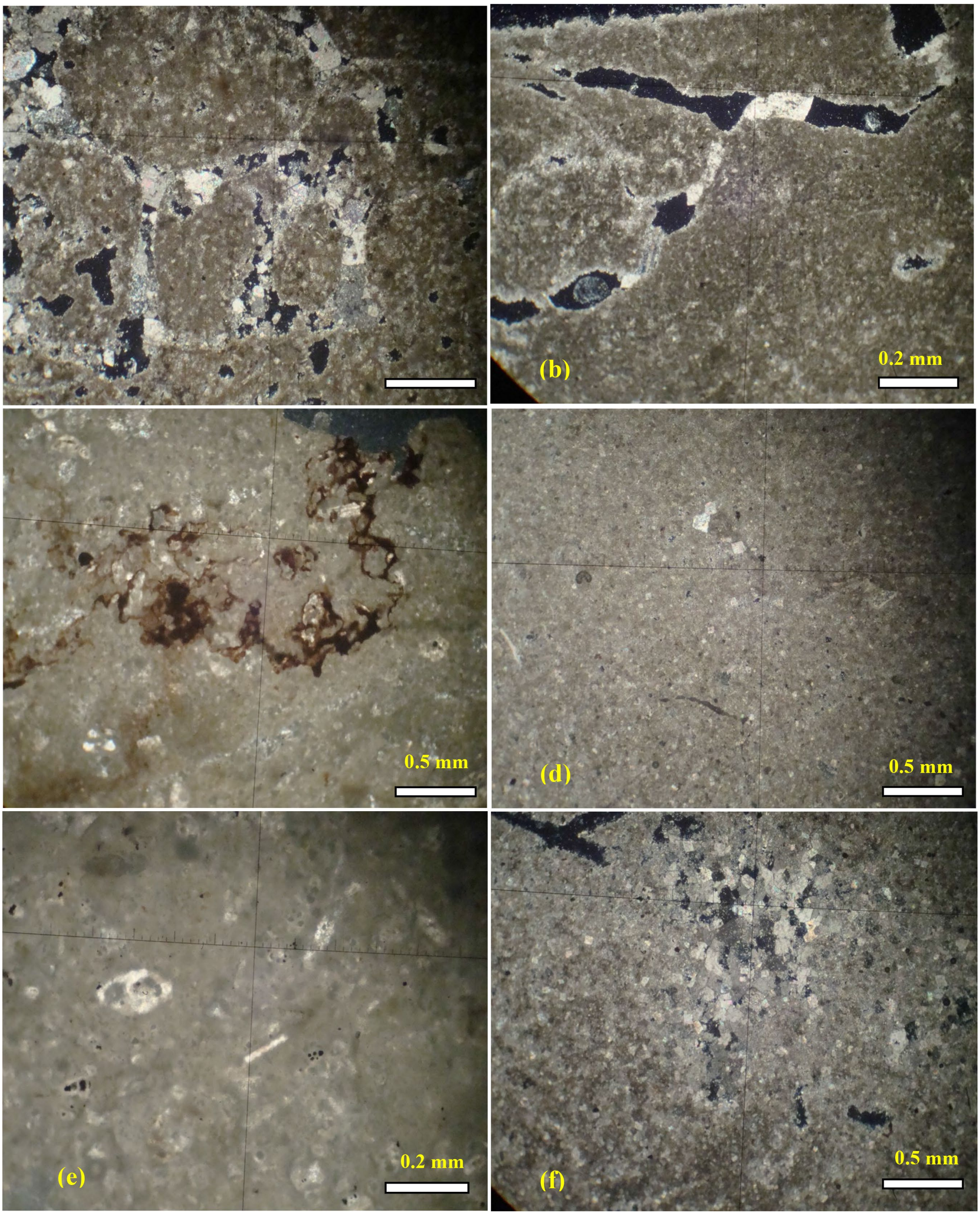

Figure 6. (a) Bioclastic wackstone microfacies, micritization process, drusy and blocky cement, channel and vuggy porosity Ga-3 C.1, 2320.50 m (40×). (b) Pelagic mudstone-wackestone microfacies, micritization process, channel porosity, blocky cement, Ga-3, C2, 2333 m (100×). (c) Bioclastic wackestone-mudstone microfacies, micritization process, sutured seam bedding parallel small amplitude, Ga-2, 2510 (40×). (d) Pelagic mudstone-wackestone microfacies, micritization process, dolomitization process (planar-porphyrotopic texture), Ga-3, C2, 2333 m (40×). (e) Pelagic mudstone-wackestone microfacies, micritization process, pyrite inside foraminifera chambers, Ga-2, 2339 m (100×). (f) Pelagic mudstone-wackestone microfacies, micritization process, intercrystaline porosity, Ga-3, C2, 2334 m (40×).

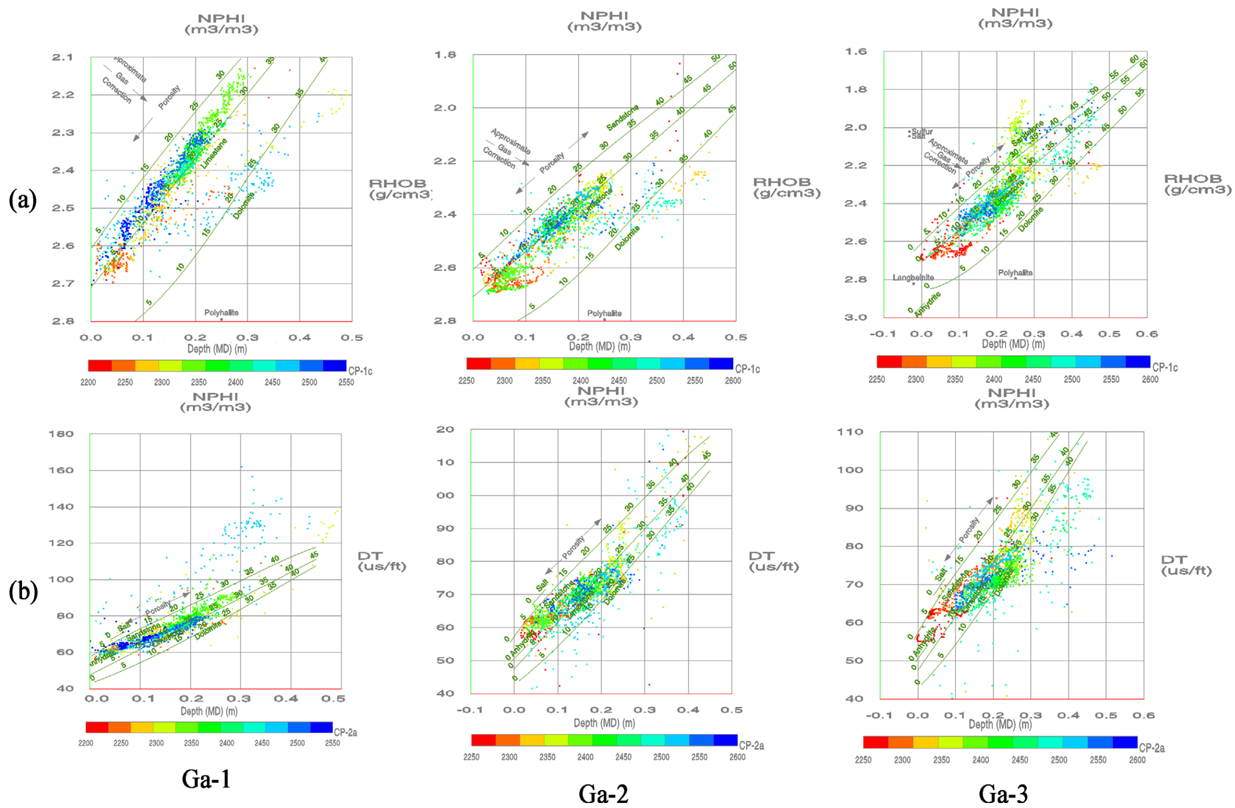

Figure 7. (a) Neutron-density lithology plot, (b) Neutron-sonic lithology plot for the Mishrif Formation in the three wells.

3.2. Mishrif Zonation

According to the Computer Processing Interpretation (CPI) results (**Figure 8**), the Mishrif Formation in Gharraf oil field has been divided into three main reservoir zones, named Upper Mishrif (MA), Middle Mishrif (MB), and Lower Mishrif (MC). These reservoir zones have been sealed by three cap layers named (CI, CII, CIII) (**Figure 9**). The cap rock intervals are characterized by high Gamma Ray (GR) and high sonic transit time (Dt) values. The neutron log records high readings in these zones due to the presence of bound water, while the density log shows comparatively lower values. In contrast, the reservoir intervals exhibit low GR and lower Dt values. Additionally, the neutron log in the reservoir zones displays lower readings than in the cap rock, indicating reduced clay and bound water content.

4. Stratigraphic Relationships and Dynamics of Trapping

Sequence stratigraphy examines how sediments react to variations in base level as well as the depositional patterns that result from the interaction between sedimentation and accommodation. Sequence stratigraphy holds great promise for improving the predictive aspect of economic exploration and production as well as for deciphering the Earth's geological record of local to global changes (Catuneanu, 2006).

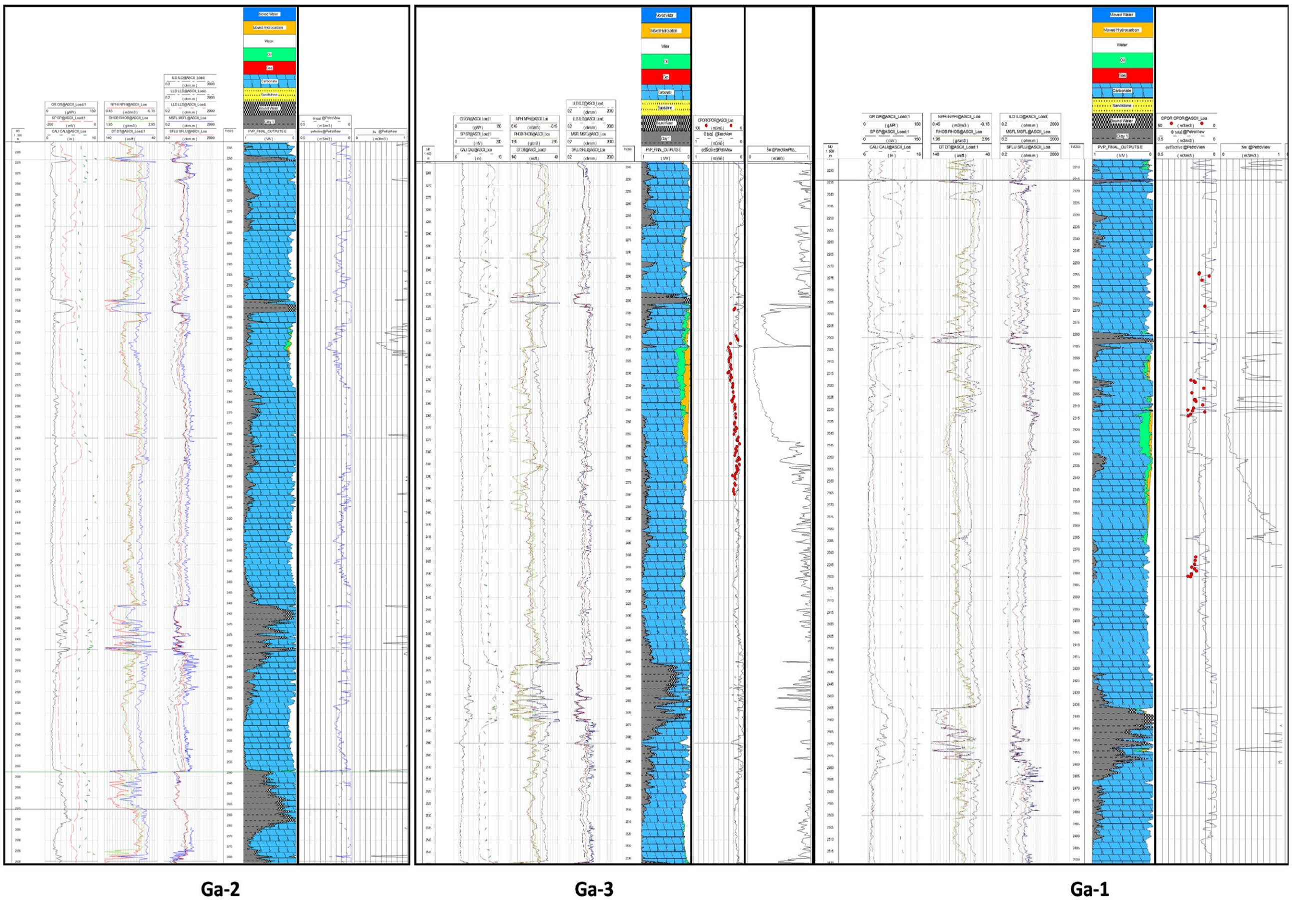

Figure 8. CPI of the Mishrif Formation for wells Ga-1, Ga-2 and Ga-3.

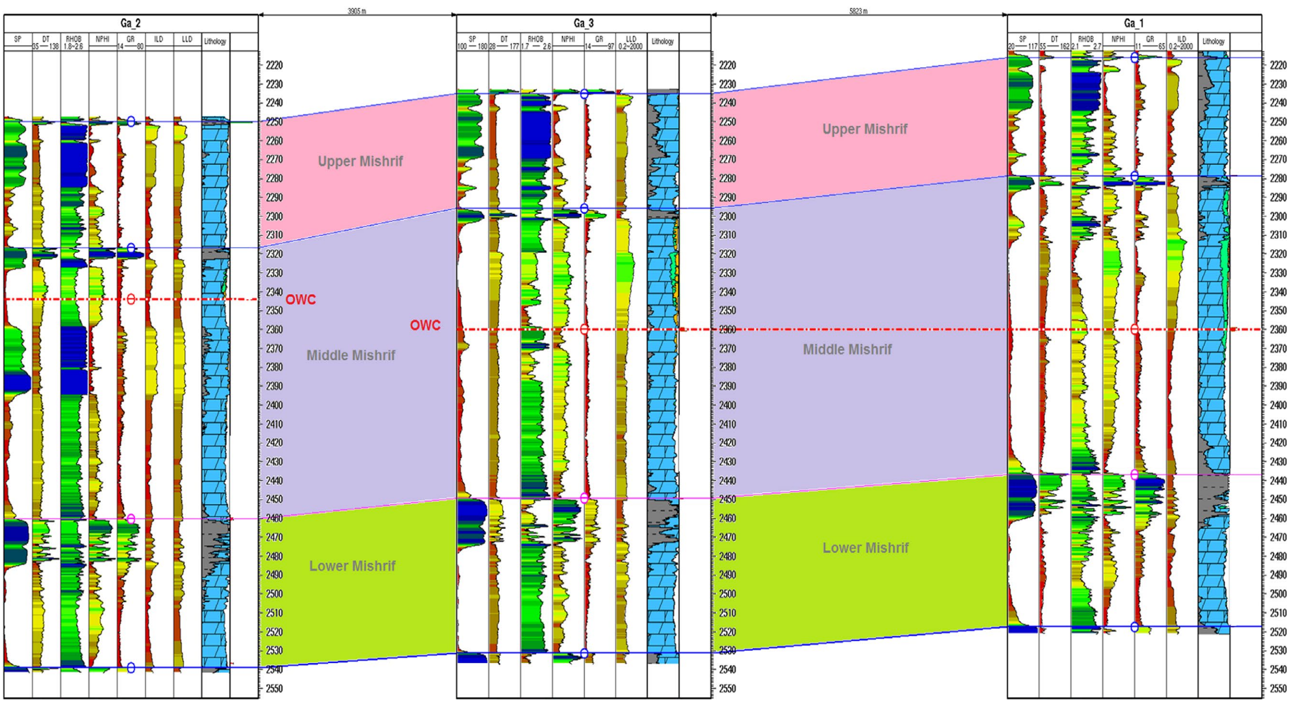

Figure 9. Mishrif zonation and correlation section between three wells using well logs data.

4.1. Sequence Stratigraphy of Mishrif Formation

The microfacies analysis for the Mishrif Formation in Gharraf oil field shows a shallowing upwards succession (**Figure 10**). The sub-basinal facies (CII) developed at the base of the upper sequence corresponds to K140 MFS of Sharland et al. (2001) (**Figure 11**). This shale unit has a regional extension named the Surgeh and is found in the three wells: Ga-1, Ga-2, and Ga-3. The other shale unit (CIII) on the top of MC corresponds to the flooding surface K135, which is intermediate between the K130 (intra-Rumaila) and K140 (top-Mishrif) MFS of Sharland et al. (2001) and found in the three wells. In the stratigraphic column sequence analysis, the Mishrif Formation succession in all wells is subdivided into three depositional sequences. They are labeled S1, S2, and S3 in ascending order in **Figure 10**.

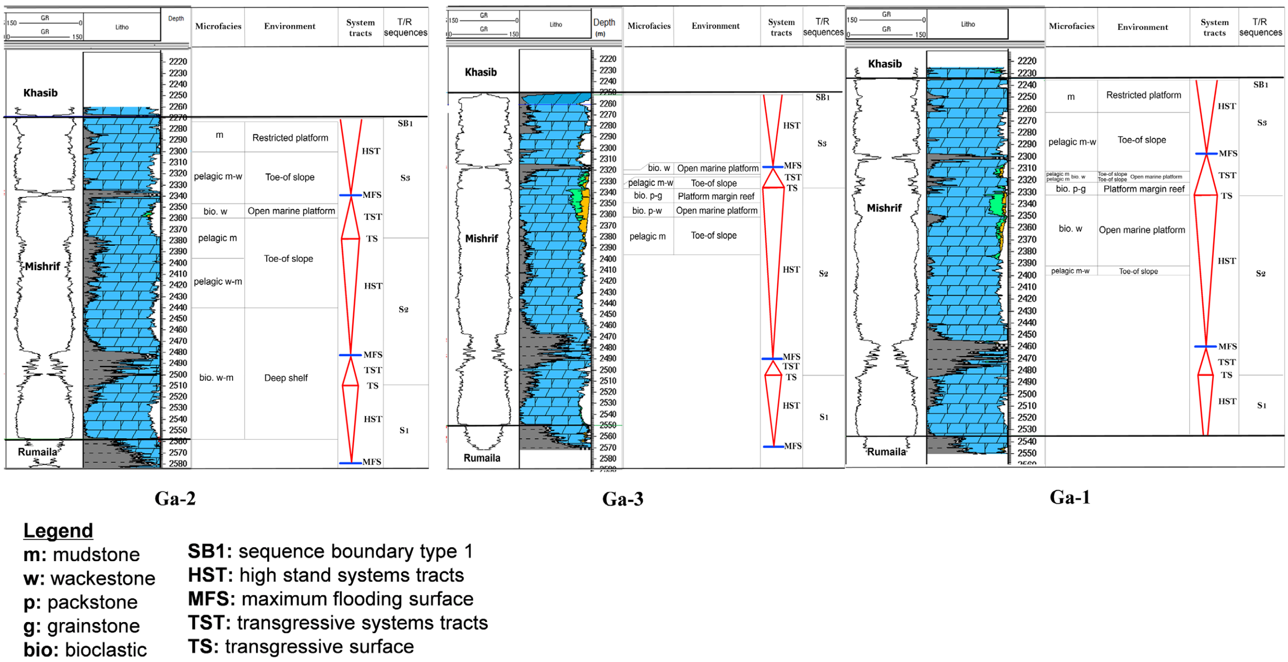

Figure 10. Sequence stratigraphic analysis of Mishrif Formation for the three wells showing T-R sequences and their subdivisions.

4.2. Mishrif Cycle

The Mishrif Formation consists of two third-order sequences separated by an intraformational unconformity. Both sequences comprise three medium-scale cycles. In Gharraf well, three order parasequences have been recognized. The lower part of the Mishrif succession represents the highstand cycle bounded below by the maximum flooding surface, which represents the lower boundary of the Mishrif Formation with the underlying Rumaila Formation. HST is followed by another episode of deepening represented by shoal deep facie TST indicating another sea level rise. This episode ended with MFS135. The same cycle is repeated again and ends with MFS140. The third cycle ended with the unconformity surface SB1 that separated the Mishrif and Khasib Formation. A minor fluctuation within each third-order cycle can be recognized in the studied wells using a gamma ray log.

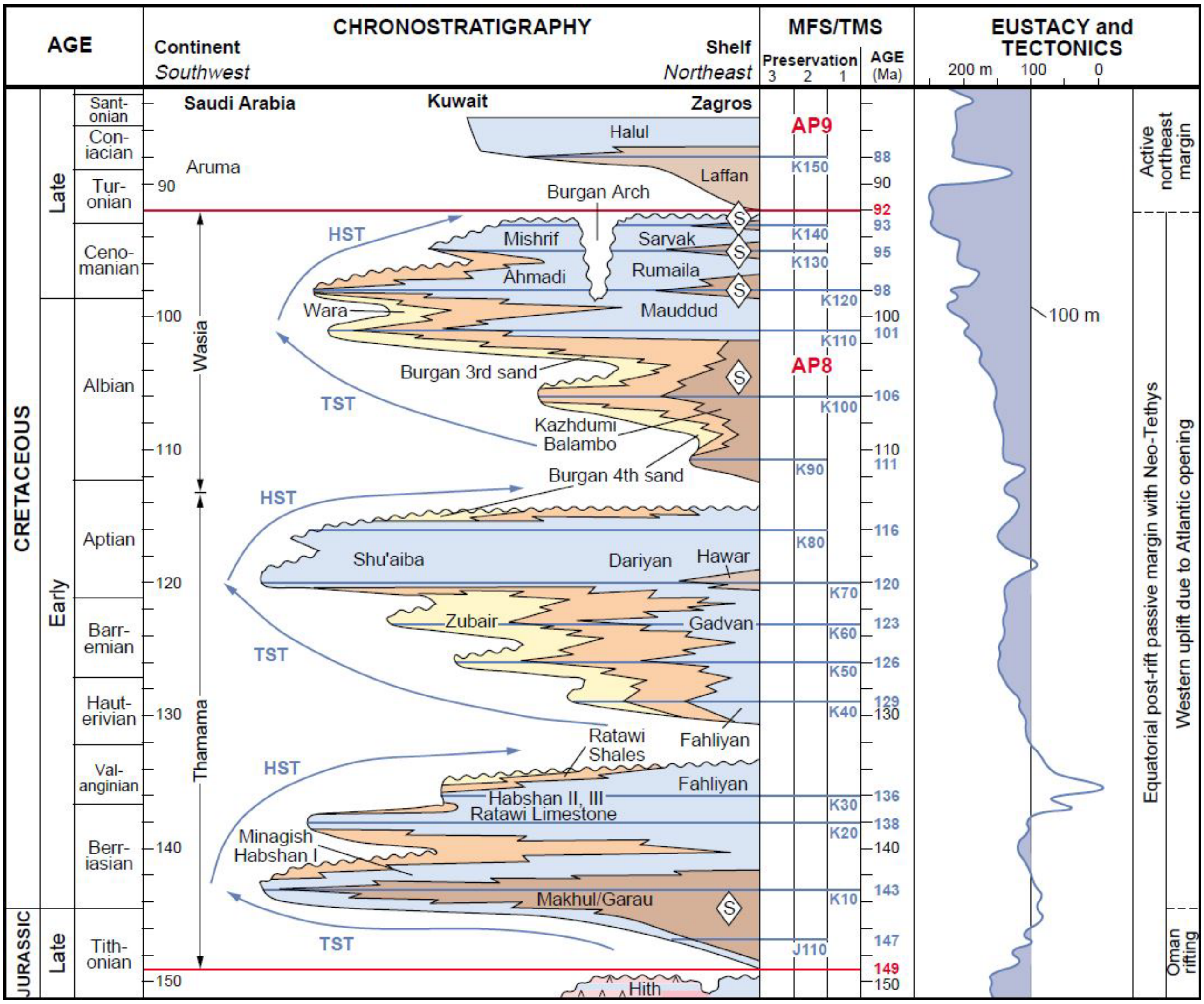

Figure 11. Schematic chronostratigraphic section for megasequence AP8 (149-92 Ma) (Sharland et al., 2001).

4.3. Dynamics of Trapping in Gharraf Oil Field

The Gharraf oil field is a northwest-southeast trending anticline. According to the microfacies analysis of the three wells in the field, there are lateral facies variations in the field, and the reservoir properties become poor toward Ga-2.

The electrical logs show that the main oil accumulation is found in wells Ga-3, Ga-1, and Ga-2, in order from most to least. The oil-water contact is determined in Ga-1 and Ga-3 at 2360 m and 2344 m in well Ga-2 by using log data, **Figure 12**.

Middle Mishrif have been divided into MB1, MB2, and MB4 in Ga-1 and Ga-3 and MB3, MB4 in Ga-2 according to log data and microfacies analysis, **Figure 12**.

3D seismic section of the field, **Figure 13** shows that the upper Mishrif (MA) and lower Mishrif (MC) are continuous along the section, while the middle Mishrif (MB1, MB2) disappears toward Ga-2 and is replaced by MB3, which has different reservoir and facies characterization than MB1 and MB2 and forms downlap strata termination.

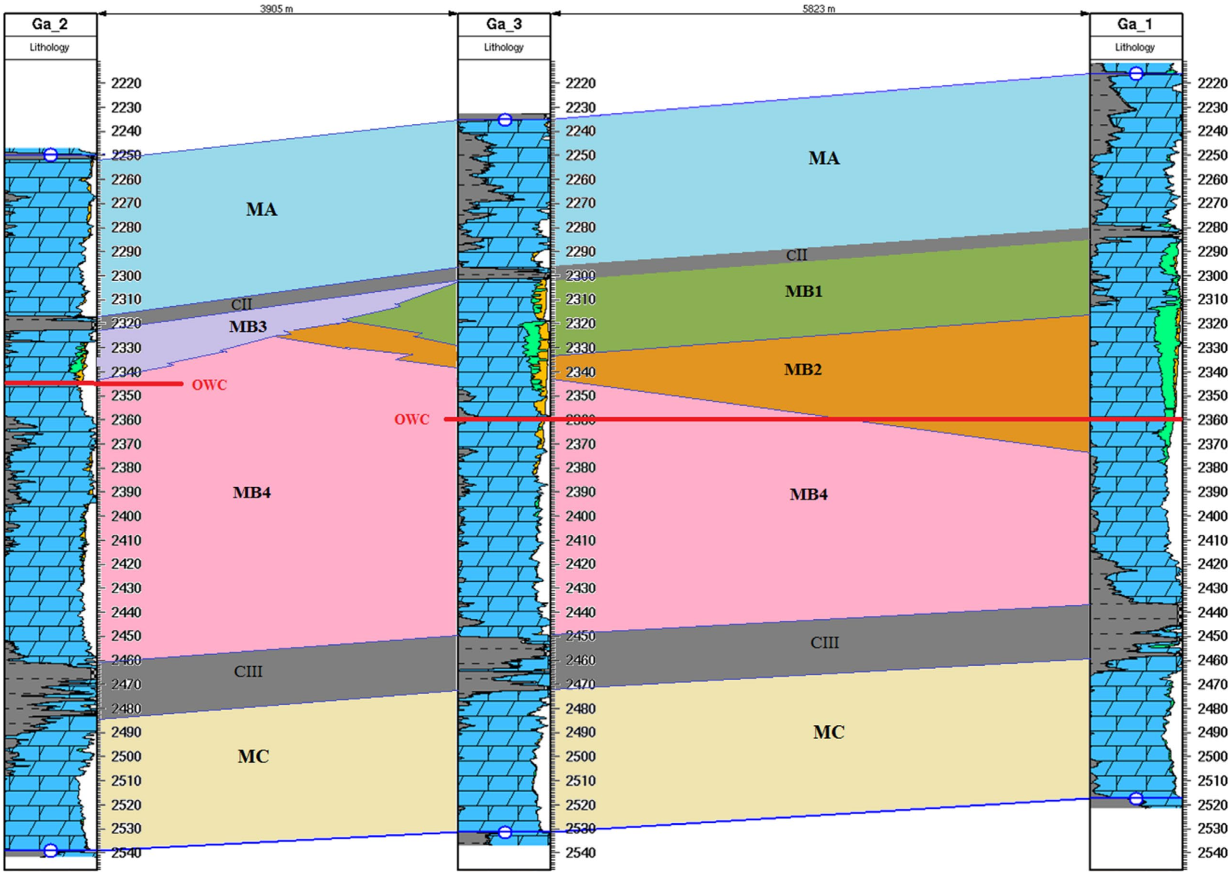

Figure 12. Correlation section between three wells from sea level.

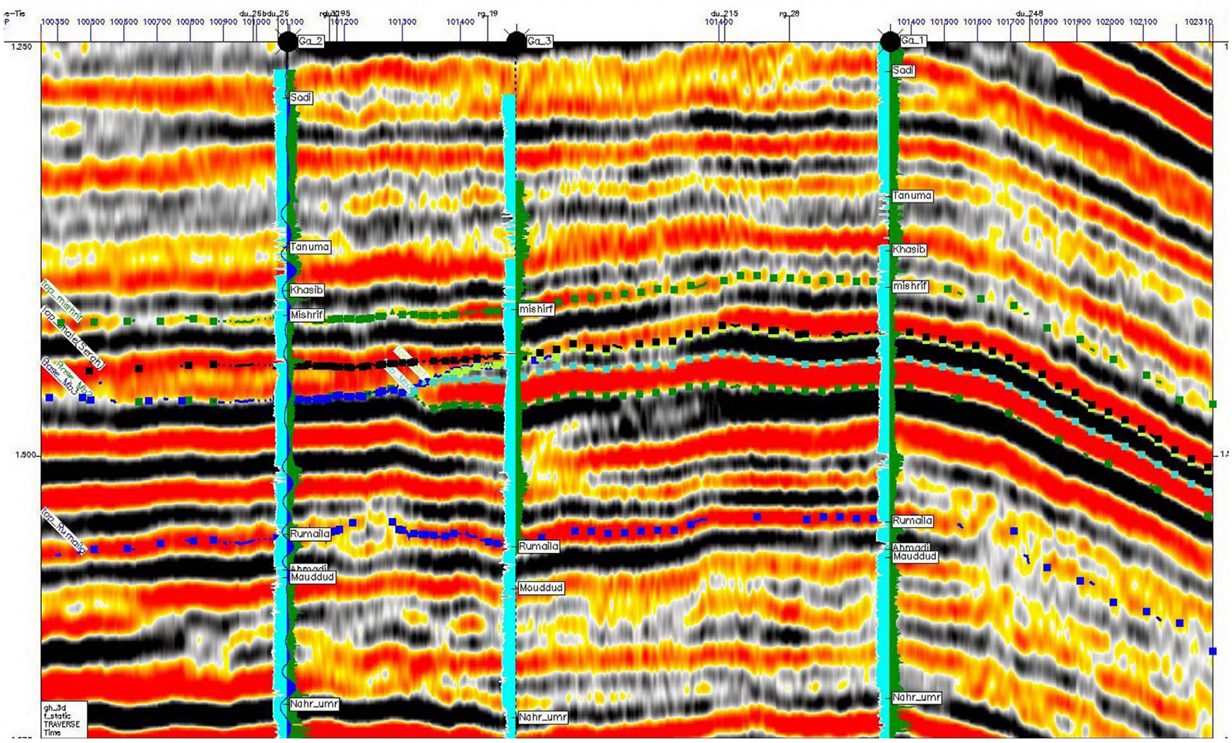

Figure 13. 3D seismic section.

According to all these studies (microfacies study, reservoir characterization study, and stratigraphic relationships study), the oil is trapped by an anticlinal trap in the east of the field, which includes Ga-1 and Ga-3. While the dynamic of trapping in the west side of the field, which includes Ga-2, is a stratigraphic trap caused by facies variation.

5. Conclusion

The study of Mishrif Formation in Gharraf oil field shows that:

1) Six microfacies are present in thin sections of Mishrif rocks, which are lime mudstone, bioclastic wackestone, bioclastic packstone-wackestone, bioclastic wackestone-mudstone, pelagic mudstone-wackestone, and bioclastic packstone-grainstone microfacies. Their association environments are restricted platform interior environment (FZ8), open marine platform environment (FZ7), deep shelf environment (FZ2), toe-of-slope environment (FZ3), and platform margin reefs (FZ5).

2) Several diagenetic processes have an impact on the Mishrif Formation. which include compaction, dolomitization, cementation, micritization, recrystallization, dissolution, and pyritization.

3) Several types of porosity have been distinguished: fabric-selective pores (interparticle, intraparticle, fenestral, intercrystalline, and moldic porosity) and non-fabric-selective pores (channel, vuggy, and cavern porosity).

4) The microfacies analysis of Mishrif Formation shows that there are lateral facies changes between Ga-1,3 and Ga-2. The main reservoir facies (bioclastic packstone-wackestone), which contains large rudists, is found only in wells Ga-1 and Ga-3 and is replaced by bioclastic wackestone microfacies, which contains talus in well Ga-2.

5) The Mishrif formation is divided into three main reservoir units (MA, MB, and MC) capped by three shale layers (CI, CII, and CIII). The middle Mishrif has been divided into MB1, MB2, and MB4 in Ga-1 and Ga-3 and MB3 and MB4 in Ga-2 according to log data and microfacies analysis.

6) The CPI shows that MB is the main producing unit, and the largest oil accumulation is found in wells Ga-3, Ga-1, and then Ga-2, in order from high to low.

7) According to the log's response and the calculations of water and hydrocarbon saturation, the oil-water contact is determined at 2360 m in Ga-1 and, Ga-3 and at 2344 m in well Ga-2.

8) The neutron-density lithology plot and neutron-sonic lithology plot showed that limestone is the main lithology of the formation.

9) The Mishrif-Khasib unconformity, maximum flooding surfaces, and transgressive surfaces are the major key surfaces used to correlate the depositional sequences.

10) The microfacies analysis shows that the Mishrif Formation forms a shallowing upwards succession starting with a deep shelf environment and ending with a restricted environment and consists of two third-order.

11) The seismic section shows the downlap termination strata caused the stratigraphic trap (facies change) in the western side of the field.

12) According to facies and logs information, the Mishrif Formation in Gharraf oil field is divided into an eastern sector, where Ga-1 and Ga-3 are located, and a western sector, where Ga-2 is located.

13) The dynamics of trapping are a structural trap in the eastern side of the field and a stratigraphic trap in the western side.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Al-Ameri, T. K., Zumberge, J., & Markarian, Z. M. (2011). Hydrocarbons in the Middle Miocene Jeribe Formation, Dyala Region, NE Iraq. *Journal of Petroleum Geology, 34,* 199-216. https://doi.org/10.1111/j.1747-5457.2011.00501.x

Aqrawi, A. A., Goff, J. C., Horbury, A. D., & Sadooni, F. N. (2010). *The Petroleum Geology of Iraq* (vol. 424). Scientific Press.

Asquith, G., & Krygowski, D. (2004). *Basic Well Log Analysis.* American Association of Petroleum Geologists. https://doi.org/10.1306/Mth16823

Boggs, S. J. (2009). *Petrology of Sedimentary Rocks.* Cambridge University Press. https://doi.org/10.1017/CBO9780511626487

Buday, T. (1980). *The Regional Geology of Iraq: Stratigraphy and Paleogeography.* Dar Al-Kutib House, University of Mosul.

Catuneanu, O. (2006). *Principles of Sequence Stratigraphy.* Elsevier.

Dunham, R. J. (1962). Classification of Carbonate Rocks According to Depositional Texture. In W. E. Ham (Ed.), *Classification of Carbonate Rocks* (pp. 108-121). American Association of Petroleum Geologists (AAPG). https://doi.org/10.1306/M1357

Flügel, E. (2004). *Microfacies of Carbonate Rocks: Analysis, Interpretation and Application.* Springer. https://doi.org/10.1007/978-3-662-08726-8

Flügel, E., & Munnecke, A. (2010). *Microfacies of Carbonate Rocks: Analysis, Interpretation and Application* (vol. 976). Springer. https://doi.org/10.1007/978-3-642-03796-2

Jassim, S. Z., & Goff, J. C. (2006). *Geology of Iraq.* Dolin, S.R.O.

Selley, R. C. (1998). *Elements of Petroleum Geology.* Gulf Professional Publishing.

Sharland, P. R., Archer, R., Casey, D. M., Davies, R. B., Hall, S., Heward, A., Horbury, A., & Simmon, M. D. (2001). *Arabian Plate Sequence Stratigraphy.* Gulf Petrolink.