

Investigation of Sedimentology and Reservoir Characterization of the Aptian-Albian Sediments in a Field of Central Persian Gulf

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Abstract

The Aptian-Albian age deposits are one of the most important reservoirs in Persian Gulf of Iran. These are equivalent to Shuaiba Formation in the southern part of the Persian Gulf. Microfacies, depositional environment and diagenetic processes of the studied reservoir formation have been investigated in studied field. Seven microfacies were identified in the studied interval including depositional environment ranged from lagoon to shoal and also open marine. Vertical and lateral facies changes were recognized and compared with modern and ancient depositional environments, showing that the sediments in this area were deposited in a homoclinal carbonate ramp. Variable diagenetic processes have been affected by this formation which has a notable impact on the reservoir quality. It is concluded that cementation, neomorphism and pyritization occluded the pore spaces and pore throat decreasing the reservoir porosity and permeability, while dolomitization, and fracturing increased the porosity and permeability and connection between the open spaces resulting in higher reservoir quality and most of the porosity consists of effective porosity in studied field which ranges between 9 to 18 percent and shows no major changes in the entire field. Considering the low volume of shale and good porosity most intervals of the studied reservoir formation show good reservoir quality in this field.

Keywords

Central Persian Gulf, Microfacies Analysis, Carbonate Ramp, Reservoir Quality

1. Introduction

The lower Cretaceous *Orbitolina* limestones of the Aptian-Albian Sediments

(Shuaiba) Formation is one of the well-known and important reservoirs in many oil fields in southwestern Iran and the Persian Gulf. This formation is part of the carbonates of the Khami group and equivalent of the Lower Cretaceous Shuaiba Formation in the central Persian Gulf. Several studies have been done regarding different aspects of Khami Group including previous work by James and Wynd (1965), which divided the Khami group into five formations: Surmeh, Heath, Fahliyan, Gadvan, and Dariyan [1]. Shemirani *et al.* (2000) conducted lithostratigraphic and biostratigraphic investigations on Dariyan and Kazhdumi formations in southwestern Iran [2]. Rahimpour-Bonab *et al.* (2002) studied the reservoir characteristics and sedimentary environment of the Dariyan Formation in the Persian Gulf (from the Strait of Hormuz to the extreme northwest) [3]. Lasemi and Siyahi (2005) performed the sequence stratigraphy studies of this formation in the southern part of Dezful-Embayment [4]. Poorbagher *et al.* (2007) compared the microfacies of the Dariyan Formation in Aneh anticline and well #3 of the Chelingar [5]. Based on petrographic and geochemical characteristics Adabi and Abbasi (2009) investigated the diagenetic history of the Dariyan Formation in Kuh-e Siyah in Shiraz and Sabzpooshan well #1 [6]. Amiri *et al.* (2009) studied sedimentary environments and sequence stratigraphy of Dariyan Formation in South Pars oil field [7]. Saadirad, *et al.* (2011) investigated syndepositional and post depositional diagenetic history of the Dariyan Formation in Azadegan oil field [8]. In recent years, this formation has been studied in many different aspects [9]-[16]. Moreover, Minasadat Hashemi *et. al.* in 2024 studied on the Microfacies features, reservoir quality and diagenetic processes of the Aptian carbonate sediments of Dariyan in southeast of the Persian Gulf [15]. Moreover, in 2024, by using the data which have been obtained from the core samples, they discerned microfacies' features of Daryian Formation, and afterwards, they determined the biostratigraphy and characterization of this important oil reservoir. In addition, when the outcomes of their microfacies study were carried out, seven carbonate microfacies and one mixed microfacies were identified. Also, due to two reasons 1) uniform facies changes and 2) the existence of Lithocodium algae, which forms patch reefs, instead of rudists (a kind of reef-builders), it is demonstrated that the environment is a homoclinic carbonate ramp. Moreover, planktonic and benthic foraminifera helped them discern five biozones, which reveals that the carbonate ramp was formed in the Aptian age [15]. Furthermore, when petrographic observation of the Dariyan Formation was interpreted by them, it was found that diagenetic processes affected the carbonate Dariyan Formation [15].

In this study, microfacies, depositional environment, and diagenetic processes have been investigated in detail to determine the reservoir quality of the studied reservoir formation in the central Persian Gulf of the studied oil field and it is worth mentioning that Dariyan Formation is equivalent to the Aptian-Albian sediments of this field.

2. Geographical Settings

Studied field of the Persian Gulf is one of the most important fields for its oil and

gas potential in this region. The field is located 144 km south of Lavan Island, and has shared reserves with the United Arab Emirates Abolbokhosh field. The field was discovered in 1960s. The first exploratory well was drilled in June of 1965, and production began in 1968. Structurally the field is composed of an asymmetric anticline with a dimension of approximately 11 kilometers in 14 kilometers. Geologically this field is composed of two reservoirs; the Buaib Reservoir produces oil and Khuff which is producing gas. **Figure 1** shows the location of the studied oil field in the Persian Gulf.

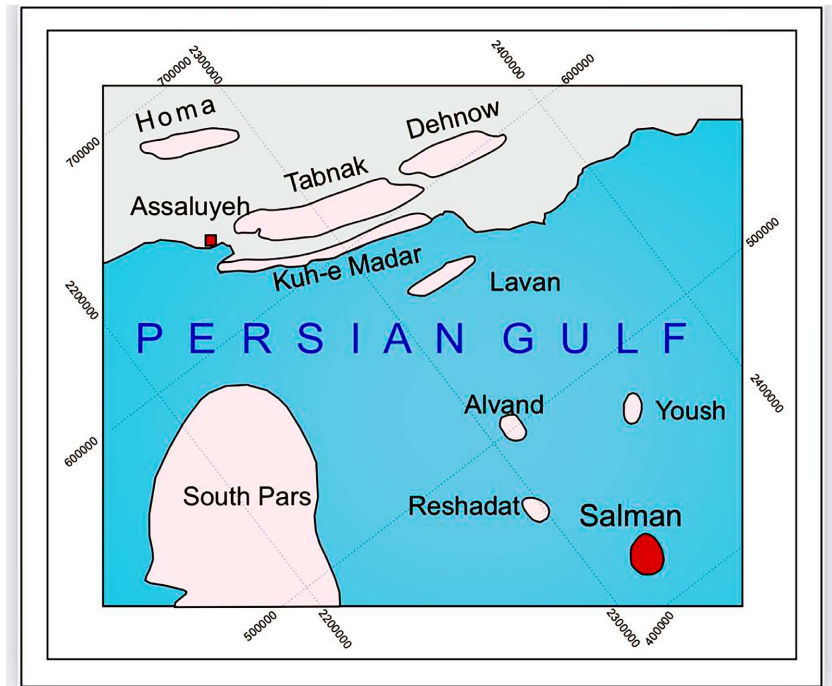


Figure 1. Location of the studied oil field in the Persian Gulf.

The Dariyan Formation type section is measured in the Gadvan Mountain which is located in the northern part of Dariyan village. At the type section, the formation consists of 286.5 meter brown-gray thick bedded to massive limestones. Orbitolina and rudist fragments are frequently found in the formation. The lower contact of the Dariyan Formation is harsh and specific with the Gadvan Formation while the upper contact with Kazhdumi Formation is severely eroded and glauconitic. A regional unconformity, representing erosion or non-deposition of the middle Aptian, marks the top of the Dariyan Formation in the area [17]-[19]. At its contact with the Kazhdumi Formation, a surface of strongly iron-stained, sandy, and glauconitic unit is observed [19]. **Figure 2** shows the situation of Aptian-Albian age deposits in the stratigraphic column of studied oil field.

3. Materials and Methods

In this investigation over 160 thin sections of well cuttings from the Dariyan res-

ervoir obtained from studied wells (Figure 3). The thicknesses of the formation in the studied wells are 121, 109, 152, 173 and 139 meters respectively. It should be noted that all the cutting samples were compared and matched with the interpreted petrographic logs before using as a reference for facies interpretation.

To determine the facies and sedimentary environment, the skeletal and non-skeletal allochems, sedimentary textures and structures, fossil content and sedimentary fabrics were identified and recorded. Dunham classification [21] was used for identifying the sedimentary facies. Subsequently, the identified facies were placed in context of the ancient and recent sedimentary environments and sedimental models [22]. In addition, the diagenetic processes were determined in order to evaluate the extent of their influence on the reduction or enhancement of reservoir quality.

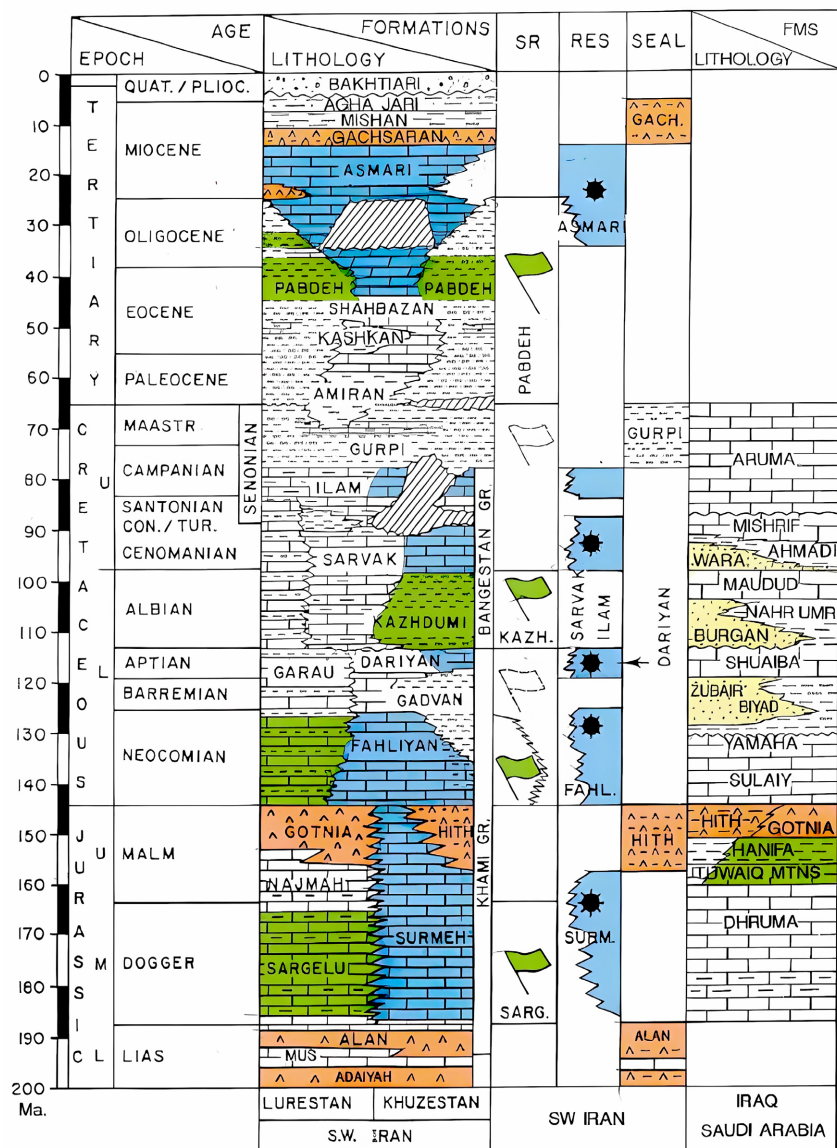


Figure 2. Stratigraphic column of the reservoir formations in the Persian Gulf [20].

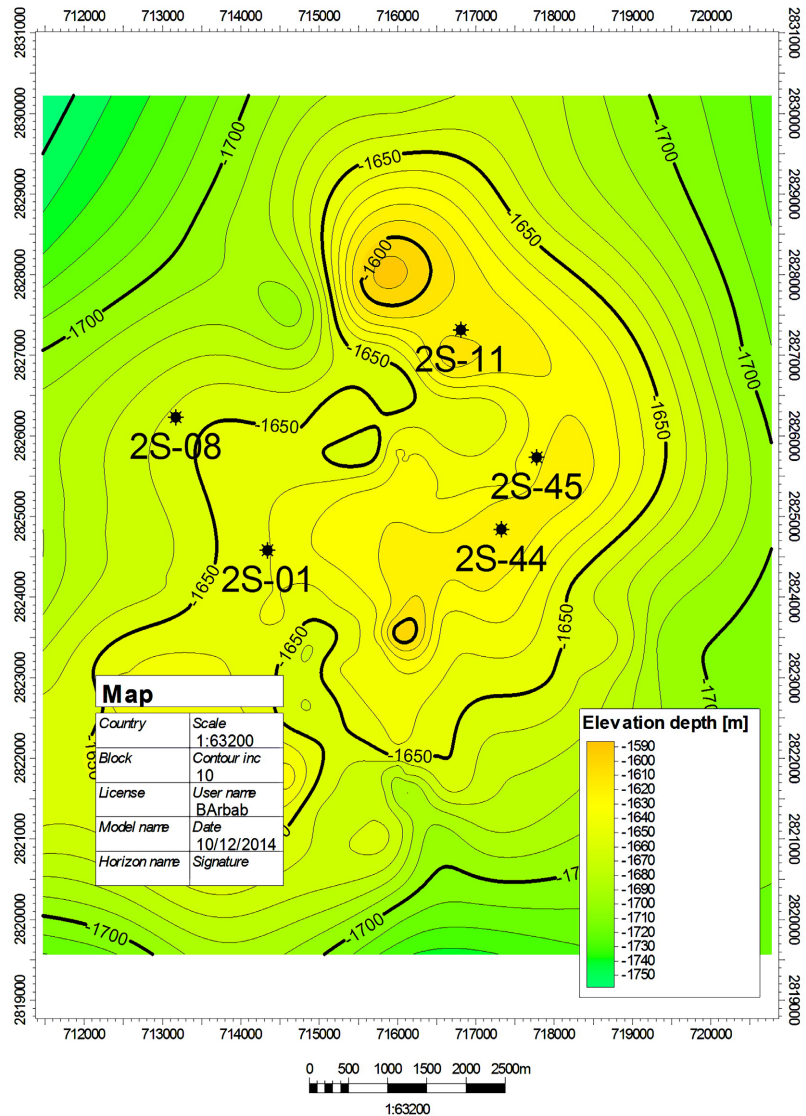


Figure 3. Location of the studied wells in the studied field.

4. Microfacies Analysis

Based on the petrographic observations of the Aptian-Albian carbonate sediments, the following facies were identified in the studied field:

1) MF1-Mudstone: This Facies mainly consists of limestone and argillaceous limestone and in some of the samples clastic particles and some glauconite were observed.

Interpretation: The absence of fossils in these microfacies is an indication of limited water circulation and lack of proper conditions for the marine environment [23]. The presence of clastic particles made up of mudstone and glauconite in some intervals indicates the effects of the delta environment of these facies. Furthermore, these evidences indicate that the facies were deposited in a restricted marine lagoon (Figure 4(A)).

2) MF2-Mudstone to Fossiliferous Wackestone: The texture of this microfa-

cies is mud-dominated and varies from mudstone to wackestone. This facies consists of limestone and argillaceous limestone with some skeletal debris including benthic foraminifera, gastropod, green algae, and also shell fragments.

Interpretation: The presence of green algae in these facies represents a normal marine environment which could be related to a protected lagoon in the tropical and subtropical regions capable of flourish in these fauna, related to subtidal realm and a depth from 5 to 3 meters down to a depth of 30 meters. Most of algae live in low-energy and subtidal zones [24]. Accompaniment of algae and large foraminifera represent shallow environment and photic inner ramp. In addition, limited fauna and lagoonal fossils, and back up mud in these facies indicate low energy environment. It shows restricted lagoon in a marine environment for this facies (**Figure 4(B)**).

3) MF3-Orbitolinid Wackestone to Packstone: The texture of these facies varies from wackestone to packstone. These facies consists of benthic foraminifera (*Orbitolina*), with gastropod, rudist debris, echinoderm fragments, shell fragments and peloids.

Interpretation: *Orbitolina* could be found in hypersaline environments. Coexistence of *Orbitolina* and green algae with gastropods indicates restricted lagoon and nutrient-rich environments of the inner reef [25]-[27]. The texture of these facies changes from mud-supported to grain-supported showing average to high-energy environments (**Figure 4(C)**).

4) MF4-Bioclastic Packstone to Grainstone: This facies consists of benthic foraminifera (*Orbitolina*), green algae, rudist fragments, echinoderm fragments, shell fragments, and peloids. The lithology is mainly composed of limestone and argillaceous limestone. In some intervals, most skeletal grains are micritized.

Interpretation: Considering the facies texture (dominated by bioclasts and low abundance of micrite), this facies appears to have been deposited in a high-energy environmental setting. It possibly accumulated in bioclastic shoals, as longitudinal bodies parallel to the shoreline situated over the ramp margin [24] [28]. The shoal area is characterized by extensive marine cementation. These bodies are developed during the highstand sea level [22]. This microfacies is formed in a poloid-bioclaster barrier where there is sufficient light for flourishing biota. This microfacies is similar to SMF11 of Flugel (2010) (**Figure 4(D)**).

5) MF5-Echinoderm Wackestone to Packstone: This facies mainly includes echinoderm in addition, there are also gastropods, rudist fragments, shells fragments, benthic foraminifera, planktonic foraminifera, and occasionally sponge spicules were observed. Lithologically, it mainly consists of limestone and argillaceous limestone.

Interpretation: The texture of these facies is mud to grain-supported representing deposition in medium energy waters. The *Orbitolina*, a particular Lower Cretaceous biota, is usually flourishing in shallow tropical to subtropical waters, normal marine environments and fore-reef areas. Its association with restricted marine biota (such as miliolids and green algae) suggests shallow water inner platform depositional settings, whereas its assemblage with open marine fauna (like

rudists and echinoderms) may indicate deeper basin [29]. The presence of planktonic fossils indicates that the biota could be the indicator of deposition in the mid ramp depositional settings (Figure 4(E)).

6) MF6-Planktonic foraminifera Wackestone to Packstone: Lithology of this facies is mainly limestone and argillaceous limestone. This facies mainly consists of planktonic foraminifera (e.g. Hedbergella). In addition, it contains gastropod, rudist debris, echinoderm fragments, shell fragments, and small amount of benthic foraminifera.

Interpretation: Planktonic foraminifera are found in abundance of the open marine at water depth of about 200 meters [24] [27] [30]. Ample presence of mud of this facies associated with mud-dominated nature shows the lack of shallow water environment while the diverse open marine fauna of these facies indicates

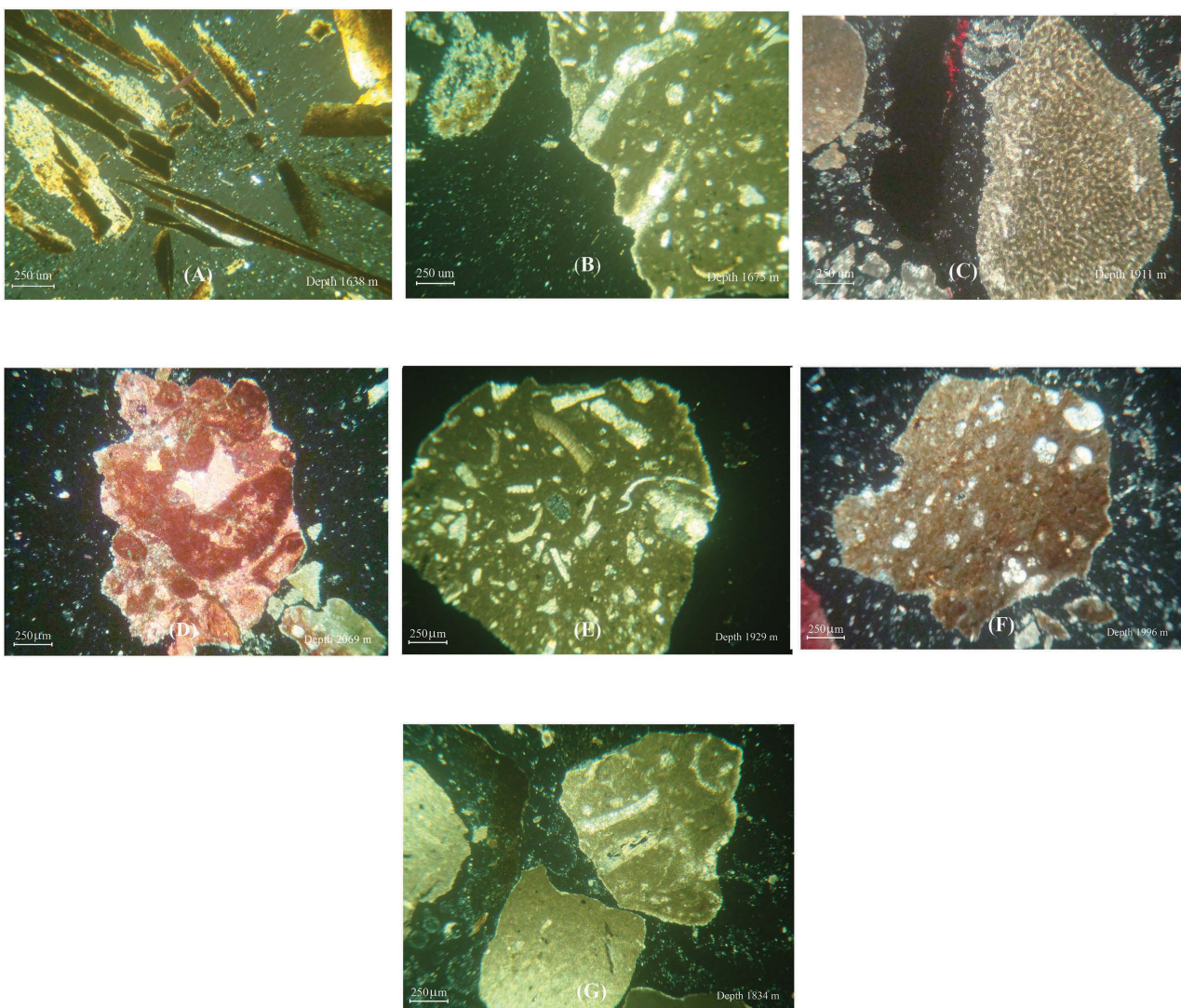


Figure 4. Different facies identified in the Dariyan Formation in the studied intervals. (A): Mudstone (MF1), xpl; (B): Mudstone/fossiliferous wackestone (MF2), xpl; (C): Orbitolinid wackestone to packstone, (MF3), xpl; (D): Bioclast packstone to grainstone with restricted microfauna, (MF4), xpl; (E): Echinoderm wackestone to packstone, (MF5), xpl; (F): Planktonic wackestone to packstone, (MF6), xpl; (G): Mudstone to Planktonic/echinoderm wackestone (MF7), xpl.

low-energy and open marine sedimental environment [24] [27]. The scarcity of the benthic fauna is caused by deposition of the sediments in the outer ramp depositional setting where the water depths often reach around 125 meters [31] (Figure 4(F)).

7) MF7-Mudstone to Planktonic/Echinoderm Wackestone: These facies mainly consist of limestone and argillaceous limestone with planktonic foraminifera and echinoderms. Gastropod, shell fragments, and occasionally sponge spicules and benthic foraminifera are also present in these facies.

Interpretation: The texture of these facies is mud-supported showing deposition in low-energy waters. The presence of planktons is mainly due to the fact that this facies was formed in deep water environment in an outer ramp depositional setting in open marine conditions (Figure 4(G)).

5. Facies Frequency

Based on petrographic observations, lithological determination and correlations of studied wells, the frequency of each facies in the studied wells of the studied field is as follows:

According to the pie charts presented for each well (Figure 5), the most abundant facies is number 7, followed by facies number 3, 6, 1, 2, respectively and finally facies 4 and 5 show the lowest frequency.

6. Depositional Environment

Determination of the sedimentary environments involves identification and careful description of the facies [22] [24] [28] [32]-[36].

Petrographic investigations conclude that seven microfacies identified in the wells formed in open marine, shoal, and lagoon environments. In addition, comparing the vertical and lateral facies variations and their distribution with the modern and ancient sedimentary facies indicate that the Dariyan Formation in the studied wells were deposited in a homoclinal carbonate ramp [37].

By focusing of the geographical position of the wells and the facie frequency in each well from the west to the east of this field, the frequency of open marine facies in outer and middle ramp increase, while the frequency of shoal and lagoon facies decrease. Furthermore, from the south to north of the field, the frequency of the lagoon and shoal facies decrease, while the frequency of open marine, outer ramp and middle ramp microfacies increase. Therefore, it appears that the depth of the depositional basin increases from the south to the north of the studied field [23] [37]. Table 1 and Figure 6 depict the locations of specified wells studies in the present investigation and the microfacies in this field within different depositional environments.

7. Diagenesis

Different diagenetic processes have been affected on the studied interval of the Dariyan depositions in the studied oilfield. These processes are including bioturbation, micritization, calcite cementation, compaction, neomorphism, dolomiti-

zation, fracturing and pyritization, which are described in the following.

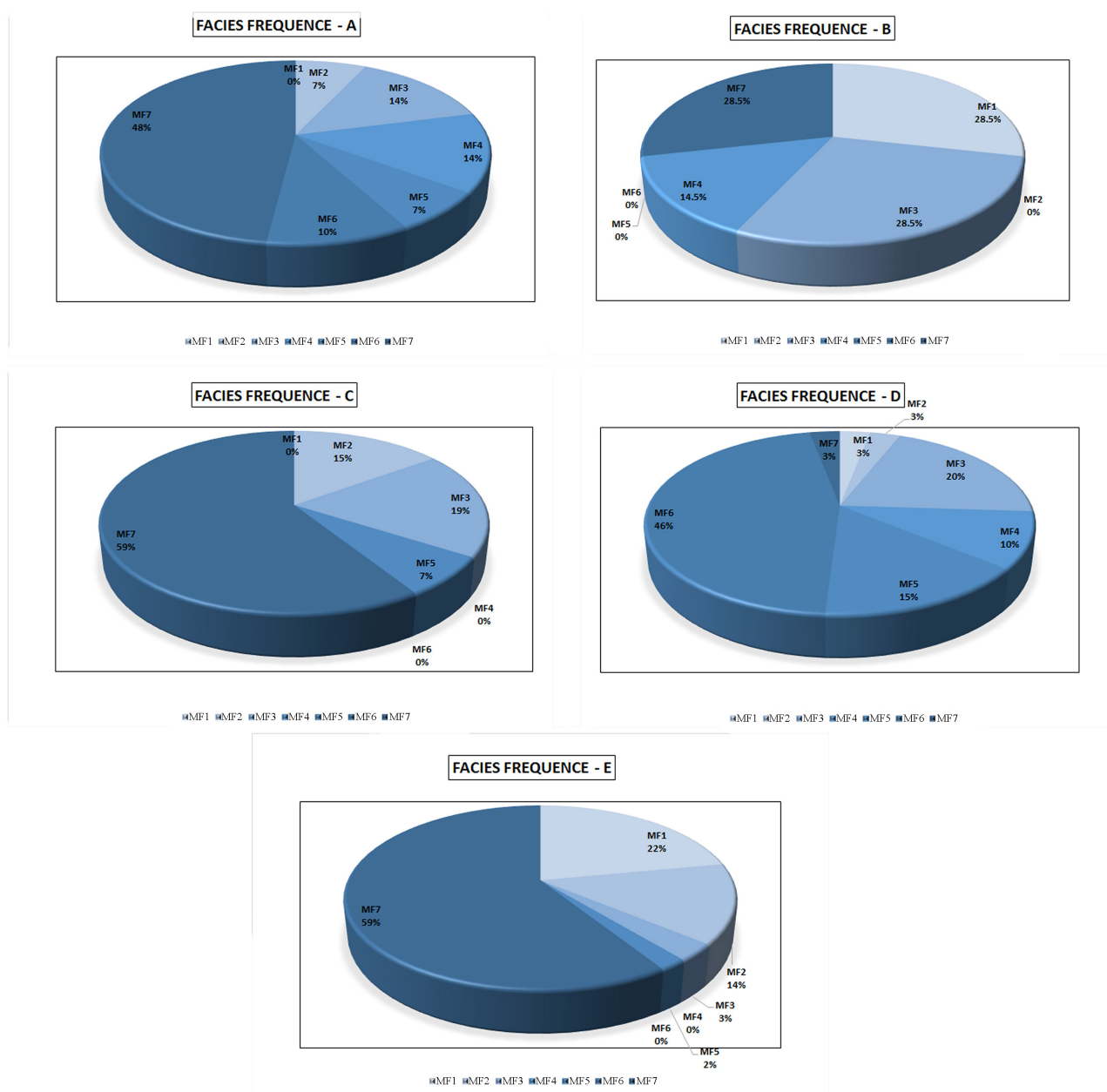


Figure 5. Facies frequency defined in the studied wells in the studied field.

Table 1. The assigned depositional environments for different facies of the Dariyan Formation in the studied field.

Lagoon	Shoal	Mid and Outer Ramp	Open marine
Mudstone/Packstone	Packstone/Grainstone	Wackestone/Packstone	Mudstone/Wackestone
Benthic Foraminifera, Gastropod, Ostracod and Green Algae	Bivalve and Echinoderm debris and rare Benthic F.	Pelagic Foraminifera, Echinoderm., and Spine Fragments of Bivalve, and rare Benthic F.	Pelagic Foraminifera, Echinoderm., and Spine Fragments of Bivalve
MF1, MF2, MF3	MF4	MF5, MF6	MF7

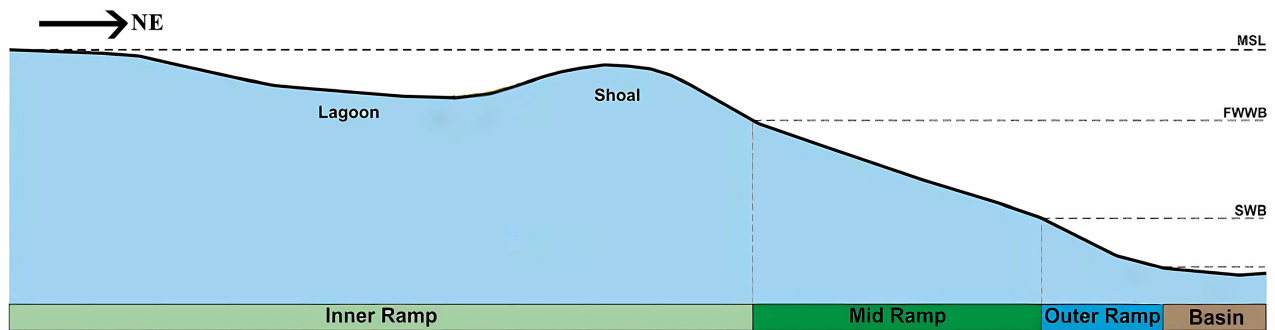


Figure 6. Schematic diagram of the sedimentary environments of the Dariyan Formation in the studied field.

7.1. Bioturbation

One of the diagenetic processes observed of the studied formation was micritization which was induced by microorganisms including fungi, bacteria and algae [38]. These microorganisms are able to excavate the skeletal fragments and fill the created open spaces with micrites. This process occurs in a marine environment during the early parts of diagenesis [24] [38]. Micritic grains are abundant in lagoon environment [39] (**Figure 7(A)**).

7.2. Cementation

Given the limitations for the high frequency sampling, and thin sections obtained from well cuttings, the only cement types observed in the Dariyan Formation in this field, includes equant, drusy, syntaxial and poikilotopic carbonate cements.

Equant and drusy mosaic calcite cements (**Figure 7(B)-(D)**) are major cement types that fill pores of skeletal grains such as the ones in bioclasts and foraminifers. These cements could be deposited in near surface meteoric or burial environments.

Syntaxial and poikilotopic cements form large crystals. Syntaxial cement surrounds most of echinoderms, with the cement growing on single crystals and often small poly-crystalline grains and creates poikilotopic cement (**Figure 7(E)**).

Different types of cements observed in the Dariyan formation represent marine (vadose zone and phreatic zone) meteoric and burial environments. Burial cements generally fill the pores and fractures, and consequently results in porosity reduction.

7.3. Neomorphism

The transformation of unstable carbonate components and mud, with aragonite and high-Mg calcite mineralogy, to low-Mg calcite is common process in carbonate diagenesis (**Figure 7(H)**). Calcitization of aragonitic bioclasts and mud (formation of pseudosparite) occurs usually in the inner ramp facies of the Dariyan Formation. The neomorphism might change the micrite partially or completely to microspar or pseudosparite (crystal size > 4 μm). Occasionally, it is hard to distinguish between orthosparite (sparry cements) and pseudosparite (neomorphic sparite). In some cases, texture of the facies is completely obliterated by

neomorphism. This might indicate meteoric diagenetic realms [38] [40] [41].

7.4. Compaction

Mechanical and chemical compaction was recognized of the studied intervals. Mechanical compaction commences immediately after initial deposition of the sediments while chemical compaction requires tens hundreds of meters of burial. The mechanical compaction is prevented only where there is substantial formation of initial or early cementation. In grainstones and packstones, it occurs as broken bioclast while in wackestones and mudstones, mechanical compaction could cause the compression of burrows [38].

Chemical compaction occurs as the result of increased dissolution at the grain contacts due to pressure [35]. Chemical compaction and pressure dissolution are the most important burial processes.

Among the chemical compaction structures, solution seams and stylolites are readily observed in this formation (**Figure 7(F)**, **Figure 7(G)**). Solution seams are common in most of argillaceous limestones. A great deal of insoluble materials and residues such as clay minerals, aggregate are formed due to the carbonate dissolution. Stylolites are cross-cutting through grains and cements frequently.

7.5. Dissolution

Dissolution is one of the most important diagenetic features occurring during meteoric and burial diagenesis (**Figure 7(C)**). While the porosity decreases with increasing depth of burial and due to the compaction process, it can also be created by the dissolution and or fracturing of the rocks [38]. The presence of the regional unconformity on top of the studied formation could confirm the dissolution of these carbonates by meteoric water during the subaerial exposure surfaces.

7.6. Dolomitization

Dolomitization is one of the most important diagenetic phenomena observed in some intervals in the studied area (**Figure 7(I)**). They are secondary dolomite and of epigenetic nature. There is no evidence for primary dolomite formation. Dolomitization of the Dariyan Formation is often associated with low-energy facies and observed as matrix-selective dolomitization. In most cases, matrix-selective dolomitization process is incomplete, resulting in floating calcitic bioclasts in a fine to medium crystalline dolomitic matrix.

Dolomite crystals vary in form from euhedral to anhedral. In some intervals in mudstone/wackestones, euhedral dolomite crystals with planner texture and straight crystal faces floating in a micritic matrix. In more advanced stages of dolomitization, the dolomite crystals with planar texture formed empty spaces between crystals and create a sucrosic texture. Some other types of dolomites observed in Dariyan Formation form planner to non-planner textures. The presence of such a texture indicates that the dolomitization process is pervasive and

the dolomite crystals are invading their crystal boundaries. Such texture leaves no intercrystalline pore space and consequently reduces the pore space and as a result the reservoir characteristics (porosity and permeability) are reduced. Scattered dolomite crystals are also observed along stylolites and solution seams (**Figure 7(G)**), indicating their formation during burial of the Dariyan carbonates [35]. Another prominent dolomite type in Dariyan Formation is the saddle dolomite. This particular type of dolomite is identified based on its large crystal size, curved crystal surfaces and wavy extinction. These dolomites with non-planar texture indicate formation from supersaturated fluids at high temperatures (50°C - 100°C). Precipitation of such type of dolomite in Dariyan Formation indicates that the formation has undergone through burial diagenetic realm.

Dolomitization and its development in Dariyan Formation occurred in three successive stages. Euhedral dolomites formed at the early stages in micritic matrix. During this stage, fine dolomite crystals selectively replaced the micritic matrix and also fine skeletal fragments [23].

With continued dolomitization process and in the second stage, dolomite rhombs formed a supportive framework and developed intracrystalline porosity due to volume reduction caused by dolomitization of the calcitic matrix [42]. From the reservoirs characteristics point of view, this type of dolomites increased the porosity and permeability of the Dariyan Formation. At this stage, the arrival of the hydrocarbons into the intercrystalline porosity could halt dolomitization and preserve the existing porosity.

In the third phase, as crystal growth continues the crystal boundaries are further grown into one another and lock together leaving no space between the crystals. Further growth of the dolomite crystals replacing the entire previous texture of limestones obliterates the texture of the primary carbonate and only a ghost or shadow of previous allochem remains. This type of dolomite occurs during deep burial, and usually fills remaining pores reducing the effective porosity and reservoir quality.

The dolomites observed in wackestone and mudstones could be interpreted by the mixed meteoric-marine model in humid climates [38]. The second type of dolomite with sucrose texture which is observed in most parts of the Dariyan Formation is generally formed in burial environmental realm and late diagenesis, under a high-temperature regime. In some cases, high intercrystalline porosity is observed in this kind of dolomite. Considering the presence of hydrocarbon trapped in the intercrystalline pore space, it can be stated that dolomitization occurred synchronously or before hydrocarbon migration.

7.7. Pyritization

The pyritization phenomenon was observed in most of the Dariyan Formation intervals (**Figure 7(J)**). Pyrite could form as an autogenic mineral in marine organic-rich mud in anoxic diagenetic environment [35]. They are observed as cubic

crystals. In many instances, pyrite partially or completely fills the bivalve or foraminifera shells. In some intervals, pyrite is so widespread that it forms the rock matrix and the main texture of rock is obliterated. Since pyrite formation in Dariyan is often associated with pressure solution features, it could be assumed that pyrite is a product of late-stage diagenesis.

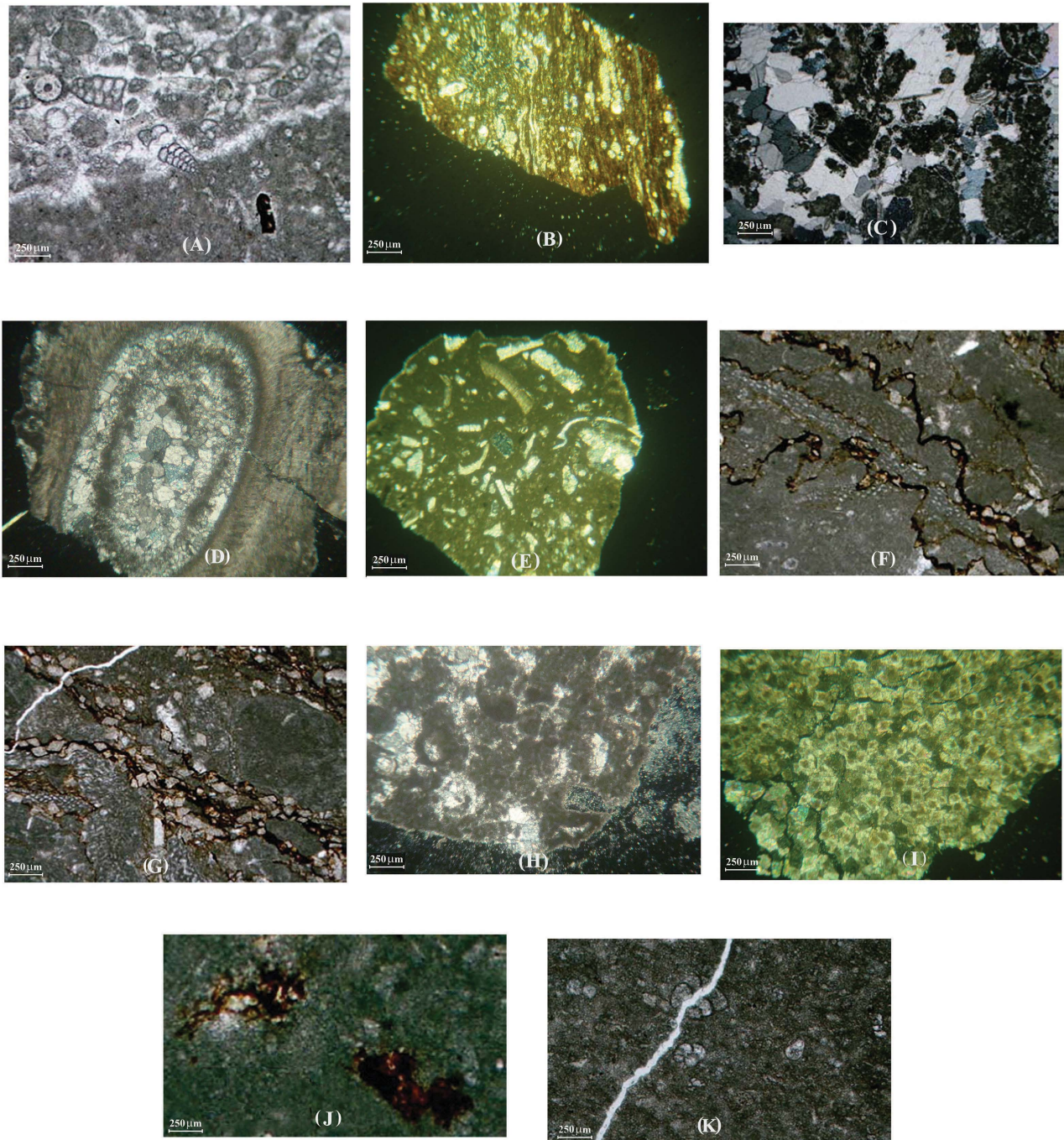


Figure 7. (A): Micritization, xpl; (B): Equant cementation, xpl; (C): Blocky cements and dissolution, xpl; (D): Drusy mosaic cement; (E): Syntaxial cement surrounding Echinoderms, xpl; (F): Chemical compactions, pressure dissolution and stylolitization, xpl; (G): Chemical compactions such as solution seams, pressure dissolution and dolomitization, xpl; (H): Neomorphism, xpl; (I): Dolomitization, xpl; (J): Pyritization, xpl; (K): Fracture, xpl.

Figure 8 shows the main diagenetic processes and their environments of studied area. Bioturbation, micritization and mechanical compaction occurred in marine phreatic environment. The diagenetic processes in fresh water (meteoric) environments include neomorphism, syntaxial and equant calcite cementation and dissolution. In the late diagenetic stages where overburden pressure is increased, the conditions are improved for diagenetic processes such as dolomitization and stylolite formation.

Some of the diagenetic processes that occur in Dariyan Fm. have a direct effect on reservoir quality. Micritization, cementation, mechanical compaction, neomorphism, and pyritization reduce the porosity and decrease the reservoir quality. On the other hand, stylolite formation, dolomitization, and fracturing (see Figure 7(K)) caused porosity enhancement and led to higher reservoir quality.

Diagenetic stages		Marine Phreatic	Mixed Phreatic	Shallow Meteoric	Post Deposition	Deep Burial
		Early		Intermediate		Late
Bioturbation		—————				
Micritization		—————				
Cementation	Equant Spary Calcite	—————				
	Syntaxial Calcite	—————				
Mechanical Compaction		—————				
Neomorphism		—————				
Chemical Compaction	Dissolution seams —————				
	Stylolitization —————				
Dolomitization	Replacement	—————				
	sacrosic	—————				
Fracturing		—————				
Pyritization		—————				

Figure 8. Paragenetic sequence of diagenetic events in studied oil field.

8. Petrophysical Evaluation

Geolog software is a widely used tool in petrophysical evaluation, offering advanced capabilities for well log analysis, formation evaluation, and rock property estimation. It provides a comprehensive suite of modules for data processing, log interpretation, and integration with core and laboratory measurements, allowing for accurate determination of petrophysical parameters such as porosity, permeability, water saturation, and lithology. Its robust computational algorithms support deterministic and probabilistic approaches, as well as machine learning ap-

plications for enhanced reservoir characterization. Additionally, Geolog enables multi-well analyses, cross-plotting, and the incorporation of image logs for fracture and facies interpretation. However, despite its strengths, the software has limitations, including high computational demands for large datasets, the necessity for expert knowledge to properly configure and interpret results, and potential constraints in handling unconventional reservoirs with complex mineralogy. Moreover, while Geolog integrates well with other industry-standard software, interoperability challenges may arise when working with proprietary or non-standard data formats.

Reservoir evaluation plays an important role in oil industry. In this study, reservoir properties in the studied wells such as porosity, water saturation, shale volume and lithology have been evaluated using log data in Dariyan Formation. All of the petrophysical calculations have been performed by Geolog, 7 (**Table 2**).

Table 2. Petrophysics calculation of the studied oil field.

Well Name	Vsh	PHIE	PHIT	SWE	SWT	VOL-Oil
A	0.0441	0.0932	0.1000	0.8834	0.9119	0.0094
B	0.1036	0.1211	0.1320	0.7096	0.7177	0.0487
C	0.0787	0.1450	0.1558	0.7798	0.7921	0.0432
D	0.0358	0.1102	0.1152	0.8980	0.9033	0.0442
E	0.0384	0.1820	0.1878	0.6970	0.7047	0.0629

Porosity estimations indicate that Dariyan Formation has a good porosity in the studied wells. Due to the low volume of shale observed, most of the porosity consists of effective porosity in this field which ranges between 9 to 18 percent and shows no major changes in the entire field.

Water saturation has been estimated based on Indonesia equation [43] and Simandoux [44]. Due to the low volume of shale, values obtained are very close. It is concluded that the values are generally higher with relatively high average water saturation (70 to 90 percent) in this field.

By calculating the volume of formation water in each studied wells and deducting it from formation saturation, the volume of existing oil in each well can be calculated. This value is affected by the effective porosity and is variable in each well. The average volume of oil produced in the studied field is 1 - 6 percent. Considering the low volume of shale and good porosity most intervals of the Dariyan Formation show good reservoir quality in this field.

However, the thickness of the pay zone is variable in wells and depends on diagenesis and microfacies of the intervals.

9. Conclusions

1) Seven different microfacies were determined using detailed investigations of core and cutting samples of the Dariyan reservoir in this field. These include; mud-

stone, mudstone to fossiliferous wackestone, orbitolinid wackestone to packstone, bioclast packstone to grainstone with restricted microfauna, echinoderm wackestone to packstone, planktonic wackestone to packstone, mudstone to planktonic/echinoderm wackestone.

2) The determined microfacies of the Dariyan Formation which belongs to open marine, shoal and lagoon, suggest the leeward mud dominated carbonate ramp sedimentary environment for this formation.

3) Considering the geographical position of the wells and frequency of facies in them, from west toward the east of the studied field, there is an increase in the depth of the sedimentary basin while it shows decreasing from north to south of the field.

4) The intervals representing the deeper facies (e.g. outer ramp and open marine) mainly display poor reservoir quality while the intervals designated to shallow marine facies (e.g. lagoon and shoal facies) have fair reservoir quality.

5) Diagenetic processes in this field include: bioturbation, micritization, cementation, mechanical compaction and neomorphism which reduce the reservoir quality while chemical compaction, dolomitization, and fracturing are diagenetic processes that enhance the reservoir quality.

Conflicts of Interest

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

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