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Depositional Setting of the Jeribe Formation in Selected Subsurface Sections, Northern Iraq

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ABSTRACT

The current research studies the depositional setting of the Jeribe Formation in the south Mosul area of northern Iraq, which is tectonically located in the Low Folded Zone characterized by the deposition of limestone and marly limestone of the Jeribe Formation during the Middle Miocene. Petrography has provided a diversity of fauna such as benthonic foraminifera (Miliolid, Peneroplis sp., Dendritina sp. and Borelis melo curdica) in addition to Red Algae and Mollusca. The Jeribe carbonates were affected by various diagenetic processes such as dolomitization, neomorphism, cementation, anhydritization, compaction and dissolution. Many microfacies have been identified, including lime mudestone, wackestone, packstone and Milioldal grainstone, with eight submicrofacies (Non-Fossiliferous lime mudstone, Benthonic lime mudstone, Fossiliferous wackestone, Red Algal wackestone, Milioldal packstone, Fossiliferous packstone, Green Algal packstone and Red Algal packstone). Depending on microfacies analysis, the Jeribe Formation was deposited in restricted and open marine environments within an interior platform setting.

Keywords: Microfacies, Jeribe Formation, Lagoon, Low Folded Zone and fauna.

الأنماط الترسيبية لتتابعات تكوين الجريبي في أبار مختارة / شمال العراق

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الخلاصة

تناول البحث الحالي دراسة الأنماط الترسيبية لتكوين الجريبي في منطقة جنوب الموصل شمال العراق، والتي تقع تكتونيا في نطاق الطيات الواطئة والتي تتميز بترسيب الحجر الجيري والحجر الجيري المارلي لتكوين الجريبي خلال عصر المايوسين الاوسط بينت البتروغرافية مجموعة متنوعة من المنخربات القاعية مثل المليوليد والبنيروبليس ودنتريتا والبوريليس ميلو كورديكا بالأضافة الى الطحالب الحمراء والرخويات .اظهرت الدراسة البتروغرافية وجود عدد من العمليات التحويرية المؤثرة على الصخور الجيرية في تكوين جريبي المتمثلة بعمليات الدلمتة والتشكل الجديد والسمنتة والانهدرتة والانضغاط والاذابة. قسمت تتابعات تكوين الجريبي الى عدد من السحنات الدقيقة الرئيسية المتمثلة بسحنة الحجر الطيني وسحنة الحجر الجيري الواكي و سحنة الحجر الجيري المرزوم و سحنة الحجر الجيري الحبيبي الحاوية على المليوليد، والى ثمان سحنات

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ثانوية متمثلة بسحنة الحجر الطيني الأحيائية وسحنة الحجر الطيني الخالية من الأحياء وسحنة الحجر الجيري الواكي الأحيائية وسحنة الحجر الجيري الواكي الحاملة على الطحالب الحمراء وسحنة الحجر الجيري المرزوم الحاوية على المليوليد وسحنة الحجر الجيري المرزوم الأحيائية وسحنة الحجر الجيري المرزوم الحاوية على الطحالب الخضراء وسحنة الحجر الجيري المرزوم الحاوية على الطحالب الحمراء، والتي اعتمدت في تحديد البيئة الترسيبية التي رسبت تتابعات التكوين على انها ترسبت في البيئة البحرية المحجوزة والبيئة البحرية المفتوحة ضمن المنصة الداخلية لحوض تكوين الجريبي.

1. INTRODUCTION

The Jeribe Formation represents the Middle Miocene age (Langhian) within the Late Palaeogene-Early Neogene succession. It is found overlying unconformably with the Dhiban Formation (Early Miocene) while underlying the Fatha Formation conformably. The study area is located in the south of Mosul area in northern Iraq within Low Folded Zone [1] (Figure1). The lithology of the formation is characterized by limestone and marly limestone.

The age of the formation has been determined depending on the most important benthonic foraminifera Borelis *melo* var *curdica,* which has been used as an index fossil to determine the age of the Jeribe Formation, depending on the presence of benthonic foraminifera and show of the Middle Miocene age [2]. The Jeribe Formation is about 19.56 Ma, corresponding to the Early Miocene (Burdigalian) age [3].

In central and southern Iraq, the Jeribe Formation (Early Middle Miocene) is mainly made up of shallow marine carbonate. Seven submicrofacies in the mudstone, wackestone, packstone, and grainstone microfacies are there, four major depositional cycles have been identified, and the growth and distribution of microfacies are influenced by cyclicity and relative sea level variations [4].

The Jeribe Formation exists in both Bai Hassan and Khabaz oil fields with 30 m thick but is not found in the Kirkuk oil field. It has 19 m in the Bai Hassan oil field. Its facies consists of marly limestone and dolomitic limestone, which are affected by dolomitization and recrystallization in addition to anhydritization and alteration, so the identification of fossils is a complex problem; thus, the fossils recognized in this formation are represented by few benthonic fossils like Miliolids, *Peneroplis, Dendertina* rangi, Echinoderm plates and Biolasts [5].[6] identified the formation rocks, which consist of layered rocks of white, crystallized, fossiliferous and dolomitic limestone, studied the microfacies of the formation in northwestern Iraq and identified the sedimentary environments, which are deposition in a forereef, reef and backreef environment. The formation rocks were divided into two parts, depending on the bedded, namely the lower stratified part and the upper massif part, which appears to be highly affected by the dolomite process. They concluded that the dolomitization was formed by a mixing model [7]. The facies of a Jeribe formation were deposited in the study area in northwestern Iraq across five depositional stages: the zones in the forereef, the reef, backreef, tidal flats and Lacustrine zone [8]. [9] studied biostratigraphy of Kirkuk Group formations in Kirkuk and Bai Hassan areas and described the lower boundary of Jeribe Formation as unconformable. [10] studied the Tertiary microfacies of Iraq, which indicated that the facies of the Jeribe Formation was deposited within the restricted - open lagoon environments, where they were identified within the facies of the lagoon with calm and warm waters with an increase in salinity. The Jeribe Formation is an important reservoir in many Iraq's oilfields [11]. Such as Kirkuk and Tawki oilfields [12]. [13] studied Miocene succession of western and southern Iraq is represented by the Jeribe Formation. It is focused on depositional environment interpretation based on a detailed petrographic study and microfacies analysis and concluded that three subenvironments were recognized within the Jeribe Formation are (restricted marine environment, Shoal environment and shallow open marine environment).

The study aims to describe the environmental characteristics and depositional properties of the Jeribe Formation, which became very important because it represents reservoir rock in the studied area.

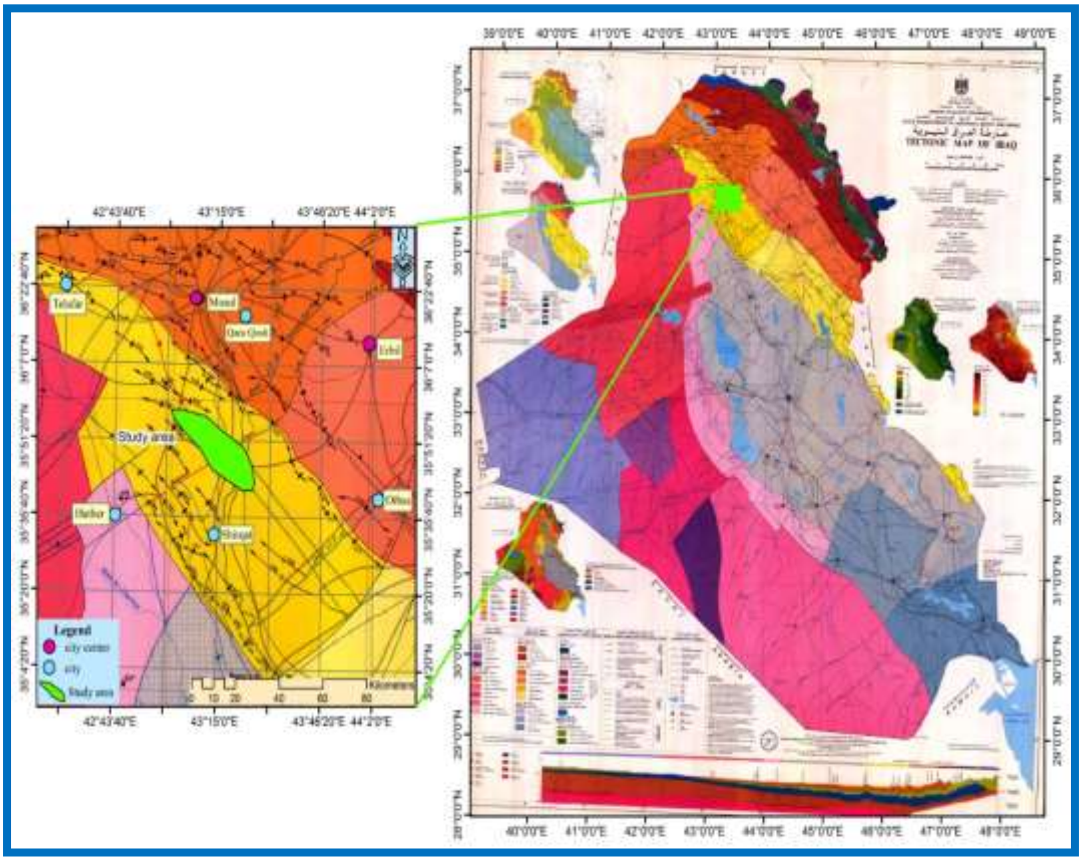

Figure 1: Study area within the tectonic map of Iraq [1].

2. Data and methods

The methodology depended on preparation and laboratory aspects:

2.1 The preparatory aspects

It consisted of reviewing the studied wells, previous studies of south Mosul Oilfield, and the conventional log data of Gamma-ray, sonic, density and neutron logs for wells (SM-A and SM-B) in south Mosul.

2.2 The laboratory aspects

The petrographic study depends on 106 thin sections (mostly cutting) of the Jeribe Formation in two oil wells, where the well SM-A includes 70 thin sections and the well SM-B (36), where 84 of them are lent from the North Oil Company, and 22 prepared by the researchers. These include 70 cutting while the rest (36) are cores. Petrographical analyses using a polarized microscope were done according to the Dunham classification [14].

2.3 Lithological Description

The rocks of the Jeribe Formation in wells SM-A and SM-B have thicknesses of about

55.5m and 40 m, respectively. The description was done based on core and cutting samples rather than logs analysis.

In the well (SM-A), the lower part of the formation appeared as grey medium hard to soft dolomitic limestone and grey medium hard marly anhydrite limestone at depth interval (295.00-283.00 m), then brown to light brown, medium-hard limestone with moldic porosity of different large benthonic fossils appeared at depth interval (283.00-275.00 m). While middle part of the formation consists of the light brown medium hard fine-grained pyritic dolomitized with low porosity and medium hard, dolomitic limestone recrystallized in parts and argillaceous with oil shows and sulfur crystals and anhydrite at depth interval (275.00-261.00 m).

As for the well SM-A, the upper part of the formation contains light brown medium hard dolomitized with a fine grain of pyrite and low porosity at depth interval (261.00-245.00 m), and medium hard dolomitic limestone recrystallized and argillaceous in some parts. Then above it, a brown medium hard to soft coarse-grained porous dolomitic limestone with white hard anhydrite in part and good oil shows appeared at depth interval (245.00-240.00 m), then porous dolomitic limestone, with anhydrite crystals. Furthermore, white hard anhydrite exists at depth interval ranges from 240.0 to 239.0 m (Figure 2).

In the well (SM-B), the formation appeared to contain brown, medium-hard, coarse-grained porous dolomitic limestone with nodules of anhydrite. The oil seems heavy oil stains at depth interval from 234.52 to 206.79m. The white massive hard anhydrite interbedded with brown medium hard dolomitic limestone porous, coarse grain with heavy oil (oil stain), and anhydrite nodules with interbedded anhydrite contain veins dolomitic limestone with at depth interval (206.79-193.0m). The thin bed is a grey soft marly thin (67 cm) in the lower part (Figure 3).

3. Results and Discussion

3.1 Petrography of the Jeribe Formation

The petrographic constituents that can be observed in the Jeribe Formation [15] and [16] are as follows:

3.1.1 Grains

Grain constituents in the Jeribe Formation consist mainly of skeletal grains and non-skeletal grains.

3.1.1.a Skeletal grains

Most skeletal grains in the Jeribe Formation are characterized by benthonic fossils or bioclast, Miliolids, *Peneroplis*, *Dendritina*, *Rotalids*, *Borelis melo curdica,* and *Borelis melo melo*, *w*hich indicate to shallow marine and lagoon environment [17]. The study also identifies other types of fossils prevalent in these sediments, Echinodermata fragments and Molluscs. The occurrence of Miliolids fossils is common, which live in isolated shallow environments that are often highly saline [18].

3.1.1.b Non-Skeletal Grains:

In the current study, non-skeletal grains represent the lithoclast in the (Pl.1-A and D) limestones of the Jeribe Formation, and its percentage was few.

3.1.2 Micrite

The micrite indicates to quiet energy environment [19]. Moreover, it consists of chemical deposition, the first sedimentation or the digenesis processes such as micratization [20], or from the crashed-green algae [21].

3.1.3 Sparry calcite cement

Different types of sparry calcite cement have been recognized throughout the Jeribe Formation such as drusy, syntaxial rim and blocky cement.

3.2 Microfacies of Jeribe Formation

Microfacies refer to sedimentary facies that can be studied and characterized in small rock sections [23]. The formation consists of four microfacies with eight submicrofacies as follows:

3.2.1 Lime Mudstone Microfacies

The facies is composed mainly of fossils, less than 10% according to [14]. It is composed of micrite matrix indicating a low-energy environment [23]. It has been divided into two the following submicrofacis.

3.2.1.a Non-Fossiliferous Lime Mudstone Submicrofacies (JEM1)

This microfacies was recognized in the lower and upper parts of SM-A well. It is characterized as containing a high percentage of micrite that reach (100 %)and may crystallize into microsparite and contain small-sized quartz grains transported from outside the sedimentary basin with lithoclast. This submicrofacies are affected by dolomitization with microcrystalline mosaic texture, according to [24]. It has low vuggy porosities (Pl.1-A), and it is compatible with the (SMF-23) within (FZ.8), which represents the restricted marine within the interior platform environment (Figure 2).

3.2.1.b Benthonic Lime Mudstone Submicrofacies (JEM2)

This submicrofacies was recognized in the lower part of the formation in the SM-B well and the middle part in the SM-A well. It comprises of *Rotalid*, lithoclast and quartz. It is affected by digenetic processes like dolomitization with microcrystalline mosaic texture, and dissolution. It has low intraparticle and intercrystalline porosity (Pl.1-B). This microfacies is compatible with the SMF-20 within FZ.8, representing a restricted marine within the interior platform environment (Figures 2 and 3), according to [25], modified by [26].

3.2.2 Wackestone Microfacies

The skeletal grains characterizes this type of microfacies which ranges between 10 and 50% according to the Dunham classification [14]. According to their components, it was sub-divided into two submicrofacies.

3.2.2.a Fossiliferous Wackestone Submicrofacies (JEW1)

This submicrofacies was distinguished within the lower and upper parts of the SM-A well, SM-B well. It mainly consists of Miliolids, Pelecypods, Red algae, Green algae, *Echinoids*, *Rotalid*, Gastropod and *Borelis melo curdica*. The most important digenetic processes associated with this submicrofacies are the dolomitization with microcrystalline texture, fogged texture and sieve mosaic texture, anhydritization and pyritiztion (Pl.1-C). This microfacies was affected by mechanical compaction, with high leaching. It has low interparticles, moldic, intercrystalline, fracture and vuggy porosities due to cementation such as drusy cement and blocky cement composed of a large crystal of calcite (Pl.1-D). This microfacies is compatible with the (SMF-8) within (FZ.7) the semi-restricted open marine within the interior platform environment (Figures 2 and 3). The diversity of Miliolids indicates a tropical and warm climate with moderate temperatures in closed conditions.

3.2.2.b Red Algal Wackestone SubMicrofacies (JEW2)

This submicrofacies was identified in the lower part of SM-A well**,** comprising Red algae and Miliolids. The most digenetic processes affected here are dolomitization with microcrystalline, fogged and sieve mosaic texture, anhydritization and quartz. It has low to medium porosity intraparticle and intercrystalline (Pl.1-E). It is compatible with the (SMF-8) within (FZ.7) and represents the open marine within the interior platform environment (Figures 2 and 3).

3.2.3 Packstone Microfacies

The skeletal components in the lime packstone microfacies comprise between (60-90%) according to the Dunham classification [14]. It was recognized in the lower, medium and upper parts of the formation, and it includes four submicrofacies as follows:

3.2.3.a Milioldal Packstone Submicrofacies (JEP1)

This submicrofacies is common microfacies in the studied succession SM-A and SM-B wells. It mainly consists of benthonic foraminifera in the form of Miliolids, *Peneroplis, Borelis melo melo, Borelis melo curdica, Dendritina, Rotalids,* echinoids plates, pelecypods, red algal and lithoclast.

It is affected by many digenetic processes such as dolomitization with fogged and sutured mosaic texture. It has high neomorphism in parts, cementation like drusy cement, composed of large crystals of calcite, anhydritization, micritization, and slight dissolution and mechanical compaction.

This microfacies is of low porosity interparticles, intraparticles, vuggy, moldic, intercrystalline porosities due to cementation type calcite and anhydrite cement (Pl.1-F). The genus (*Peneroplis*) lives on algae and seaweeds at a temperature of (27-18)$^{\circ}$C, and at a depth of up to (35) meters in the lagoon areas and near the coast[27]. It is compatible with the (SMF-18) within (FZ.8) and represents the restricted lagoon within the interior platform environment (Figures 2 and 3).

3.2.3.b Fossiliferous Packstone Submicrofacies (JEP2)

It was observed in the SM-A well lower, middle and upper parts of the formation. It mainly consists of Miliolids, pelecypods, *Peneroplis, Borelis melo curdica,* and fewer red algae and Echinoids. It has been affected by digenetic processes like dolomitization with sutured, fogged and sieve mosaic texture", micritization, anhydritization and glauconite mineral. It has low to medium interparticle, intraparticle and vuggy porosity due to the cementation type drusy cement and mechanical compaction with slight dissolution (Pl.2-A). It is compatible with the (SMF-18) within (FZ.7), where the sediments of this submicrofacies was deposited in open-marine within the interior platform environment (Figures 2 and 3).

3.2.3.c Green Algal Packstone Submicrofacies (JEP3)

This submicrofacies was distinguished within the middle part of the formation in the SM-A well, and it contains green algae, Miliolids, Red algae and Pelecypods with few proportions of Echinoids. It suffered many digenetic processes such as dolomitization with sieve mosaic texture, micritization, anhydritization and cementation like drusy cement. It has mechanical compaction. The types of porosity observed in this submicrofacies are medium interparticle and vuggy porosity (Pl.2-B). This submicrofacies is identical to (SMF-18) in facies zone (FZ.7), suggesting deposition in open marine within the interior platform environment (Figures 2 and 3).

3.2.3.d Red Algal Packstone Submicrofacies (JEP4)

This submicrofacies was recognized in the middle part of the formation in SM-A well, while in SM-B well in the middle and lower parts, it mainly consists of Red algae, Miliolids, less than (10%), *Rotalids*, Echinoids, *Borelis melo curdica*, *Peneroplis* and Pelecypods.

It has been severally affected by dolomitization with sieve mosaic texture, anhydritization, micritization and cementation, such as type syntaxial cement formed by the precipitation of continuous calcite around single grain or fossil fragment. The most important types of porosity observed in this submicrofacies are porosity interparticle and vuggy, slightly dissolution (Pl.2-C).

This microfacies is compatible with the (SMF-18) within (FZ.7) and represent the open marine within the interior platform environment (Figures 2 and 3).

3.2.4 Miliolidal Grainstone Microfacies (JEG)

According to the Dunham classification, the skeletal components in the grainstone microfacies comprise grain supported or with sparry calcite cement [14].

This microfacies was identified in the upper and lower parts of the formation in SM-A well, while it appears in the middle part in SM-B well, and it comprises Miliolids, *Peneroplis*, Pelecypods and *Borelis melo curdica*. The most important digenetic processes associated with this submicrofacies are dolomitization with fogged and sutured mosaic texture. It has low dissolution, such as calcite and anhydrite cement in different proportions, and the appearance of minerals authigenic pyrite and glauconite. The most important types of porosity are observed. It has low interparticle, vuggy porosity, and high intercrystalline porosity (Pl.2-D) (Figures 2 and 3). Pale green mineral glauconite in this microfacies indicates slow sedimentation rates or that it was re-deposited more than once [28]. It is compatible with the (SMF-15) within (FZ.7), where the sediments was deposited in a restricted environment.

3.3 Lateral Correlation

A lateral correlation has been made between the studied wells. Upon the microfacies and it appears that deposition is started with Milioldal Wackestone Submicrofacies (JEW1) in both wells, then followed by Milioldal Packstone Submicrofacies (JEP1), which appear in both wells too, with appearing Benthonic Lime Mudstone Submicrofacies (JEM2) in alternating with this microfacies in the SM-B only (Figure 4). The Milioldal Wackestone Submicrofacies (JEW1) existed again in both well too. The Milioldal Wackestone Submicrofacies (JEW1) followed by deposition Non- Fossiliferous Lime Mudstone Submicrofacies (JEM1), Green Algal Lime Packstone Submicrofacies (JEP3) and Fossiliferous Packstone Submicrofacies (JEP2) in the well SM-A instead of deposition of Red Algal Packstone Submicrofacies (JEP4) in wellSM-B. The Milioldal Packstone Submicrofacies (JEP1) is deposited in both well, too, which changed to Miliolidal Grainstone Microfacies (JEG) in well SM-A. Then Fossiliferous Wackestone SubMicrofacies (JEW2) was deposited, followed by Green Algal Packstone Submicrofacies (JEP3) in the well SM-A only.

The Milioldal Packstone Submicrofacies (JEP1) is deposited in both wells, and it alternate with Fossiliferous Packstone Submicrofacies (JEP2), Benthonic Lime Mudstone Submicrofacies (JEM2) and Green Algal Packstone Submicrofacies (JEP3) in well SM-A, while at alternated with Miliolidal Grainstone Microfacies (JEG) and Milioldal Wackestone Submicrofacies (JEW1) in the SM-B. The Milioldal Wackestone Submicrofacies (JEW1) was deposited in both wells and followed by Milioldal Packstone Submicrofacies (JEP1), which interbedded with Fossiliferous Packstone Submicrofacies (JEP2) and Milioldal Wackestone Submicrofacies (JEW1) in the well SM-A and SM-B respectively. It ended with the deposition of Fossiliferous Packstone Submicrofacies (JEP2) and Non- Fossiliferous Lime Mudstone Submicrofacies (JEM1) in the SM-A well, and the Milioldal Wackestone Submicrofacies (JEW1) in the SM-B well.

3.4 Depositional Environment Model

The current study showed an evident change in the climate that resulted in the deposits of the Jeribe Formation. This cycle was distinguished by marine transgression. [29] showed the sedimentary environment is determined by several factors that depend on changes in sea level, including water depth, salinity, temperature, nature of currents, turbidity and optical permeability, and thus this difference in these factors reflects the difference in the sedimentary environment in terms of the difference in sedimentary facies.

[30] The Early Cenozoic sequences are governed by tectonic activities, while the Late Cenozoic sequences reflect cycles of sea level fluctuations. It may explain the rapid variations in sedimentary facies, their multiplicity, and the different thickness of these sequences. Pointed out [31], That the rocks of the upper and lower Miocene cycle formations were deposited within (Marginal basins) the formation of these basins continued during the middle Miocene cycle, and at the end of this, the cycle transformed the marine environment close to lagoon environment, which resulted in Jeribe Formation.

Determining the paleo-depositional environment can be done after identifying microfacies zones, depending on microfacies contents and associated fossils, in which each type of fossil reflected a suitable depositional environment. The identifying of these microfacies (JEM, JEW, JEP and JEG) are divided into submicrofacies (JEM1, JEM2, JEW1, JEW2 and JEP1, JEP2, JEP3, JEP4 and JEG) and in the present study corresponds to the standards microfacies (SMF: 8, 15, 18, 20 and 23) belonging to the facies zones (FZ.7) fluctuated to (FZ.8) if compared with standard microfacies types of ([25] and [26]).

That is, the formation of the Jeribe was deposited within two environments as in (Figures 2 and 3). which is an open marine environment. It is an open lagoon environment located under the influence of calm waves, with evidence through the appearance of the (JEW2, JEP4 and JEG) show compared with standard microfacies types [25] and [26]. The identification of these microfacies and submicrofacies in the present study corresponds to the standards microfacies (SMF: 8, 15 and 18) and deposited within facies zones (FZ.7). The presence of echinoderms reflects the conditions of an open, shallow, warm, marine environment with normal salinity [32].

Restricted environment, with evidence the through the appearance of the (JEM2 and JEP1) show compared with standard microfacies types of ([25] and [26]). It is compatible with standard faces (SMF: 18, 20 and 23) and deposited within facies zones (FZ.8). Appearance (Molluscs) refers to a restricted environment back reef with a depth of between (70-20m) [33].

This association also indicates areas with shallow depths of the lagoon [34]. The same source added that the presence of the genus (*Borelis melo curdica*) reflects a warm shallow environment. [20] show that the presence of pieces of echinoderms indicates an open, shallow marine environment with medium salinity. Studies indicate that the presence of the genus of the group (Alveolinida) reflects the conditions of a marine environment behind the reef, with calm, shallow and warm waters within depths of (10-80m), containing a small amount of clastic materials [34]. The presence indicates the presence of lithoclast in an environment with variable energy currents that erode non-solidified sediments to produce lithoclast [35].

The existence of other fossils such as Peneroplids and Miliolids reflects a lagoonal marine environment with high salinity. An approximate sketch representation of the depositional model of the Jeribe Formation is depicted in (Figure 5). The association of Miliolids and *Rotalids* aggregates together may indicate the transition of the environment from normal marine waters to highly saline marine waters [27]

The depositional conditions of this Miliolidal grainstone submicrofacies are the environment of the inner lagoon. They are associated with contact with the open sea through high-energy tidal channels - moderated by winds and tidal storms, which can be inferred by the presence of different types of molluscs shells and rock fragments [36] as well as sparite, which reflects energy High [37].

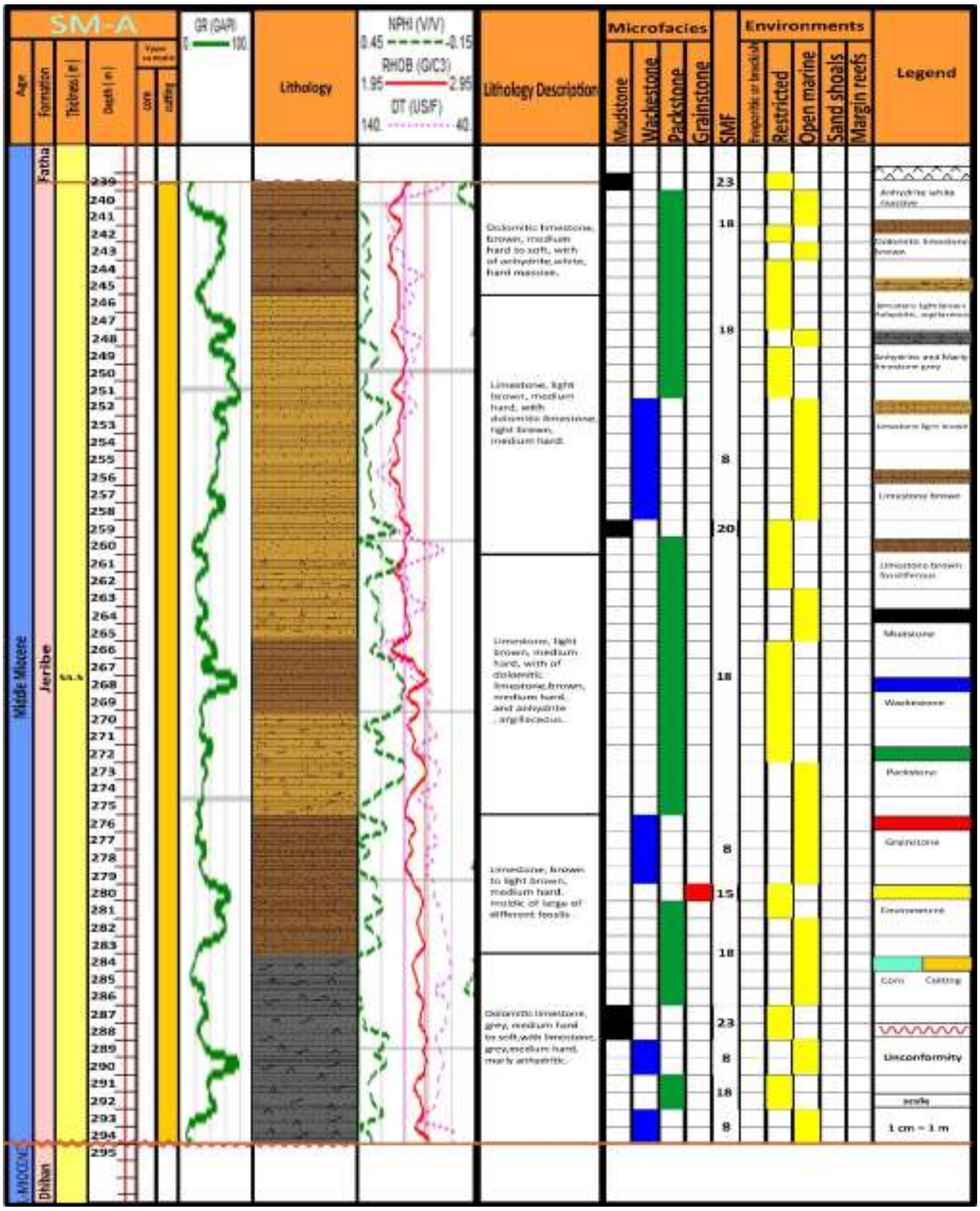

Figure 2: Stratigraphic column and microfacies of the Jeribe Formation in the well SM-A.

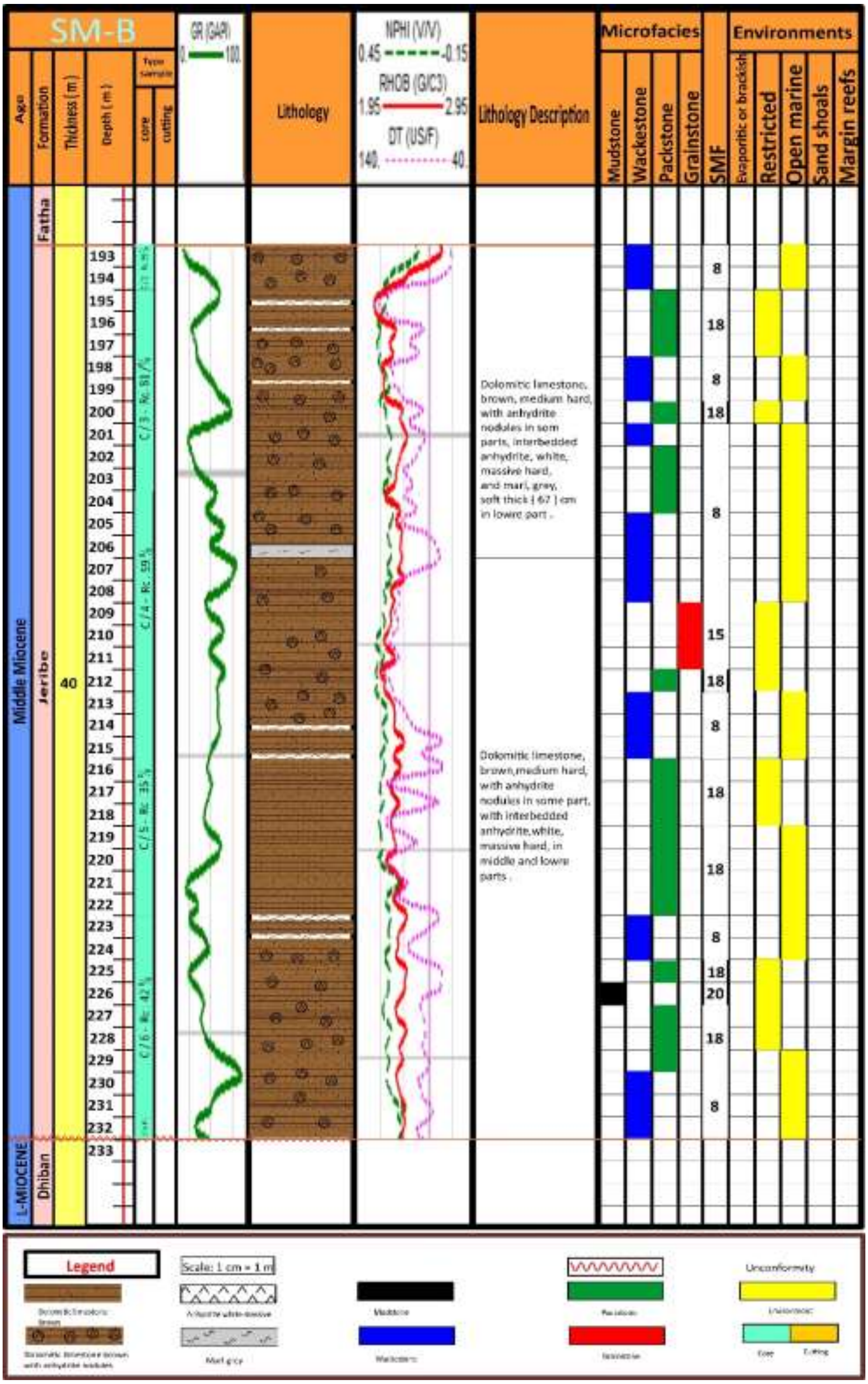

Figure 3: Stratigraphic column and microfacies of the Jeribe Formation in the well SM-B.

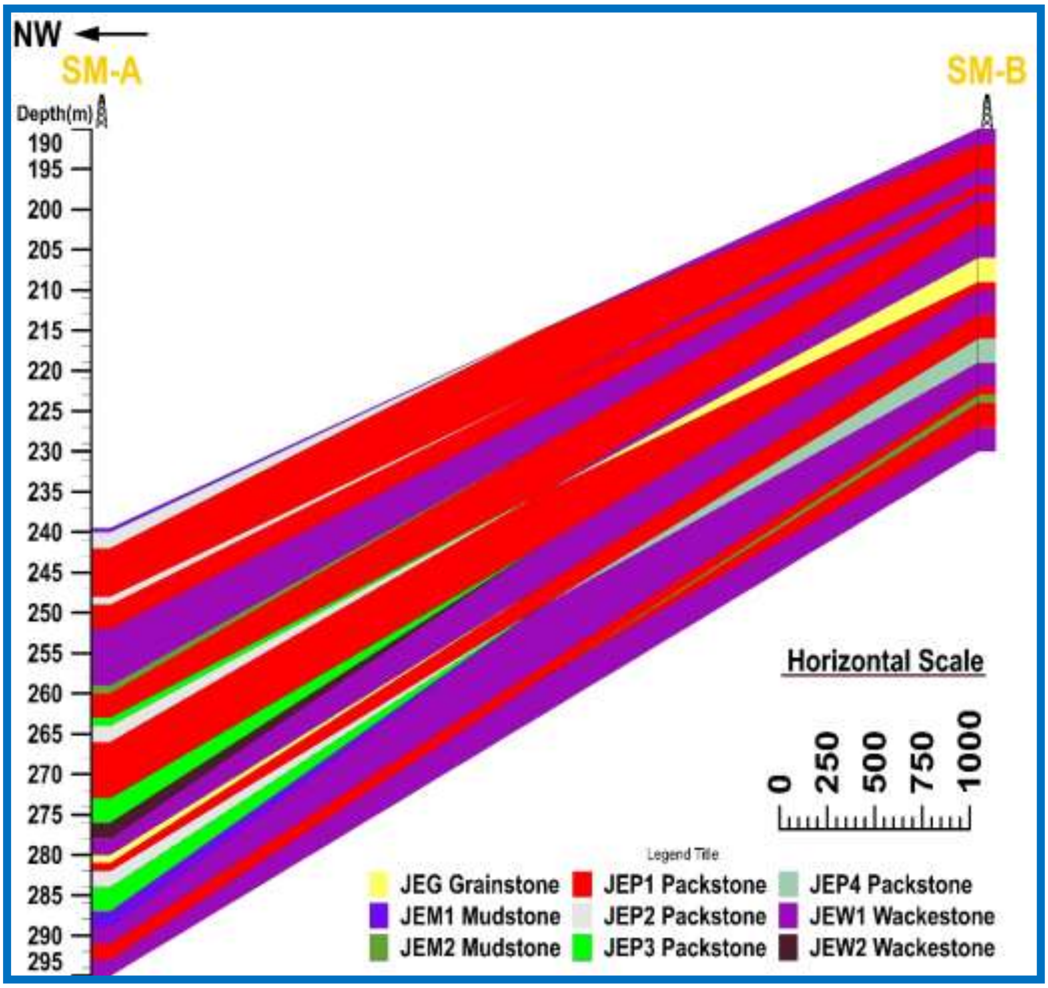

Figure 4: lateral correlation.

Plate-1

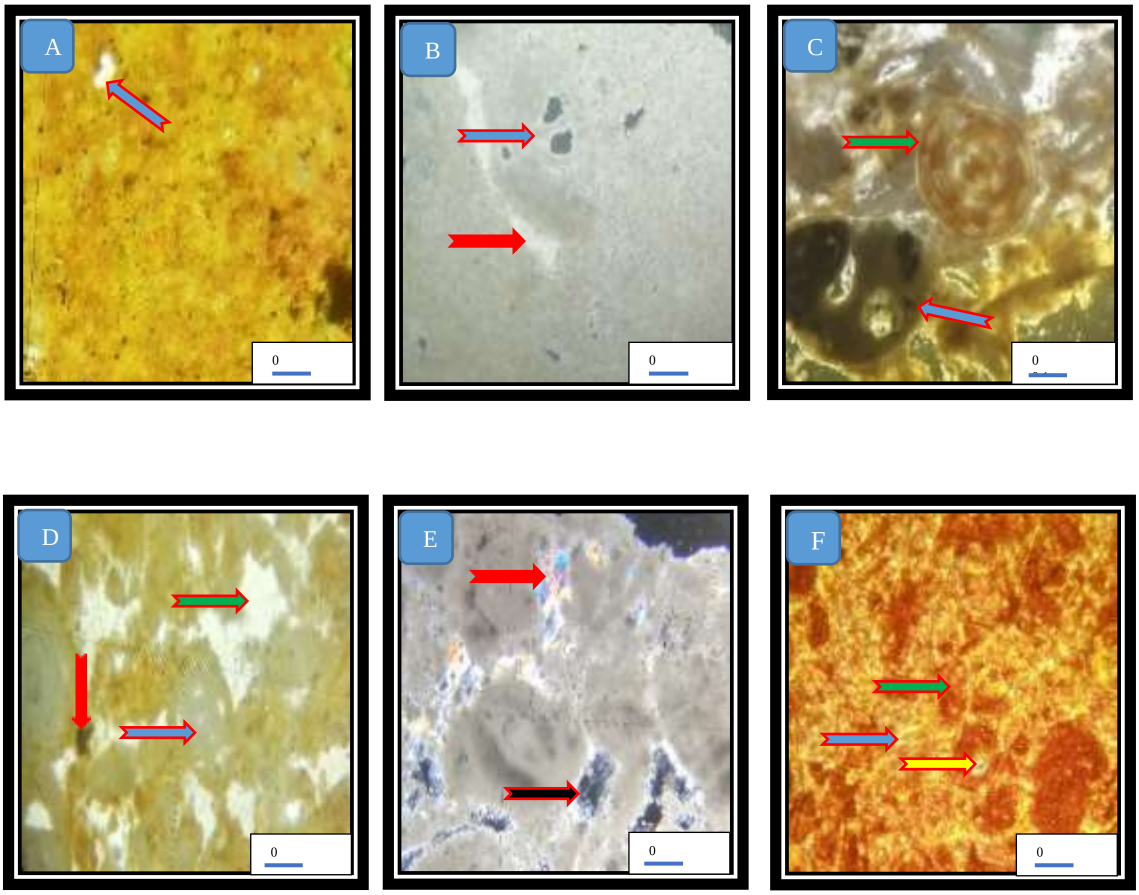

Plate -1 Thin section photomicrographs:
A - Non- Fossiliferous lime mudstone submicrofacies quartz grains lithoclast (blue arrow).
B - Fossiliferous lime mudstone submicrofacies with Rotalid and intraparticles porosity (blue arrow), cementation type calcite (red arrow).
C – Fossiliferous Wackestone Submicrofacies Gastropoda (blue arrow), Borelis melo curdica (green arrow).
D – Fossiliferous Wackestone Submicrofacies it is not clear the exiting of the peloid, miliolid (blue arrow), cementation type drusy and blocky cement (green arrow), lithoclast (red arrow).
E - Red Algal Wackestone Submicrofacies interparticle porosity (black arrow), cementation type anhydrite (red arrow).
F - Milioldal Packstone Submicrofacies Peneroplis (green arrow), vuggy porosity(yellow arrow), cementation type drusy cement (blue arrow).

Plate-2

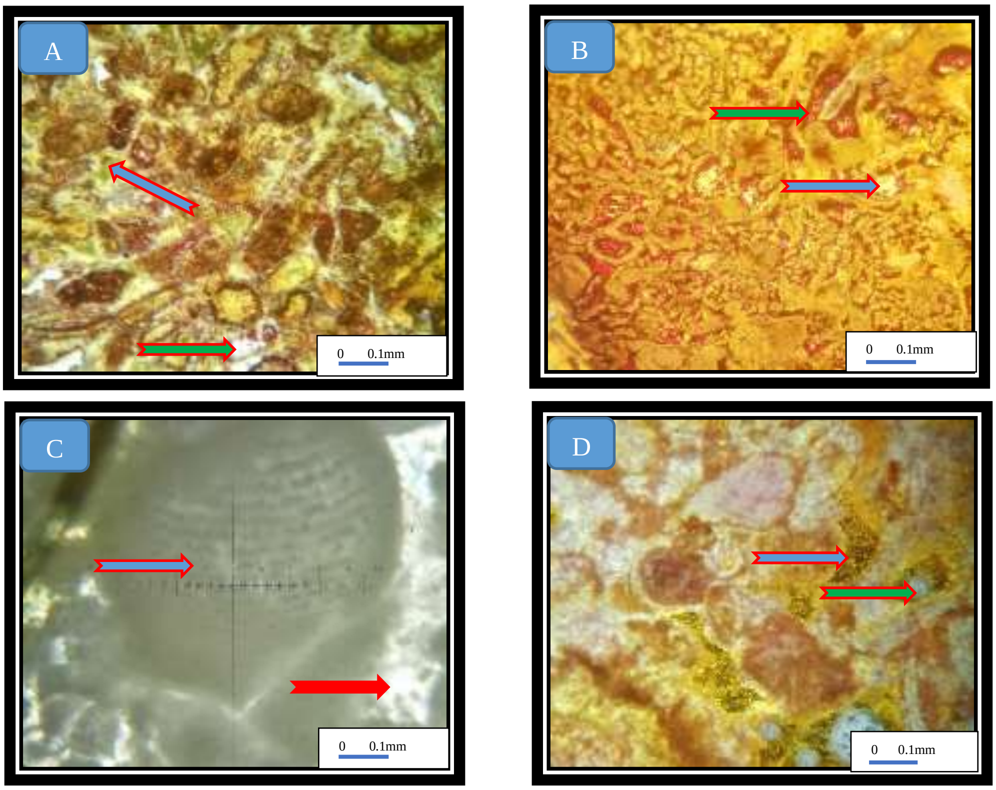

Plate -2 Thin section photomicrographs:

A - Fossiliferous Packstone Submicrofacies found glauconite (green arrow), and cementation type calcite (blue arrow).

B - Green Algal Packstone Submicrofacies green algae cementation type calcite (blue arrow), interparticle porosity (green arrow).

C - Red Algal Packstone Submicrofacies red algae (blue arrow), cementation type syntaxial cement (red arrow).

D - Milioldal Grainstone Submicrofacies interparticle porosity (blue arrow) vuggy porosity (green arrow).

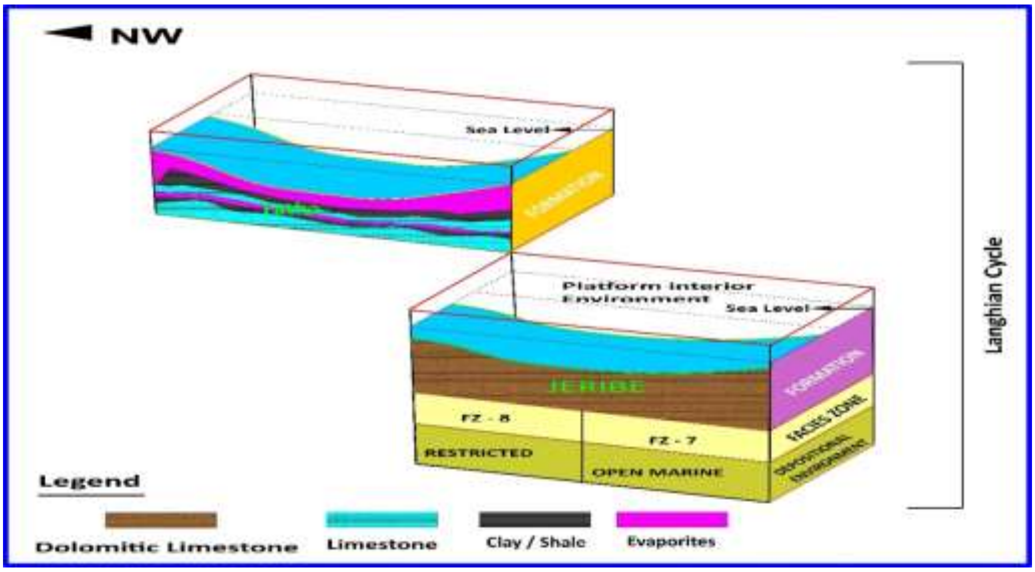

Figure 5: Schematic represents a depositional model of the Jeribe Formation.

4. Conclusions

The Jeribe Formation (Middle Miocene) was deposited in a shallow marine environment. Four main microfacies (lime mudstone, wackestone, packstone, and grainstone) were observed in this formation. These microfacies were divided into eight sub-microfacies. The Jeribe Formation is affected by dolomitization, micritization, cementation, dissolution, neomorphism and anhydritization. The interparticle, intraparticle, moldic, vuggy and intercrystalline, as most porosity types, are filled with anhydrite cement in the studied section. The authigenic minerals like pyrite and glauconite are observed. The depositional properties of the Jeribe Formation represent a shollow marine affected by completely closed conditions forming Miliolid facies. In contrast, the Miliolid and Rotaliad were deposited in a semi-closed condition that partially joined with the open sea at the deposition time. The micrite increase in these facies indicates that the environments are sheltered or isolated from high energy conditions, which recorded a few grainstone of facies and the shallow closed basin formed the Jerebe facies cycles.

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