Facies And Environmental Analysis Of Jaddala Formation (Middle-Late Eocene) For Selected Wells, North Iraq

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Abstract :

This study was carried out for Jaddala Formation (Middle-Late Eocene). Microfacies in three fields ,north Iraq, Qaiyarah field (QY-54) , Ajeel field (AJ-10) and Pulkana field (PU-7). From petrography study, it was found that the Planktonic foraminifera forming the main skeletal grains such as (*Globigerina and Morozovella*), while the benthonic foraminifera such as (*Rotalia and Nodosaria*) in second order , and other fossils such as mollusca, radiolaria, and echinods in minor amount. The matrix formed of gray to light micrite. The rocks effected by diagenetic processes with many types like compaction, cementation, dissolution, neomorphism, replacement and authigenic minerals such as pyrite, glauconite, and phosphates, in addition to dolomitization recrystallization . microfacies analysis study, the recognized main facies are three ; Lime mudstone, Lime Wackstone and Lime Packstone. These facies divided into seven submicrofacies; planktonic foraminiferal lime mudstone (M1), silica lime mudstone (M2), planktonic foraminiferal lime wackstone (W1), bioclastic lime wackstone (W2), dolomatic lime wackstone (W3), planktonic foraminiferal lime packstone (P1) and bioclastic lime packstone (P2). Based on facies and petrographic studies, its deposited within three sedimentary environments are ; deep sea, deep shelf and toe-of-slope.

Key words; Jaddala microfacies Petrograghy depositional environment

Introduction :

The Jaddala Formation was first described by Henson in 1940 from the type locality near Jaddala village in north Iraq (Bellen *et al.*, 1959). The Jaddala Formation studied by (Al-Bayati,2000) sedimentary study in North west Iraq, in four sections; it are type locality and Sinjar section with two sections subsurface, (QY-90) and (SF-6), it showed most of the facies forming are mud supported and rich with Foraminifera specially Planktonic and Radiolaria . as showed it is affected by diagenetic processes like Compaction, Dissolution , Cementation , Neomorphism , Dolomitization and Dedolomitization . as produced sedimentary environments ,it is formulated from the interferences of three deep facial zones ; Outer shelf , Bathyal and Abyssal. It is represents the off-shore facies of the Late Early Eocene-Late Eocene Sequence in the Western and central areas of Iraq. The Jaddala Formation was deposited in a basin lying between two belts of carbonate shoals on the SW and NE margins of the basin . The NE shoals were deposited on a ridge separating the basin from the platform in which the Gercus Formation and Pila Spi Formation were deposited (Jassim and Goff,2006).

Generally, the Jaddala Formation outcrops showed up on narrow area in Jabal Sinjar , NW- Iraq of the Foothill Zone. It was occupied most of sediments of north areas, during Eocene period. And was occur in most of subsurface sections with different thicknesses . In present study three wells selected; Qaiyarah field (QY-54), Ajeel field (AJ-10) and Pulkana field (PU-7), (Fig.1). The sum of 133 samples from these wells, collected which mostly cutting (Table.1).

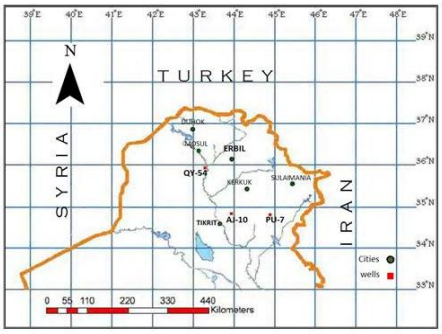


Figure (1) Location map

Table (1) location, samples number, wells and formation thickness and elevation.

Wells	Location Geographic Units	No. samples	depth of well (m)	Thick. of Ja. Fm. (m)	Elevation (m)
QY- 54	35° 50' 16.7" N 43° 53' 27.8" E	29	881	59	265
AJ- 10	34° 50' 14.8" N 43° 53' 59.0" E	31	2506	68	158
PU- 7	34° 46' 53.3" N 44° 46' 15.6" E	73	2240	336	303

Petrography :

The petrographic study of carbonate rocks is particularly useful because carbonate grains, unlike clastic terrigenous ones, normally are produced in close proximity (from less than a meter to hundreds of meters) to the site of their ultimate deposition. In addition, carbonate grains are formed mainly by organisms, and thus the grains convey ecological information about the environment of formation as well as stratigraphical information on the age of the deposit (Scholle, 2003). Petrographic study is an important, and useful guide to reconstructing the depositional environment by determination of microfacies which is primarily dependant on discrimination of grains, fabrics, biocontents and type of matrix. (Flugel, 1982).

The Jaddala Formation deposition in study area is found by high content of skeletal grains, compose Foraminifera shells most of grains specially planktonic forams such as *(Globigerina, Morozovella, Globigerina yeguaensis, Subbotina senni, Pseudohastigerina micra* and *Acarinina)* (plate 1,2,3,4), while the benthic forams are coming in second order such as (*Rotalia, Nodosaria, Discorbis, Lenticulina* and *Bulimina.* (plate 5). In addition to some of other fossils such as Mollusca, Radiolaria, Red Algae, Ostracoda and bioclasts. Also it is found on some non-skeletal grains as a silica grains and rock fragments.

The matrix was formed of microcrystalline calcite ; it is associated of the grains, with light gray to darkish color, with some sparite, it found by high content in all wells, especially in (PU-7). The rocks were affected by Diagenetic processes with many types like Compaction, Cementation, Dissolution, Dolomitization, recrystallization, Neomorphism, Replacement and Authigenic minerals such as Pyrite, Glauconite, Anhydrite and Phosphates, in addition to secondary porosity.

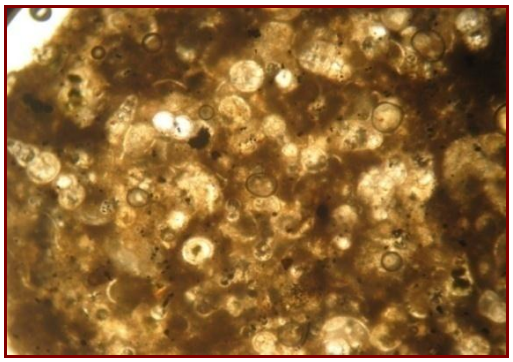


Plate (1) *Globigerina* and *Morozovella* in Lime Wackstone microfacies, (QY-54), depth 437-38, (X 30).

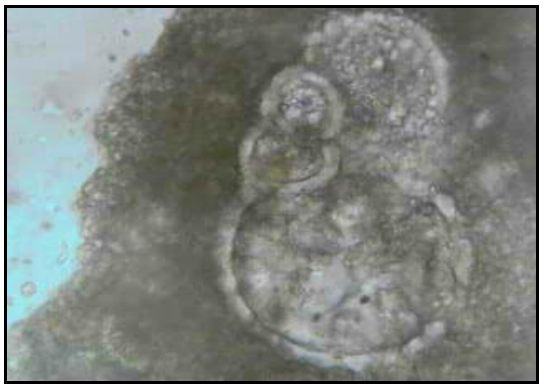


Plate (2) *Globigerina yeguaensis*, (AJ-10), depth 1238-39, (X 40)

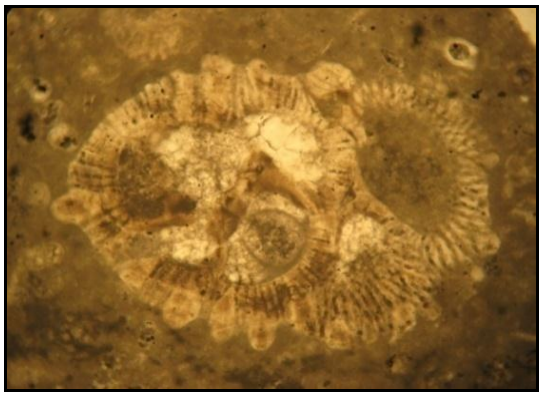


Plate (3) *Subbotina senni*, (AJ-10), depth 1228-29, (X40)

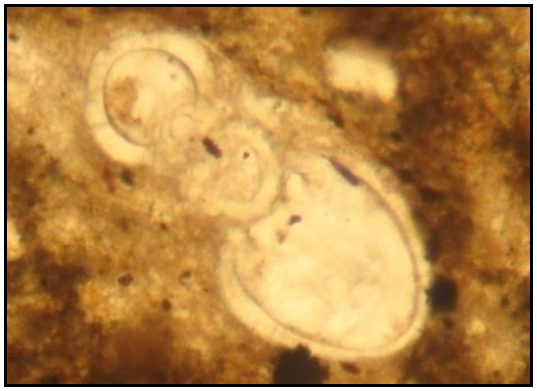


Plate (4) *Pseudohastigerina micra*, (PU-7), depth 1855-56, (X 40)

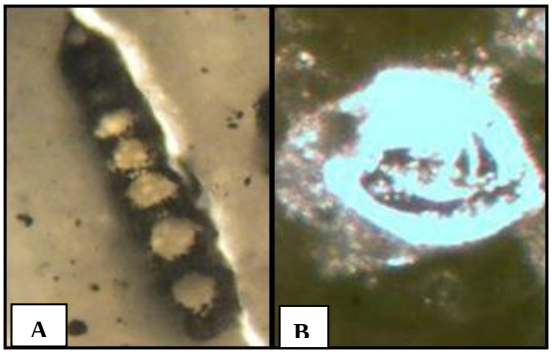


Plate (5) benthonic foraminifera, A : *Nodosria*, (AJ-10), depth 1230—31m, (X 40) B: *Rotalina*, (AJ-10), depth 1212-13m, (X 40).

Lithology :

Carbonate rocks are classified into limestone, dolomite, mixed siliciclastic-carbonates (marl, argillaceous and sandy limestones), evaporates (gypsum, anhydrite, salt). Carbonate rocks make up 20 to 25 percent of all sedimentary rocks in the geological record and are classified into limestones and dolomites (dolostones), see (Fig. 2), (Flugel,2004).

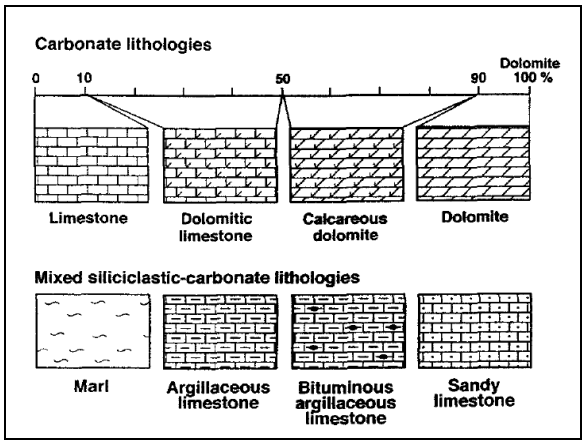


Figure (2) Common lithologies of carbonate rocks and mixed carbonate-siliciclastic rocks (Flugel,2004).

The Lithology of the Jaddala Formation in present study consist of limestone, marly limestone, chalky limestone, dolo-limestone and marl, with gray to light color and other nodules of pyrite, glauconite and anhydrite, (Figures 3,4,5).

Age of the Jaddala Formation according to Bellen *et al.*, (1959) is considered Mid-Late Eocene. Al-Dawoody, (2010) confirm the Mid-Late Eocene age in the studied area. The boundaries of the Jaddala Formation are underlined by Aliji Formation and overlaid by Oligocene Group Formations in (AJ-10) and (PU-7) and by Avanah Formation in (QY-54)well.

Microfacies Analysis :

The study of microfacies would highlight some of the environmental and depositional conditions of sedimentary rocks. Facies unite or all rocks with particular petrographic and or biologic criteria (Selley, 1985). Carbonate of the Jaddala Formation were classified according to Dunham's (1962) classification based on ; matrix, grains and texture, taking into consideration Wilson's (1975) standard microfacies analysis, the major identified microfacies for the Jaddala Formation are; Lime mudstone, Lime Wackstone and Lime Packstone. Each type consists of several submicrofacies depending on their components. The following facies had been listed below.

1- Planktonic Foraminiferal lime Mudstone SubMicrofacies (M1)

This facies is composed of micrite (more 90%) with rare fossils content (less than 10%), usually with dark color. It is present in the Pulkana well (PU-7), Some of fossils may it recognized from Planktonic foraminifera such as *Globigerina*, *Morozovella* and *Subbotina senni*, with little of a Mollusca (plate 6,A).

This facies has endured diagenetic processes such as dissolution, cementation, dolomatization and anhydritization, this facies is coinciding with Wilson's (1975) Standard Microfacies (SMF-3) which belongs to (FZ-1) which was defined (Deep Sea), (Fig. 3,4,5).

2- Siliceous lime Mudstone SubMicrofacies (M2)

This facies is recognized by accumulation of silica grains identity biogenic original or (Biogenic Silica), and single grains, varied sizes, pellicular and dark color. It is present in the Pulkana well too, the ratio of skeletal grains less than 5% from rocks component total. In some places, it is composed of micrite alone or mixed with microspare (plate 6,B). This facies is coinciding with Wilson's (1975) Standard Microfacies (SMF-1) which belongs to (FZ-1) which was defined (Deep Sea), (Fig. 4,5).

3- Planktonic Foraminiferal Lime Wackstone Submicrofacies (W1)

This facies is characterized by predominant skeletal grains has about (10%-50%) from rocks component total, and high distribution of planktonic foraminifera about 70% from skeletal grains total, these Planktonic included on (*Globigerina*, *Morozovella*, *Subbotina senni* and *Globigerina yeguaensis*), It also included some benthic forams such as (*Bulimina* ، *Nodosria* ،*Textularia*), and some broken shells of molluscs (plate 7,A).

The matrix content of the micrite with light brown to dark brown, it is found in each wells. And recognized some grains of authogenic minerals, it was subjected to some diagenetic processes especially dissolution and compaction. This facies is equivalent to Wilson's Standard Microfacies (SMF-8) which belongs to Facies Zones (FZ-2) described (Deep Shelf), (Fig. 3,4,5).

4- Bioclastic Lime Wackstone Submicrofacies (W2)

This facies consists of grains about (10%-40%) from components total of the rock, and percentage of bioclast more than 50% from grains components total, it is found in all wells, the matrix is dark micrite because abundant of organic materials, and included Radiolaria and Mollusca (plate 7,B). This facies is equivalent to Wilson's Standard Microfacies (SMF-2) which belongs to Facies Zones (FZ-1) described as deep sea or (Deep sea), (Fig 3,4,5).

5- Dolomatic Lime Wackstone Submicrofacies (W3)

This facies is characterized by dolomite crystals in proportion up to 40% (plate 7, C) , its also content of some grains are; *Globigerina* and *Rotalina*, in addition, with limited attributing of Red Algae debris, Molluscs and Bioclast. This facies have been effected at various levels by the following diagenetic

processes; Dolomitization, Cementation, neomorphism, Compaction and Authigenic minerals. This facies is equivalent to Wilson's Standard Microfacies (SMF-3) which belongs to Facies Zones (FZ-3). It is a representative of a shallow marine environment or (Toe-of-Slope), (Fig. 3,4,5).

6- Planktonic Foraminiferal lime Packstone Submicrofacies (P1)

Diversified assemblage of skeletal grains were the main constituents of this facies in proportion up to about 60% of the Lithology, and principally composed of abundant Planktonic forams such as (*Globigerina*, *Morozovella* and *Globorotalia aspensis*) and some benthic forams such as *Textularia* and *Bulimina*, with other fossils as Bioclast (plate 8,A).

Physical and Chemical Compaction and Cementation are the main diagenetic processes affected this facies, it were observed Glauconite, pyrite and phosphate, filling of some foram shells. This facies is characteristic of deep marine environment and corresponding to (SMF-2) in (FZ-2) of Wilson's (1975), (Fig. 3).

7- Bioclastic Lime Packstone Submicrofacies (P2)

It is characterized by a high content of bioclastic about 50% of the grains, which are associated with limited number of some Planktonic foraminifera such as *Globigerina* ، *Morozovella* and *Globigerinatheka*, and vary rare benthonic forams, in addition to some other fossils, total of skeletal grains about 50% of the Lithology (plate 8,B).

This facies is found in upper part of Qaiyarah well (54), it is composed of brown to dark micrite, it had been effected at various of diagenetic process such as cementation, dissolution and recrystallization, as well as authigenic minerals. It is interpreted to indicate a open marine environment or (Toe-of-Slope), corresponding to (SMF-2) of (FZ-3) of Wilson's (1975), (Fig. 3,4,5).

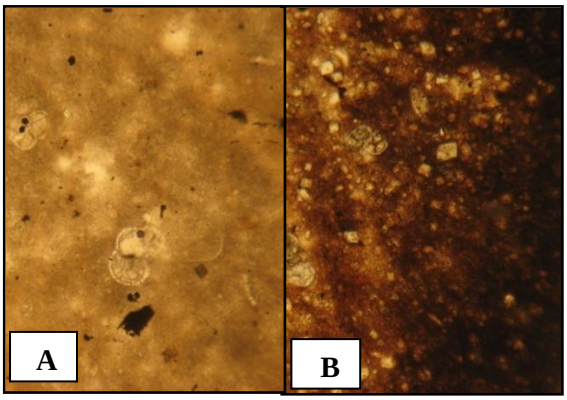


Plate (6) Lime mudstone microfacies, A : Planktonic Foraminiferal lime Mudstone SubMicrofacies, (PU-7), depth 1665-66m, (X 20). B: Siliceous lime Mudstone SubMicrofacies, (PU-7), depth 1682-83m, (X 20).

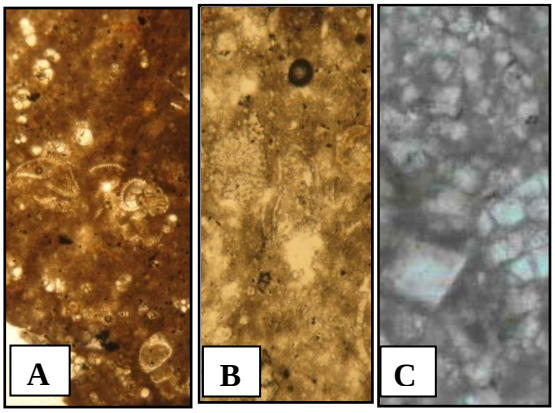


Plate (7) Lime Wackstone microfacies, A : Planktonic Foraminiferal lime Wackstone SubMicrofacies, (PU-7), depth 1778-79m, (X 20). B : Bioclastic Lime Wackstone Submicrofacies, (PU-7), depth 1790-91m, (X 20) C : Dolomatic Lime Wackstone Submicrofacies, (QY-54), depth 409-10m, (X 20).

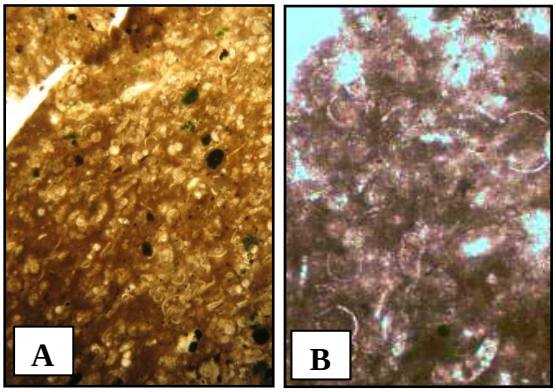


Plate (8) Lime Packstone microfacies, A : Planktonic Foraminiferal lime Packstone Submicrofacies, (QY-54), depth 443-44m, (X 10). B: Bioclastic Lime Packstone Submicrofacies, (QY-54), depth 390-91m, (X 10).

Depositional Environment

It is that part of the earth surface which get it the sedimentation, and possible his recognition from other parts depending on variations in conditions the physical, chemical and biological, and any interpenetration between this conditions lead to changes in sedimentation and getting different type of the facies, (Boggs, 2006). Present study related to facies changes may be due to topographic variation in sedimentary basin which effect within the following environmental indicators ;

1-Jaddala Formation characterized by enrichment of Planktonic foraminifera assemblages (Ooze), indicate deep marine environment.

2-The matrix consists of micrite, with rare sparite, it is indicated to quiet sedimentary environment.

3-The marl is the most common in all facies represents a deep marine environments.

4-Radiolaria and silica grains (Biogenic Silica) are represents high deep marine environments.

5-Dolomite, cement crystals and increasing of benthonic foraminifera as *a Rotalid* are represents of sea regressive and occurring shallow marine , it is found in upper part of (QY-54) well.

6- Abundance pyrite, glauconite and phosphate are represents to absence of oxygen and deep sea, as well as slowly of deposition processes. (Nichols, 1999; Chilingar *et al.*, 1967) it is found in some submicrofacies such as (w3).

Generally, from microfacies analysis and corresponding to Standard Microfacies by Wilson's (1975). Show that Jaddala Formation consist (SMF-2,3,8) which explain three facies zones are ; (FZ-1) which was defined (Deep Sea), (FZ-2) was defined (Deep Shelf) and (FZ-3) which was defined (Toe-of-slope). Wilson(1975) and developed by (Flugel, 2004).

The Planktonic assemblage, silica grains and some of Radiolaria shells of the Jaddala Formation represented deposition in deep marine (deep sea and deep shelf), on difference that, increasing in benthonic ratios and dolomite grains it is found in upper part of (QY-54) are represented deposition in shallow marine (Toe-of-Slope). Result of these differences led to a changes in the topographic of sedimentary basin.

Present study is signal and through facies analysis environmental indicators to concluding three deposional environments are : Toe-of-Slope , Deep shelf and Deep sea (Figure 6).

Conclusions :

The study was revealed the following results :-

1-The main petrographic study of Jaddala Formation constituents has shown diversity of Planktonic foraminifera (*Globigerina, Morozovella, Subbotina senni* and *Globigerina yeguaensis*), in addition to benthonic foraminifera (*Bulimina, Rotalina* ، *Nodosria* and *Textularia*), Other, less common, fauna included (Molluscs, Radiolaria, Ostracods and Bioclasts).

2-Various Diagenetic processes had influenced limestones of Jaddala Formation, which are: compaction, cementation, dissolution, authigenic minerals, neomorphism, and dolomitization . these processes were effective in late and early diagenetic stages.

3-The matrix of Jaddala Formation was composed of micrite with light brown to dark color, rich in organic materials.

4- Lithologically, the carbonate rocks of Jaddala Formation are composed mainly of Limestone, marly limestone and shelly limestone as well as thin beds of marl and dolomite.

5-Microfacies Analysis , mainly based on Dunham's Classification (1962), has exposed three major microfacies (mudstone, Wackstone and packstone), subdivided into seven Submicrofacies are :

a- Planktonic Foraminiferal lime Mudstone SubMicrofacies (M1)

b- Siliceous lime Mudstone SubMicrofacies (M2)

c- Planktonic Foraminiferal Lime Wackstone Submicrofacies (W1)

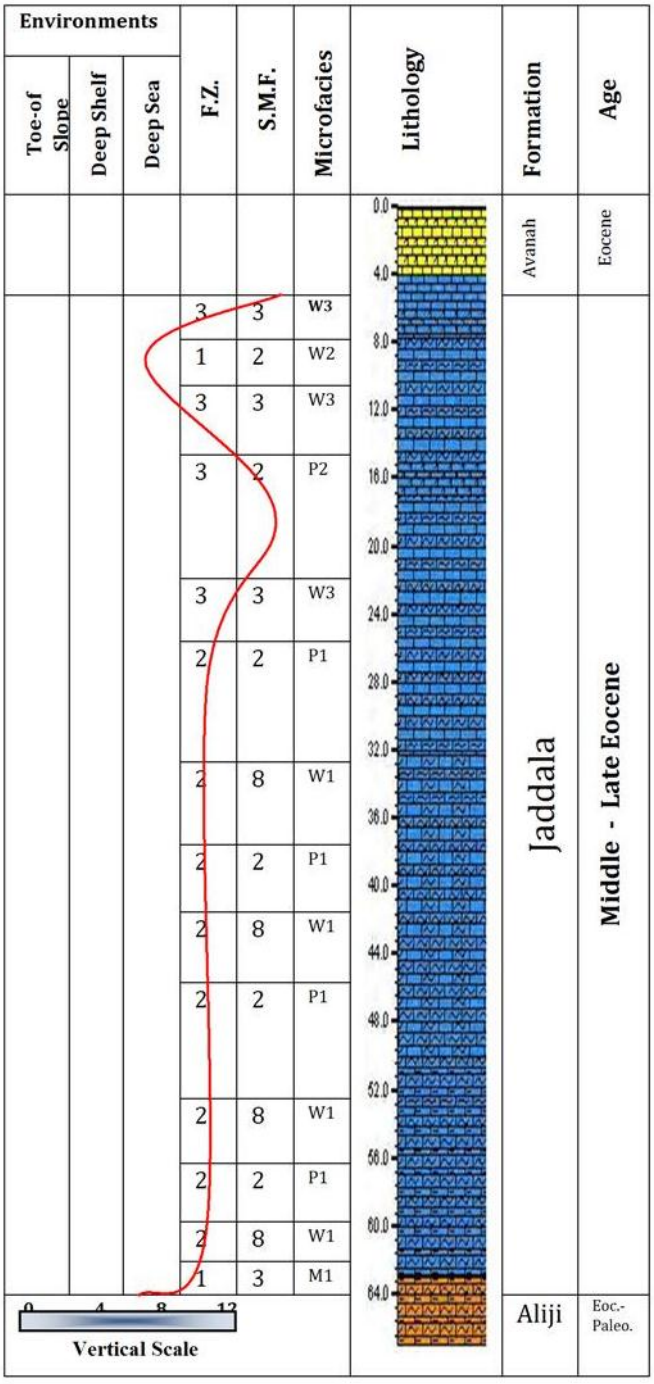
d- Bioclastic Lime Wackstone Submicrofacies (W2)

e- Dolomatic Lime Wackstone Submicrofacies (W3)

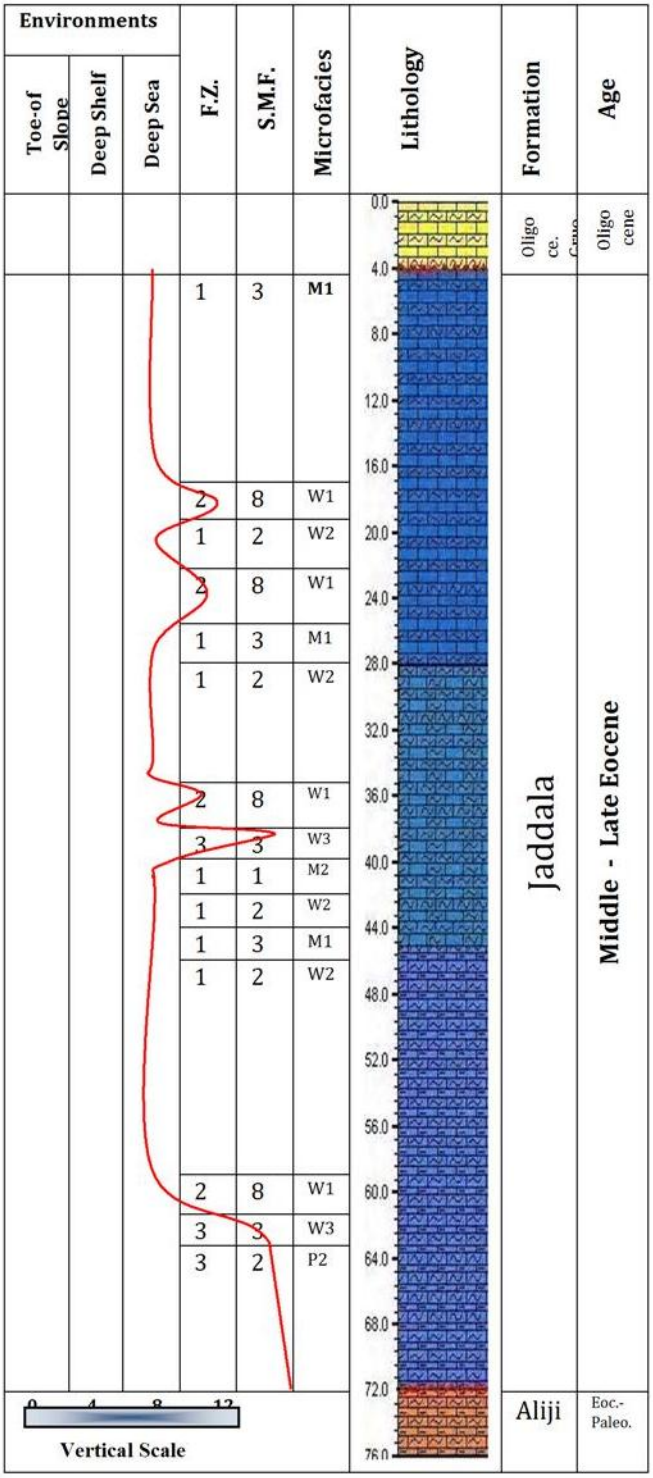
f- Planktonic Foraminiferal lime Packstone Submicrofacies (P1)

g- Bioclastic Lime Packstone Submicrofacies (P2)

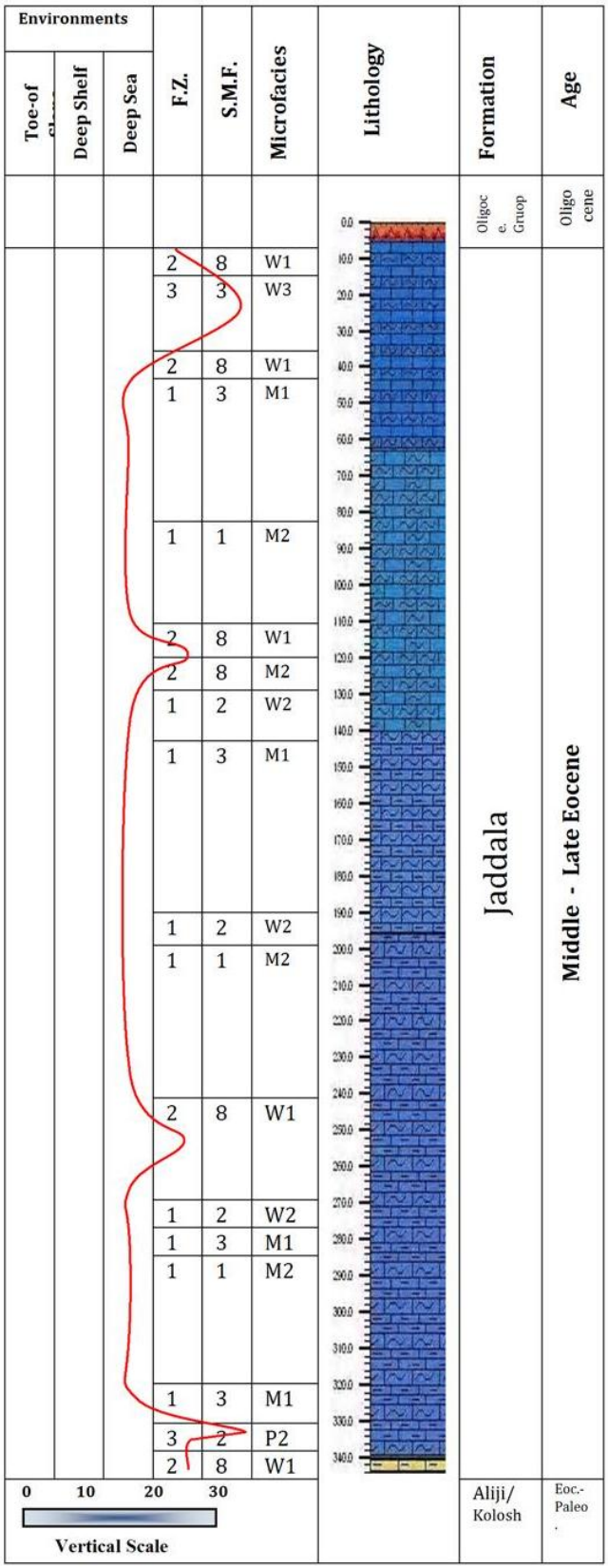
6-This study deduce may was silica grains deposited in sedimentary basin, were his biochemical source, and it transported as a rock fragment within the sedimentary basin.



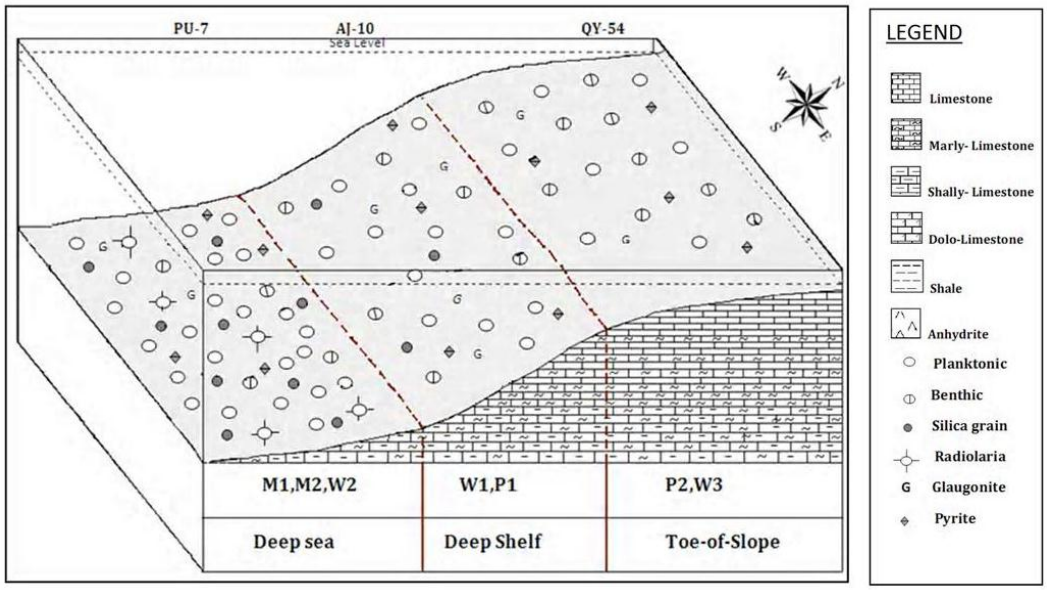
Figure(3) Stratigraphy column, facies and environment distribution of the Jaddala Formation (QY-54).



Figure(4) Stratigraphy column, facies and environment distribution of the Jaddala Formation (AJ-10).



Figure(5) Stratigraphy column, facies and environment distribution of the Jaddala Formation (PU-7).



Figure(6) sedimentary model of Jaddala Formation

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التحليل السحني والبيئي لتكوين جدالة (الايوسين الأوسط– الأسفل) لأبار مختارة في شمال العراق

صباح عباس مجيد ، لفته سلمان كاظم ، عبداللة سلطان شهاب

قسم علوم الأرض التطبيقية ، كلية العلوم ، جامعة تكريت ، تكريت ، العراق

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الملخص:

درس تكوين جدالة (الايوسين الأوسط – المتأخر) سحنياً وبيئياً في ثلاثة حقول نفطية ، موزعة على المنطقة الشمالية من العراق وهي بئر قيارة (54) وبئر عجيل (10) وبئر بلكانة (7). واعتماداً على المعطيات الوصفية والبتروغرافية بينت ان المنخربات الطافية تشكل الجزء الأكبر من بين الحبيبات الهيكلية التي تتركب منها ترسبات التكوين ، لاسيما أجناس (*Globigerina, Morozovella*) ، أما المنخربات القاعية فتاتي بالدرجة الثانية بعد الطافية من حيث الشيوع ، لاسيما جنسي (*Rotalia , Nodosaria*) . فضلا عن وجود المتحجرات الأخرى من الرخويات والراديولاريا والاوستراكودا والطحالب وبعض القطع غير معروفة الأصل . بالنسبة للقاعدة الأرضية فإنها تتألف أساساً من الميكرايت وبلون بني غامق – فاتح . كما يبين التكوين بأنه متعرض الى العديد من العمليات التحويرية ، من أبرزها الانضغاط والإذابة والسمنتة والإحلال وعمليات تكوين معادن موضعية النشأة من البايرايت والكلوكونايت وعمليات تكوين الدولومايت وإعادة التبلور .

أظهرت دراسة السحنات الدقيقة ان تكوين جدالة يتألف أساساً من ثلاث سحنات رئيسة وتبعاً لشيوعها هي : سحنة الحجر الجيري الطيني وسحنة الحجر الجيري الواكي وسحنة الحجر الجيري المرصوص ، وقد تم تقسيم هذه السحنات الرئيسة بدورها على سبع سحنات ثانوية ، وهي : سحنة الحجر الجيري الطيني الحاملة للمنخربات الطافية (M1) ، وسحنة الحجر الجيري الطيني الحاملة للحبيبات السليكية (M2) ، وسحنة الحجر الجيري الواكي الحاملة للمنخربات الطافية (W1) ، وسحنة الحجر الجيري الواكي الحاملة للفتاتات العضوية (W2) ، وسحنة الحجر الجيري الواكي الدولومايتي (W3) ، وسحنة الحجر الجيري المرصوص الحاملة للمنخربات الطافية (P1)، وسحنة الحجر الجيري المرصوص الحاملة للفتاتات العضوية (P2).

اعتمادا على التحليل السحني والبيئي تبين ان تتابعات تكوين جدالة قد ترسبت ضمن ثلاث انطقة بيئية هي : نطاق البحر العميق ونطاق الرصيف العميق ونطاق مقدمة المنحدر ، إذ بينت الدراسة الحالية ان جزءاً كبيراً من السحنات كانت مترسبة ضمن النطاقين العميقين الأول والثاني .