DOI: 10.24996/ijs.2023.64.9.17

ISSN: 0067-2904

Depositional Framework and Stratigraphic Sequence of Early – Middle Miocene succession in Balad and East Baghdad oil fields, Central Iraq

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Received: 15/9/2022 Accepted: 16/11/2022 Published: 30/9/2023

Abstract

This study deals with microfacies analysis, diagenetic facies, environmental interpretations related to sequence stratigraphy for Early – Middle Miocene in selected wells within Balad (Ba-X) and East Baghdad (EB-Z) oil fields.

Seven major microfacies were recognized in the successions of the study wells, these facies were used to recognize six facies association (depositional environments) within the study oil fields: deep marine, toe of slope, open marine, restricted interior platform, evaporitic interior platform and brackish interior platform. The facies associations interpreted were based on texture and obtainable fauna.

The Early - Middle Miocene succession was deposited during two depositional cycles as a third order cycle (C1and C2). These cycles are asymmetrical and started with cycle one (C1) which divided into three sub-cycles in Balad oil field. The first (C_S1) deep open marine association facies in lower part of Serikagni Formation represents by relatively thin transgressive system tract (TST). This facies overlying by evaporitic interior platform association facies as highstand system tract (HST) within the upper part of Serikagni Formation and bounded by MFS. The second sub - cycle (C_E1) is represented by relatively thin transgressive system tract (TST) reflected by restricted interior platform occupies the lower part of Euphrates formation, while middle and upper part occupies by highstand system tract (HST), which represented by evaporitic interior platform facies. At the lower part of Dhiban Formation sub - cycle ($C_{Dh}1$) is started with transgressive system tract (TST) reflected by Evaporitic interior platform overlying by open marine environment which represent the starting of highstand system trac (HST).

Cycle two (C2) is almost symmetrical cycle started with transgressive system tract (TST) reflected by restricted interior platform occupies the lower part of Jeribe Formation, while middle and upper part occupied by highstand system tract (HST), which represented by open marine environment.

This succession appeared high cyclicity in East Baghdad oil field during the same two major cycles (C1 and C2) with absence of deep open marine association facies (Serikagni Formation). Where C1 cycle is appeared five sub-cycles of HST overlying the TST within Euphrates and Dhiban succession. The second cycle is characterized by three sub-cycles of HST overlying TST sub-cycle within the Jeribe succession. The above gives accurate evidence that the location of the East Baghdad oil field was the closest to the continental part, while the Balad oil field was towards the deep sea. This clearly affected the number of sedimentation cycles and the shallowness of the deposition environment in the East Baghdad field compared to the Balad oil field.

Keywords:- Depositional Framework, stratigraphic sequence, Early – Middle Miocene, Balad oil field, East Baghdad oil field, Central Iraq

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الإطار الترسيبي والتتابع الطباقي لتتابع المايوسين المبكر – الأوسط في حقلي بلد وشرقي بغداد النفطيين ، وسط العراق

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الخلاصة

تتناول هذه الدراسة تحليل السحنات الدقيقة ، والسحنات التحويرية ، والتفسير البيئي المتعلق بالتتابع الطباقي للميوسين المبكر والاوسط في آبار مختارة ضمن حقلي بلد وشرقي بغداد النفطيين.

تم التعرف على سبع سحنات دقيقة رئيسية في تتابع آبار الدراسة ، واستخدمت هذه السحنات للتعرف على ستة مترافقات سحنية (بيئات ترسيبية) في تتابع الدراسة: بيئة بحرية عميقة ، ومقدمة المنحدر ، والبحرية المفتوحة ، والمنصة الداخلية المحجوزة ، والمنصة الداخلية التبخرية والمالحة. استندت تفسير هذه المترافقات على النسيج والمحتوى الحياتي التي تم تشخيصها.

تم ترسيب تعاقب الميوسين المبكر والاوسط خلال دورتين ترسيبيتين كدورتين من الدرجة الثالثة (د1 و د2) هذه الدورات غير متكافئة وبدأت بالدورة (د1) والتي تتقسم إلى ثلاث دورات فرعية في حقل نفط بلد. تمثل المترافقة السحنة البحرية العميقة الأولى (دس1) في الجزء السفلي من تكوين سريكاكني خلال نظام التكديس التقدمي . (TST)هذه السحنة تعلوها مترافقة المنصة الداخلية التبخيرية كترسبات نظام التوقف العالي (HST) ضمن الجزء العلوي من تكوين السيريكاكني ويحده سطح الانغمار الاعظم .(MFS) تمثل الدورة الفرعية الثانية (دف1) من خلال نظام تقدم رقيق نسبيًا (TST) ينعكس من خلال الترسيب في المنصة داخلية المقيدة التي تحتل الجزء السفلي من تكوين الفرات ، بينما يحتل الجزء الأوسط والجزء العلوي من النظام التوقف العالي (HST) ، والذي يمثله واجهات المنصة الداخلية. في الجزء السفلي من الدورة الفرعية لتكوين ذيبان (دذ1) تبدأ مع نظام التقدم (TST)الذي تعكسه منصة التبخر الداخلية والتي تعلوها بيئة بحرية مفتوحة والتي تمثل بداية نظام التوقف العالي.(HST)

الدورة الترسيبية الثانية (د2) هي عبارة عن دورة متناظرة تقريبًا تبدأ مع نظام التكديس التقدمي (TST) الذي تعكسه المنصة الداخلية المقيدة التي تحتل الجزء السفلي من تكوين الجريبي ، بينما يشغل الجزء الأوسط والعلوي نظام التوقف العالي (HST) ، والمتمثل بالبيئة البحرية المفتوحة.

اظهر هذا التتابع دورية رسوبية ثانوية عالية في حقل شرقي بغداد خلال نفس الدورتين الرئيسيتين (د1 و د2) مع عدم وجود مترافقة سحنية بحرية عميقة (تكوين السيريكاكني) . حيث ظهرت الدورة الاولى خمس دورات فرعية من نظام التوقف الاعلى (HST) تعلو نظام التقدم (TST) ضمن تكويني الفرات و ذيبان. تتميز الدورة الثانية بثلاث دورات فرعية من نظام التوقف الاعلى (HST) فوق الدورة الفرعية لـ نظام التقدم (TST) ضمن تتابع الجريبي . ما ورد أعلاه يعطي دليلاً دقيقاً على أن موقع حقل شرقي بغداد النفطي كان الأقرب إلى الجزء القاري ، بينما كان حقل نفط بلد باتجاه أعماق البحر. وقد أثر ذلك بوضوح على عدد دورات الترسيب وضحالة بيئة الترسيب في حقل شرقي بغداد مقارنة بحقل بلد النفطي.

1. Introduction

The Miocene Sequence (23.03 – 5.33 Ma), in Iraq has large diversity in lithofacies, biofacies, depositional environments, tectonic effect, and geographical distribution [1]. Carbonate – evaporate deposition occurred in Early Miocene time. Basin wide evaporates and marls were deposited in mid Miocene time [2].

The Early - Middle Miocene succession in Iraq is including the Euphrates, Serikagni and Dhiban formations of Early Miocene age, and the Jeribe and Fatha formations of Middle Miocene age.

This study details with microfacies analysis, diagenetic facies, environmental interpretation related to sequence stratigraphy.

The studied area is including two oil fields located in central Iraq these are East Baghdad and Balad (Figure 1). East Baghdad is a super-giant oil field located in Baghdad and Saladin governorates, 10 km east of Baghdad city [3], and crossing both the Diyala and Tigris Rivers. It extends further north-westwards into the Salah Ad-Din Governorate [4].

Balad Oil Field is considered as one of the main oil fields in Central Iraq. It's located within Salah Al-Din Province alongside the Tigris River and approximately 65 km north of capital city, Baghdad [5](Figure 1).

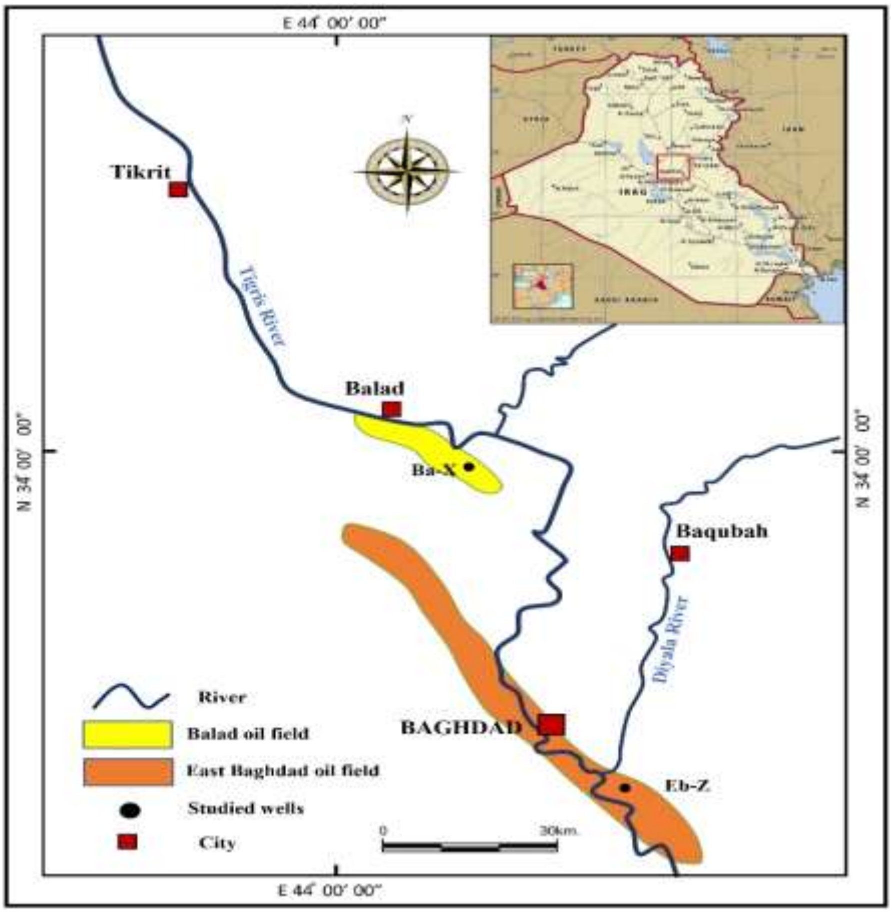


Figure 1: Location map for the studied area.

Al-Zaidy [6] studied the backstripping analysis and basin evolution of the Neogene Succession in the northeastern Iraq. He suggested that the Sirekagni and Euphrates succesdsions were deposited during the transgression stage with high subsidence and accumulation rates in the Hamrin - Makhul, and north of Tigris Subzones. While the Chemchemal–Arbil and Butmah–Mosul subzones were represented positive areas during Early Miocene (Aquitanian age). This stage was ended with a sea withdrawal to the southeast to generate the lagoon of Dhiban basin with it is characteristic low rates of accumulation and subsidence. During the Early Burdigalian, the Jeribe succession was deposited during another transgressive stage which covered the area except the uplift positive area in Chemchemal-Arbil and Butmah-Mosul subzones.

Al-Dabbas *et al.*, [7] studied the sedimentological and diagenetic features of Jeribe succession in the northern oilfields. According this study the Jeribe Formation was deposited in open, restricted, and edge platform which represent lagoon depositional environment. While the deposits of the lower parts of the Jeribe succession especially in well Hamrin- 2 which reflect a deeper fore slope environment.

Omar *et al*. [8] studied the sedimentology and microfacies analysis of the Early Miocene sequence in the Zurbatiya area. They suggested deep open marine, outer shelf and the slope/toe slope for Serikagni succession, and lagoon, restricted and semi-restricted for Dhiban Formation.

Alkhaykanee and Al-Dulaimi [9] studied the Miocene succession in Ajil oil field and they suggested "*Ammonia beccarii-Miogypsina globulina*" Assemblage zone for the Eupherates succession, and "*Borelis melo curdica*" Range zone for Jeribe succession. Dhiban succession includes no marker faunal elements and was dominated by anhydrites.

Aoudah *et al*. [10] named the Oligocene – Early Miocene Sequence as the Missan Group. These sediments were subdivided into two cycles, where each one is ended by a sequence boundary, equivalent to the lowstand siliciclastic residues in the basin center. The second cycle is represented by the Early Miocene Epoch (Aquitanian), during the Euphrates Formation was deposited during the transgressive and highstand conditions and ended by the lowstand conditions sediments in the basin center as an Upper Missan Sandstone Member. These two cycles are conformably bounded by Lower Miocene (Jeribe Formation).
Aim of the current study are analysis of microfacies and digenesis features to define the paleoenvironments and stratigraphic sequence development during the Early – Middle Miocene time in Balad and East Baghdad oil fields.

2. Materials and Methods

Two oil field represented here by two wells one from every field were selected for this study. More than 150 thin sections, in ditch and core samples are prepared and described for their textures, and type of pores between the grains, and to determine depositional environments.

The well-logging data is used to compare the microfacies which were extracted from the laboratory work as electrofacies and diagnostic of the horizontal and vertical facies changes.
Base and location map with columnar lithologic sections for the studied wells were draw by using the Corel Draw X7.

3. Stratigraphic Setting

Towards the end of the Oligocene Epoch the sedimentary basin became shallower probably due to tectonic movement along the margin of Zagros and progradationally infilled by the Oligocene – Aquitanian shelf sediments. Restriction in the basin center led to deposition of evaporites and conglomerates [2].

The Early-Middle Miocene succession can be classified into two second order sequences, each with carbonate shallow water passing up into evaporite sediments. They are the Early Miocene and the Middle Miocene successions [12].

The Early Miocene succession is including the Euphrates, Serikagni and Dhiban formations; the Middle Miocene succession is including the Jeribe and the Fatha formations. The Early-Middle Miocene succession is thicker in the eastern part of the basin (Figure 2). The maximum thickness of the sequence is 240 m near Injana oil field, more than 190 m near Baghdad and more than 80 m Balad oil field.

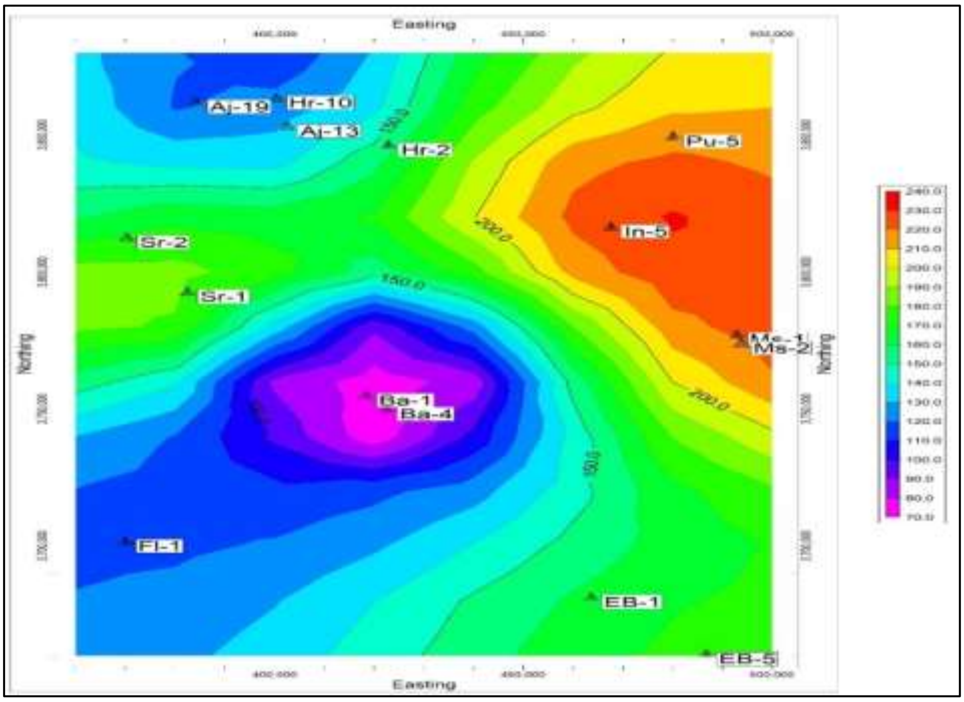


Figure 2: Isopach map showing thickness of Early – Mid Miocene sequence in central of Iraq.

3.1 Serikagni Formation (Basinal):-

The Serikagni Formation is representing a basinal association facies. The formation was first described by Bellen in 1955 [13]. The type locality lies at Bara Village in Jebel Sinjar area within Foothill Zone. The formation consists in the type locality of globigerinal, chalky limestone with a few more calcareous bands. The thickness of the succession in the type area reach 150m. Fossils are abundant. The assemblages consist mainly of Foraminifera. The fossils prove the late Lower Miocene [14].

The Serikagni Formation has a limited exposure distribution, it is found in Sinjar Anticline North West of Iraq. The depositional environment of the formation (marine basinal) and its distribution indicates the development of broad and shallow basins, in which carbonates were deposited, during Savian movements, and were restricted in small areas, which mean the developed basins were mainly narrow and small; therefore, the Serikagni Formation has very restricted coverage areas [1].

3.2 Euphrates Formation (Carbonate inner shelf):-

The Euphrates Formation is the most widespread in the Central part of Iraq. It was originally identified by De Boeckh in 1929 and later studied by Bellen, 1957 [13]. The type locality near Wadi Fuhalmi near Anah City within Stable Shelf which comprising of 8 meters of shelly, chalky and well bedded recrystallized limestone. However, it represents only small part of the succession and does not include the basal conglomerates. Sandstone and anhydrites also occur in some subsurface sections [13], and are possibly tongues of the Ghar and Dhiban successions respectively. The formation composed mainly of limestone with textures ranging from oolitic to chalky, which locally include corals and shells of coquinas; they are often recrystallized and siliceous sediments. Beds of green marl, argillaceous sandstones, breccia, conglomerate, and conglomeratic limestone also occur [12].

The age of the Euphrates succession is late Early Miocene (Burdigalian), proved by the presence of *Miogypsina globulina* and *Miogypsina intermedia* (Ctyroky and Karim, 1971 in [12]). *Miogypsina globulina* is appeared to be restricted to the Early Miocene (early-middle Burdigalian); M. *intermedia* to the Early - Middle Miocene (Burdigalian to Early Langlhan) [15]. These faunas are Tethyan faunas indicating the continuous presence of the seaway connection with the Tethys Ocean during Burdigalian [1].

3.3 Dhiban Formation (Evaporite lagoons) :-

During the Late Burdigalian, the Tethys Ocean way was closed due to the collision of the African / Arabian Plates, and Iranian (Eurasian) Plate; consequently, this led to the deposition of lagoonal facies (Dhiban Formation) [1].

The Dhiban succession was defined at the first time by Henson, 1940 and amended by Bellen, 1957 [13] from the type locality near Dhiban Village in the Sinjar area within Foothill Zone. The succession consists of 72 meters of gypsum, thin bedded marl and brecciated recrystallized limestones. The thickness of the succession is more than 150 meters but it averages about 70 meters. [12]. The age of the Dhiban Formation has been identified on the basis of stratigraphic position with other formations. The Dhiban Formation overlies the Serikagni Formation, interfingers with the Euphrates succession and is overlain by the Jeribe Formation. Therefore, it was considered of Early Miocene age [12].

3.4 Jeribe Formation (Carbonate inner shelf and shoals) :-

The Jeribe Formation was identified by Bellen, 1957 [13] from the type area near Jaddala Village in the Sinjar anticline, and assumed to be of Early Miocene age. However, the formation was considered of Middle Miocene age [12].

The thickness of the Jeribe Formation in the type locality reaches 70 meters with abundant fossils. The index fossil for the formation is *Borelis melo curdica* which used to assign the formation to the Middle Miocene [14].

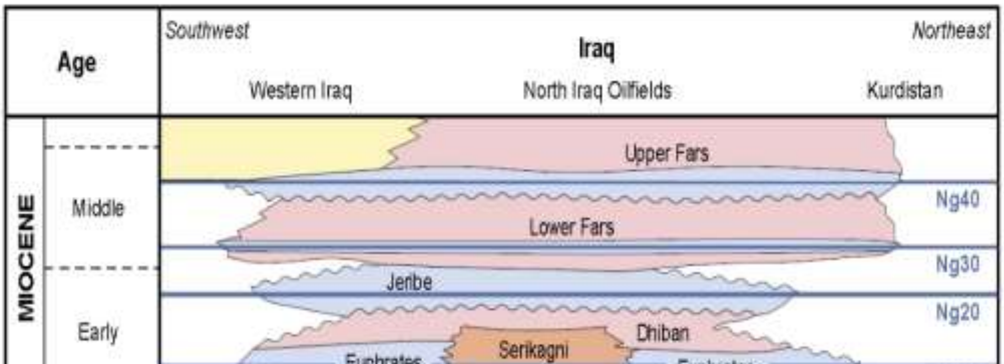


Figure 3: Stratigraphic correlation of the Oligocene-Miocene formations recorded of Megasequence Ap11in Iraq [16].

4. Microfacies Analysis

The microfacies term refers to the sedimentary features and facies that can be studied and characterized in thin sections of a rock [17]. The purpose of microfacies analysis is to provide a detailed inventory of the carbonate rocks characteristics (types of carbonate grain, kinds and growth fossils forms, grains sized and shaped, nature of micrite, cement, particle fabrics) that can subsequently be related to depositional settings and conditions [17].

After examining the thin sections by using polarizer microscope, the carbonate microfacies have been identified according to Dunham [11], Wilson [18] and Flugel [19]. Seven major microfacies were recognized in the studied successions of the study wells. These facies were used to recognize the paleoenvironments paleoenvironmental conditions prevailed during deposition of the studied succession.

Microfacies (A):- Bioclastic mudstone to wackestone:-
This facies consists mainly of bioclasts, shell fragment and fossils affected by micritization. It can be divided into:-

1. **fossiliferous mudstone:-** This facies consists mainly of lime muds (micrite) with appeared less than 5% of bioclasts (Plt. 1- A).
2. **Bioclastic wackestone:-** This facies including debris algae, echinoderms (spine and plate), and peliods affected by micritization, dolomitization, and dissolution (moldic pores) are the main continent of this facies (Plt. 1-B).

Microfacies (B):- Bioclastic peloidal wackestone – packstone:-
The main content of this facies is peloids with bioclast and micritized grains (Plt.1-C).

Microfacies (C):- foraminiferal wackestone – packstone:-
This facies is mainly consisting of benthic foraminifera (miliolid and Rotalia) in addition to *Miogipsynia sp.* as index fossil in Euphrates Formation.

Microfacies (D):- Bioclastic planktonic mudstone – wackestone:-
This facies is diagnosing in Serikagni Formation (Plt. 1-D).

Microfacies (E):- Ooidal-peloidal packstone-grainstone:-
This facies consists of ooid affected by micritization and peliod (Plt. 1-E).

Microfacies (F):- Evaporitic dolomitic wackestone-packstone:-
This facies is recorded in Jeribe and Dhiban formation which include:-

1.**Evaporitic dolomitic wackestone – packestone** (Plt. 1-F)
2.**Dolomite** (Plt. 1-G)

Microfacies (G):- Evaporitic lime mudstone and evaporites:-
This facies is mainly represented in Dhiban Formation (Plt. 1-G).

5. Paleoenvironment: -
Paleoenvironmental analysis refers to study or use of ancient geological materials (rocks) to infer the depositional environment or setting within which they were deposited [20].
Facies association (which defined as collection of commonly associated sedimentary attributes such as rock types, sedimentary structures and fauna [21], were compared with the standard microfacies types and depositional environment belts of carbonates which proposed by Wilson [18]. The characteristics of an environment are determined by the combination of processes which occur there [22].

Six facies association were distinguished within the studied successions: deep marine, toe of slope, open marine, restricted interior platform, evaporitic interior platform and brackish interior platform. These facies associations interpreted were based on texture and obtainable fauna with the diagenetic features (Figures 4, 5, 6 and 7).

Facies association 1: Deep marine environment: -
This association is remarked within Sarikagni Formation, it is represented by

A. Planktonic wackestone:-
This facies consist of planktonic foraminifera wackestone, it was observed in Ba – 1, this facies characterize by micrite matrix with common planktonic foraminifera. The facies types indicate deep marine and quite water sedimentation within SMF3 and Fz2.
Calcareous and siliceous shells of planktonic organisms settle through the column of water to the seafloor upon death. The geographical distribution of these organisms in the surfaces waters is affected by nutrients and prevailing ocean currents. After the tiny shells settle onto the ocean floor, they may be transported by the turbidity currents [23].

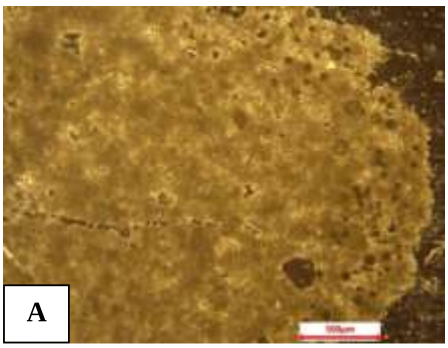
Facies association 2: platform – margin:-
This association is observed in Jeribe Formation in East Baghdad - X, and it is represented by:
A. Bioclastic fossiliferous grainstone
B. Fossiliferous packstone
Both facies types are mainly consisting of coated grains due to micritization occurs in very shallow environment [19]. These are represented in MFS11 which was deposited under Fz-5.

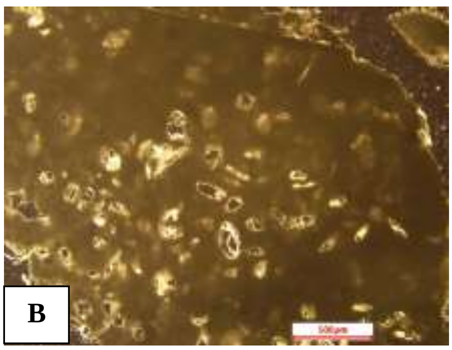
Facies association 3: Open marine: -
The dominant particles have been transported from high-energy to low-energy environments (e.g. from shoals to swales in the proximity) [19]. This association is observed in all wells in particular in Jeribe and Euphrates Formations, and it include: -

A. Bioclastic mudstone – wackestone
B. Bioclastic peloidal wackestone – packestone
C. Bioclastic foraminiferal wackestone – packestone
These types of facies are represented SMF-10 which deposited in Fz-7.

Facies association 4: Restricted interior platform: -
This association is the dominated in study wells, this facies is not well connected with the open marine, causing large variations in temperatures and salinities. Water depths below one meter and a few meters to a few tens of meters [19], it consist of:-
A. peloidal, Ooidal wackestone-packstone
B. Foraminiferal peloidal packstone
C. dolomitic lime mudstone
D. Dolomite
All these facies types are represented of SMF-15m (A), 16 (B), 23 (C, D) within Fz-8.
Facies association 5: Evaporitic interior platform: -
In this association gypsum, anhydrite or halite may be deposited beside the carbonates. It includes: -
A. **Evaporitic lime mudstone – wackestone**
B. Evaporitic lime mudstone
C. Evaporite
All these facies types are represented of SMF-25 within Fz-9.

Plate -1-





A. Mudstone (Jeribe Formation) (Eb – Z, 1368.5m).
B. Biomoldic wackestone (Dhiban Formation) (Ba – X, 1340m).
C. Peloidal packstone-grainstone (Jeribe Formation) (Ba – X, 1310m).
D. Foraminiferal packstone (Euphrates Formation) (EB – Z, 1470m).
E. Wackstone with trace of planktonic (Serikagni Formation) (Ba – X, 1440m).
F. Ooidal peloidal packstone (Jeribe Formation) (EB – Z, 1382.5m).
G. Evaporitic dolomitic wackstone-packstone (Dhiban) (EB-Z, 1416)
H. Evaporitic lime mudstone (Dhiban) (Ba-X, 1330)

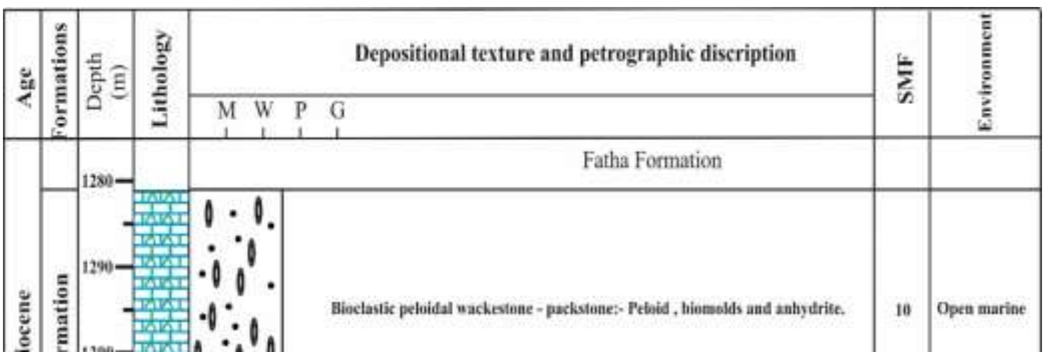


Figure-4 Microfacies and depositional environments with standard microfacies (according to

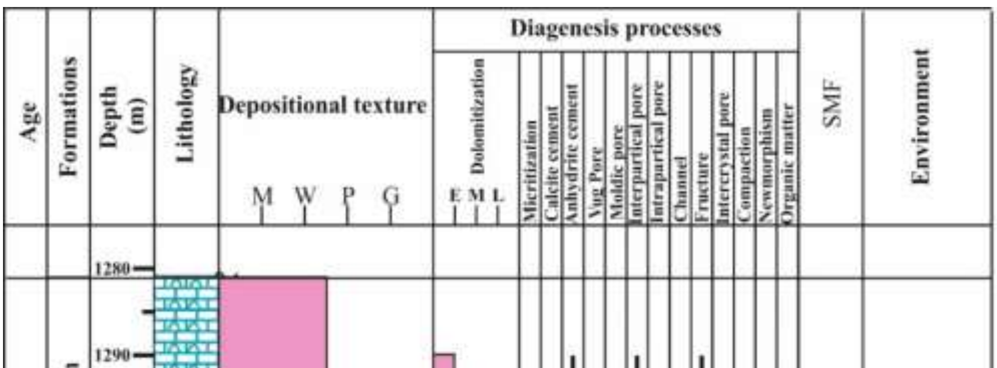


Figure 5: Diagenetic facies related to depositionals environment with standard microfacies (according to Wilson, [18] and Fugle, [19]) for Early – Middle Miocene in Balad – X.

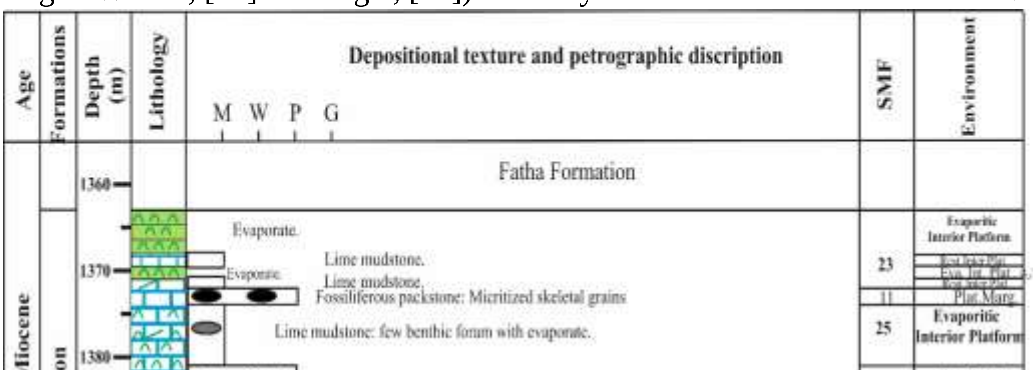


Figure 6: Microfacies and depositionals environment with standard microfacies (according to Wilso n, [18] and Fugle, [19]) for Early – Middle Miocene in East Baghdad – Z.

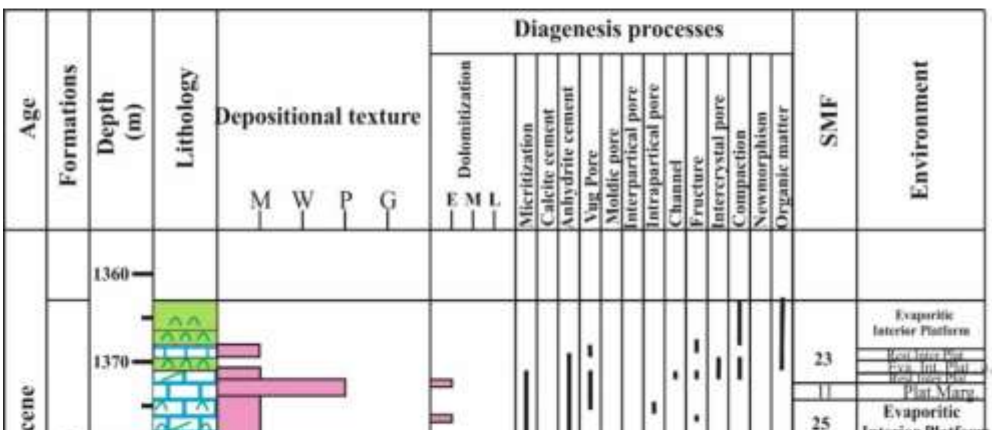


Figure 7: Diagenetic facies related to depositional environments with standard microfacies (according to Wilson, [18] and Fugle, [19]) for Early – Middle Miocene in East Baghdad – Z.

6. Stratigraphic Sequence Development: -

Sequence stratigraphy classifies the sedimentary sections into sequences every one of them is subdivided into there systems tracts arranged from older to younger: lowstand systems tract, transgressive systems tract and highstand systems tract and bounded by unconformity surfaces at base and top. Discuss your units in this outline with focus on the stacking pattern and depositional trend in relation to sea level change within the sequence.

The study succession in Ba – X is subdivided into two order cycles (C1and C2) from base upwards. These cycles are asymmetrical and divided into three sub – cycle (Fig.8). The first one is sub – cycle (C_S1) where the deep-water basin facies in lower part of Serikagni Formation represents by relatively thin transgressive system tract (TST) bounded below by a transgressive surface (TS). The highstand system tract (HST) of this cycle is reflected by evaporitic interior platform facies, which appears in the upper part of Serikagni Formation.

This system tract bounded above by (MFS) which separated between Serikagni Formation and Euphrates Formation.
Sub - cycle (C_E1) is represents by relatively thin transgressive system tract (TST) reflected by restricted interior platform occupies the lower part of Euphrates Formation, while middle and upper part occupies by high system tract (HST), which represented by evaporitic interior platform facies.

At the lower part of Dhiban Formation sub - cycle ($C_{Dh}1$) is started with transgressive system tract (TST) reflected by Evaporitic interior platform overlying by open marine environment which represent the starting of highstand system trac (HST).
Cycle (C2) is almost symmetrical cycle started with transgressive system tract (TST) reflected by restricted interior platform occupies the lower part of Jeribbe Formation, while middle and upper part occupied by high system tract (HST), which represented by open marine environment.

Two cycles are observed in East Baghdad -Z named C1 and C2 (Fig.9). The first cycle (C1) started with relatively thin transgressive system tract (TST) which bounded below by Sequence boundary (SB1) and above by Maximum Flooding Surface (MFS) and occupies the lower part of Euphrates succession represents by restricted interior platform and open marine.

The highstand system tract (HST) in this cycle divided in to five sub – cycles, they are (C_{E1}, C_{E2}, C_{E3}, C_{Dh1}, and C_{Dh2}). The first three sub – cycles (C_{E1}, C_{E2}, and CE3) occupy the middle and upper part of Euphrates Formation started from (MFS) and end at conformable boundary which separated between Euphrates Formation and Dhiban Formation, reflected by open marine, evaporitic interior platform and restricted interior platform environments.

The last two sub – cycles (C_{Dh1}, and C_{Dh2}) started from the conformable surface and ended at Sequence boundary (SB2) which separated between Dhiban Formation and Jeribe Formation, these sub – cycles represented by evaporitic interior platform and restricted interior platform environments.

The cycle (C2) started from (SB2) with thin transgressive system tract (TST) which occupied the lower part of Jeribe Formation and bounded above by (MFS) represented by open marine, restricted interior platform and Platform margin environments.
In this cycle the high system tract (HST) divided in to three sub – cycles ($C_{J1}2$, $C_{J2}2$, and $C_{J3}2$), it bounded below by (MFS) and expended to conformable surface that separate between Jeribe Formation and Fatha Formation. The (HST) reflected by restricted interior platform, open marine, evaporitic interior platform and Platform margin environments.

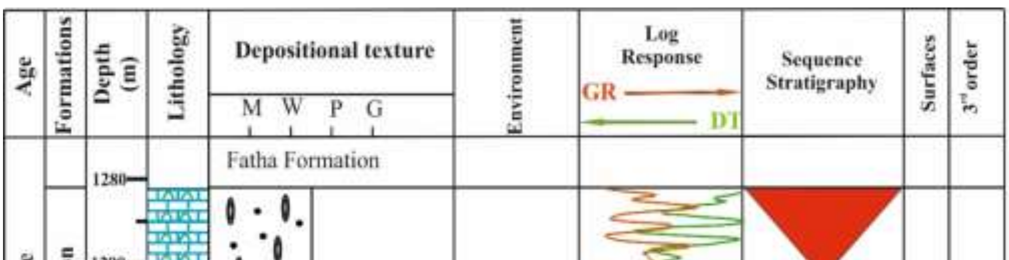


Figure 8: Depositional environments and sequence stratigraphy of Early – Middle Miocene in Balad – X.

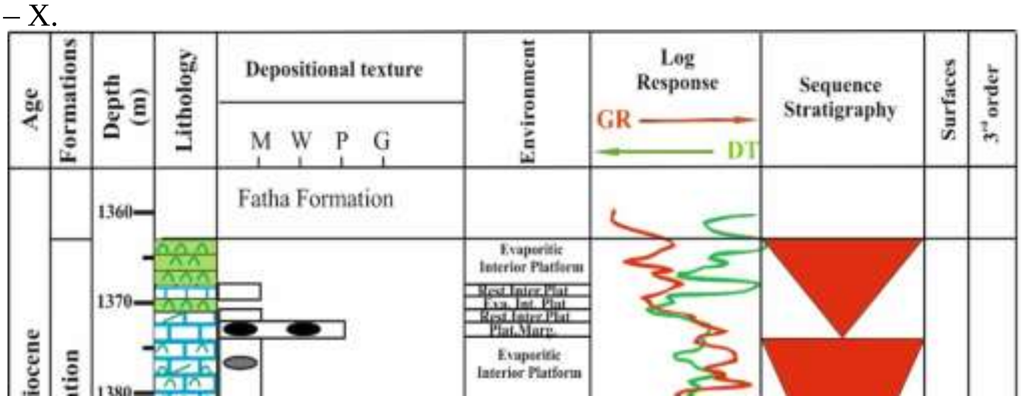


Figure 9: Depositional environments and sequence stratigraphy of Early – Middle Miocene in East Baghdad- Z.

7. Conclusions

Seven major microfacies were recognized in the successions of the study wells, these facies were used to recognize six facies association (depositional environments) within the study fields: deep marine, toe of slope, open marine, restricted interior platform, evaporitic interior platform and brackish interior platform. The facies associations interpreted were based on texture and obtainable fauna.

The Early - Middle Miocene succession was deposited during two depositional cycles as a third order cycles (C1and C2). These cycles are asymmetrical and started with cycle (C1) which divided into three sub-cycles in Balad oil field. The first (C_S1) deep open marine association facies facies in lower part of Serikagni Formation represents by relatively thin transgressive system tract (TST). This facies overlying by evaporitic interior platform association facies as highstand system tract (HST) within the upper part of Serikagni Formation and bounded by MFS. The second sub - cycle (C_E1) is represents by relatively thin transgressive system tract (TST) reflected by restricted interior platform occupies the lower part of Euphrates Formation, while middle and upper part occupies by high system tract (HST), which represented by evaporitic interior platform facies. At the lower part of Dhiban Formation sub - cycle (C_{Dh}1) is started with transgressive system tract (TST) reflected by Evaporitic interior platform overlying by open marine environment which represent the starting of high-stand system trac (HST). Cycle (C2) is almost symmetrical cycle started with transgressive system tract (TST) reflected by restricted interior platform occupies the lower part of Jeribbe Formation, while middle and upper part occupied by high system tract (HST), which represented by open marine environment.

This succession appeared high cyclicity in East Baghdad oil field during the same two major cycles (C1 and C2) with absence of deep open marine association facies (Serikagni Formation). Where C1 cycle is appeared five sub-cycles of HST overlying the TST within Euphrates and Dhiban succession. The second cycle is characterized by three sub-cycles of HST overlying TST sub-cycle within the Jeribe succession. The above gives accurate evidence that the location of the East Baghdad oil field was the closest to the continental part, while the Balad oil field was towards the deep sea. This clearly affected the number of sedimentation cycles and the shallowness of the deposition environment in the East Baghdad field compared to the Balad oil field.

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