Sedimentology and Facies Analysis of the Early Miocene Succession in the Zurbatiya Area, Eastern Iraq

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Abstract

The present study is focused upon the sedimentology and basin development of the Serikagni and Dhiban Formations by using the field observations and microfacies analysis. The area of study situated in the Zurbatiyah area to the south of the Shur sharin valley about 21 km northeast of Badrah city to the southeast of Baghdad. This area lies within the Zagros foreland basin and located between the Zagros Mountains at the northeastern and the Arabian shield at the southeastern. The studied succession which including the Serikagni and Dhiban Formations were deposited within four associated facies for the Serikagni Formation and three for the Dhiban Formation, as shown below:

Serikagni Formation includes planktic foraminiferal packstone microfacies, planktic foraminiferal wackestone / packstone, algal-foraminiferal lime mudstone microfacies, and bioclastic packstone, which represent the deposition in the deep open sea, deep shelf, outer shelf and the slope/toe slope.

Dhiban Formation includes Dolomitic mudstone and dolomitic wackstone, Miliolid mud to wackstone, Stromatolite boundstone, and Massive gypsum. Which representing the deposition in the lagoon, restricted and semi-restricted environments. The facies analysis for the studied succession showing three stages of deposition:

The First stage was started during the sea level rise after the regression stage which marked by the unconformity between the studied succession and the Oligocene succession. The Sea level continued to rise and to settle at the deposition of the deep shelf margin during the

transgression stage. The sea level was settled with the deposition was continued to fill the basin by the sediments causing the shallowing upward. Second stage was represented the deposition during the transgressive stage as a deepening upward. This stage is represented by the alternative of the basinal shale sediments and deep shelf margin. Near the contact with Dhiban Formation the environment was changed to shallow open marine to record the sea level fall and end this stage. At last, the sea level was falled and deposition the dolostone in the restricted environment to refer upon the end the Serikagni deposition. Then the lagoon environment was deposited the massive gypsum overlying the dolomite unit for the Dhiban Formation.

Keywords: Sedimentology, Facies Analysis, Early Miocene Succession, Zurbatiya.

رسوبية و تحليل سحنات تتابع المايوسين المبكر في منطقة زرباطية، جنوب شرق العراق

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الخلاصة

لقد ركزت الدراسة الحالية على رسوبية وتطور الحوض الرسوبي لتكويني سيريكاني وذبان باستخدام المشاهدات الحقلية وتحليل سحنات صخورهما. ان منطقة الدراسة تقع في منطقة زرباطية إلى الجنوب من وادي شورشيرين حوالي 21 كم شمال شرق مدينة بدرة إلى الجنوب الشرقي من بغداد. تقع هذه المنطقة داخل حوض زاكروس المتقدم وتحدها من الشمال الشرقي جبال زاكروس وعلى الجنوب الشرقي من الدرع العربي. ترسب التتابع المدروس المتضمن تكويني سيريكاني وذبان في أربعة مترافقات سحنية لتكوين سيريكاني وثلاثة لتكوين ذبان، كما هو مبين أدناه:

تكوين سريكاكني؛ تشمل سحنة الحجر الجيري المرصوص الحاوي على الفورامنيفرا الطافية و سحنة الحجر الجيري الواكي/المرصوص الحاوي على الفورامنيفرا الطافية و سحنة الحجر جيري الوحلي الحاوي على الفورامنيفرا وسحنة الحجر الجيري ذي المكسرات الحياتية المرصوص. والتي تمثل ترسب في أعماق البحار المفتوحة و الجرف العميق و الجرف الخارجي والمنحدر/ اسفل المنحدر.

بينما يتضمن تكوين ذبان سحنة الحجر الجيري والوحلي المتدلمت و سحنة الحجر الواكي المتدلمت و سحنة الحجر الجيري الوحلي / الواكي الحاوي على المليوليد و سحنة رزم الستروماتوليت والجبس الكتلي. والتي تمثل ترسب في بيئة البحيرات وبيئات مقيدة ومحدودة. ان تحليل سحنات التتابع المدروس اظهر ثلاث مراحل للترسيب :-

بدأت المرحلة الأولى خلال ارتفاع مستوى سطح البحر بعد مرحلة التراجع التي تميزت بعدم التوافق بين التتابع المدروس وتتابع الأوليغوسين. واستمر مستوى البحر في الارتفاع واستقر عند ترسب هامش الرف العميق خلال مرحلة التقدم. ثم اسقرار مستوى سطح البحر مع استمرار ترسب لملئ الحوض من الرواسب مما تسبب في التضحل للاعلى. في حين أظهرت المرحلة الثانية إعادة تنشيط مستوى سطح البحر لتبدأ مرحلة تقدم جديدة لتظهر بشكل تعمق للاعلى. حيث تمثلت بتعاقب رواسب الحوض الحميق مع حافة الرف العميق. بالقرب من الحد العلوي مع تكوين ذبان حدث تغيير في البيئة الترسيبية لتصبح بحرية ضحلة مفتوحة، وعليه تم تسجيل أول دليل على انخفاض مستوى سطح البحر وانتهاء هذه المرحلة. في النهاية، مرحلة تراجع في مستوى سطح البحر حدثت في عموم المنطقة وترسبت صخور الدولومايت في البيئة الضحلة المحجوزة تمثل نهاية ترسيب تكوين السريكاكني.

الكلمات المفتاحية: رسوبية، تحليل سحنات، تتابع المايوسين المبكر، زرباطية.

Introduction

The latest Eocene-Recent Megasequence is associated with collision of Neo-Tethyan terrains along the north and east sides of the Arabian plate, and the opening of the Gulf of Aden and red sea on the south and west sides of the plate. The opening of the red sea and Gulf of Aden was associated with thermal uplift, flood basalt, and rifting. The Golf of Aden of end first in Oligocene time followed by the red sea in the early Miocene (Makris and Henke,1992 and Hughes and beydoun,1992 in [1]. The north and northeast drift of Arabia and the closure of the Neo-Tethys resulted in folding and thrusting of the neo-Tethyan terranes along the new margin of the Arabian plate [1].

This Megasequence is subdivided in to three sequences of latest Eocene-Oligocene, Early-Middle Miocene is including the Ghar, Euphrates, Serikagni and Dhiban Formations, and the Late Miocene-recent age is including the Jeribe and Fatha Formations. The latest two subdivisions are the more important in the present study, because of the expected succession in the studied area is within these cycles.

The goals of the present study are the sedimentology and basin development of the Serikagni and Dhiban Formations by using the field observations and microfacies analysis.

The area of study situated in the Zurbatiyah area to the south of the Shur sharin valley (To the south east the section Zt-4) at N33°16'48.38" E46°05'46.53" about 21 km northeast of Badrah city to the southeast of Baghdad figure (1). This area lies within the Zagros foreland basin,

bordered on the northeast by the Zagros Mountains and on the southeast by the Arabian shield, and consists of linear and high-amplitude folds that trend in a northwest-southeast direction.

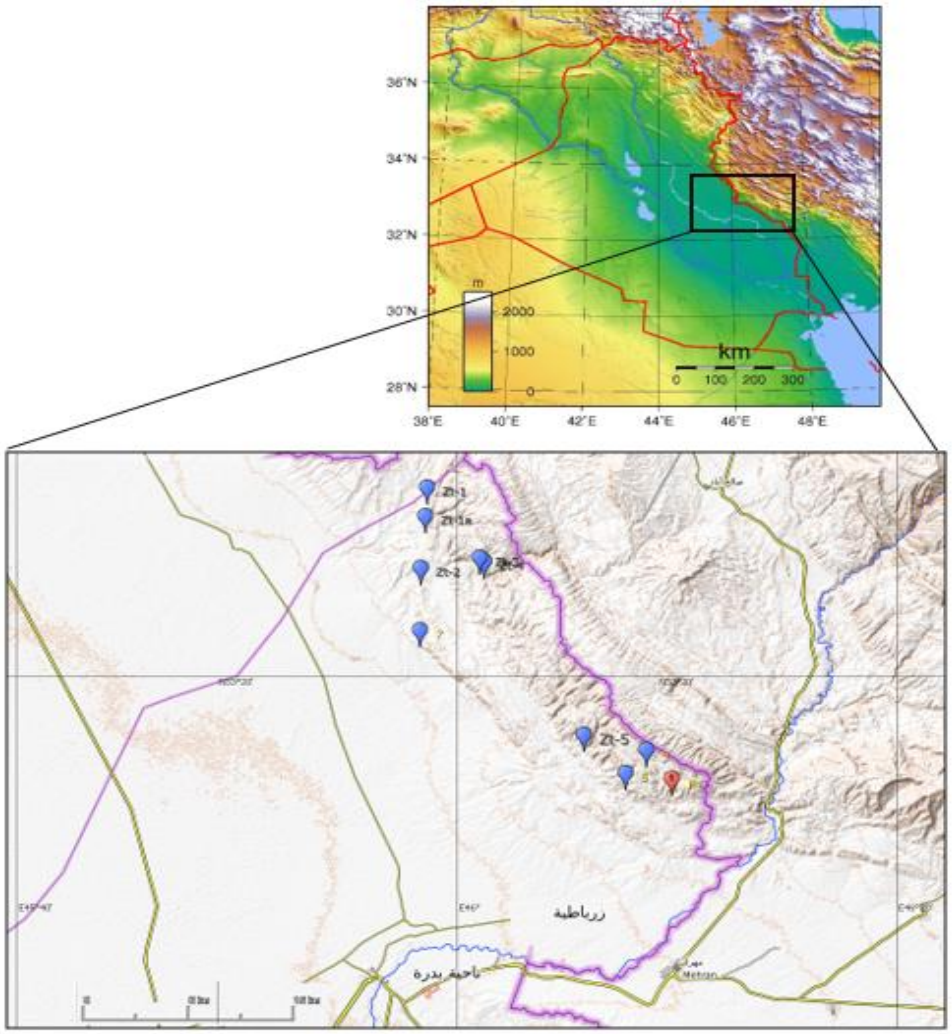

Figure 1: Location map of studied area.

Methodology:

The present study was completed by two main stages:

1. **Field observation and sampling stage:** This stage is represented the field measurements, sampling, describe the sedimentary structure, the geometry and the unit rocks relationships figures (2, 3 and 4).

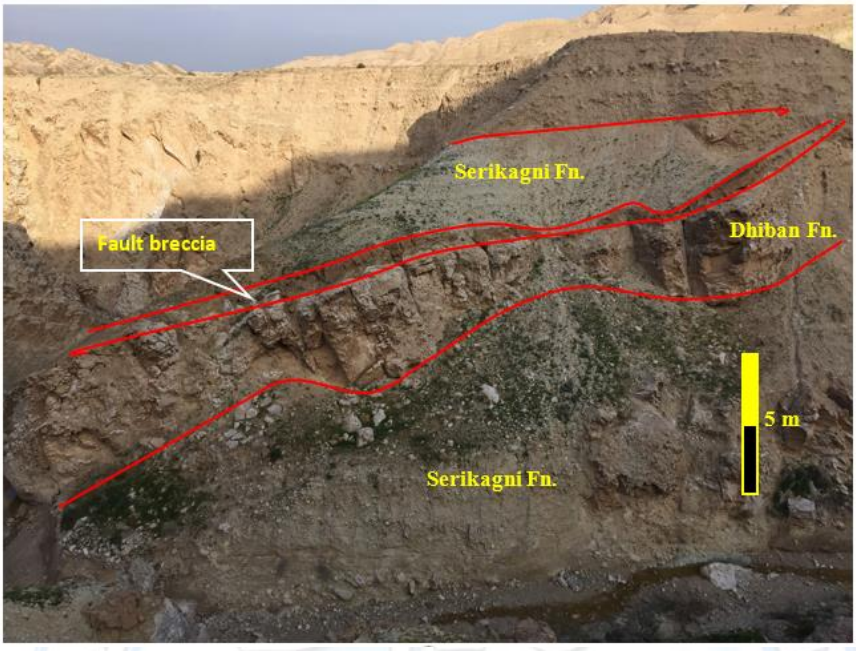

Figure 2: Serikagni and Dhiban Formations outcrop in Shur sharin valley (Zt-4).

Figure 3: Serikagni Formation lithologic section (Zt-4).

Figure 4: Dhiban and Serikagni Formations lithologic section (Zt-4).

2. **Laboratory work:** this including thin sections preparation for the collecting samples in order to study the microfacies in these successions.

Stratigraphic setting

Serikagni Formation is first introduced by Bellen [3] for about 150 meters of rhythmic globigerinal chalky limestone. The lower contact of the studied formation is unconformable either with the middle-upper Eocene Jaddala Formation [3] or the Oligocene Ibrahim Formation [4], [5]. The Serikagni Formation underlies the Dhiban Anhydrite (lower Miocene) conformably or the Jeribe Formation (lower Miocene) unconformably [4]. The presence of planktonic foraminifera was limited to the Serikagni Formation. The most important species

of foraminifera which diagnosed in this formation, which have been described by Bellen *et at.* in 1959 [3] addition to others and observed in the present study are *Globigerina bulloides* d'ORBIGNY (Plt-1.a), *Globigerina subcretacea* LOMNICKI (Plt-1.b), *Globigerinoides rubra* (d'ORBIGNY) (Plt-1.c), *Globigerinoides triloba* (REUSS) (Plt-1.d), *Paragloborotalia siakensis* LEROY (Plt-1.e), *Globigerinoides altiapertura* BOLLI (Plt-1.f).

In addition to the species which described in the present study such as *Paragloborotalia kugleri* BOLLI (Plt-2.a); *Globorotalia miocenica* PALMER (Plt-2.b); *Globigerinatella insueta* (Cushman and Stainforth) (Plt-2.c); *Globigerinoides quadrilobatas* trilobus (Reuss) (Plt-2.d); *Globigerina angulisuturalis* BOLLI (Plt-2.e). Additionally, there are many types of the small benthic foraminifera (Undiagnosed species) observed in the studies section as textularids (Plt-3.a), rotaliids (Plt-3.b), miliolids (Plt-3.c) *and operculina* sp (Plt-3.d). The Dhiban Formation was first defined by Henson in 1940 and amended by Van Bellen in 1957 [3] from the type area in Dhiban village in the Sinijar area, it comprises 72 m. of gypsum, thin beds of marl and brecciated recrystallised limestones. The formation represents the final evaporatic sediments of the late Lower Miocene subcycle.

The contacts of the formation are of great importance for both the determination of its age and for the reconstruction of the paleogeographic development of the Miocene [6]. The age of the Dhiban Formation has been defined on the basis of stratigraphic relationships with other formations. The Dhiban overlies the Serikagni Formation, interfingers with the Euphrates Formation and is overlain by the Jeribe Formation. Therefore, its age has been established as Early Miocene [1]. Fossils in the formation are absent but some modern studies point the occurrence of Benthic foraminifera (Milliolid Group), in addition to pelecepoda and gastropoda [7].

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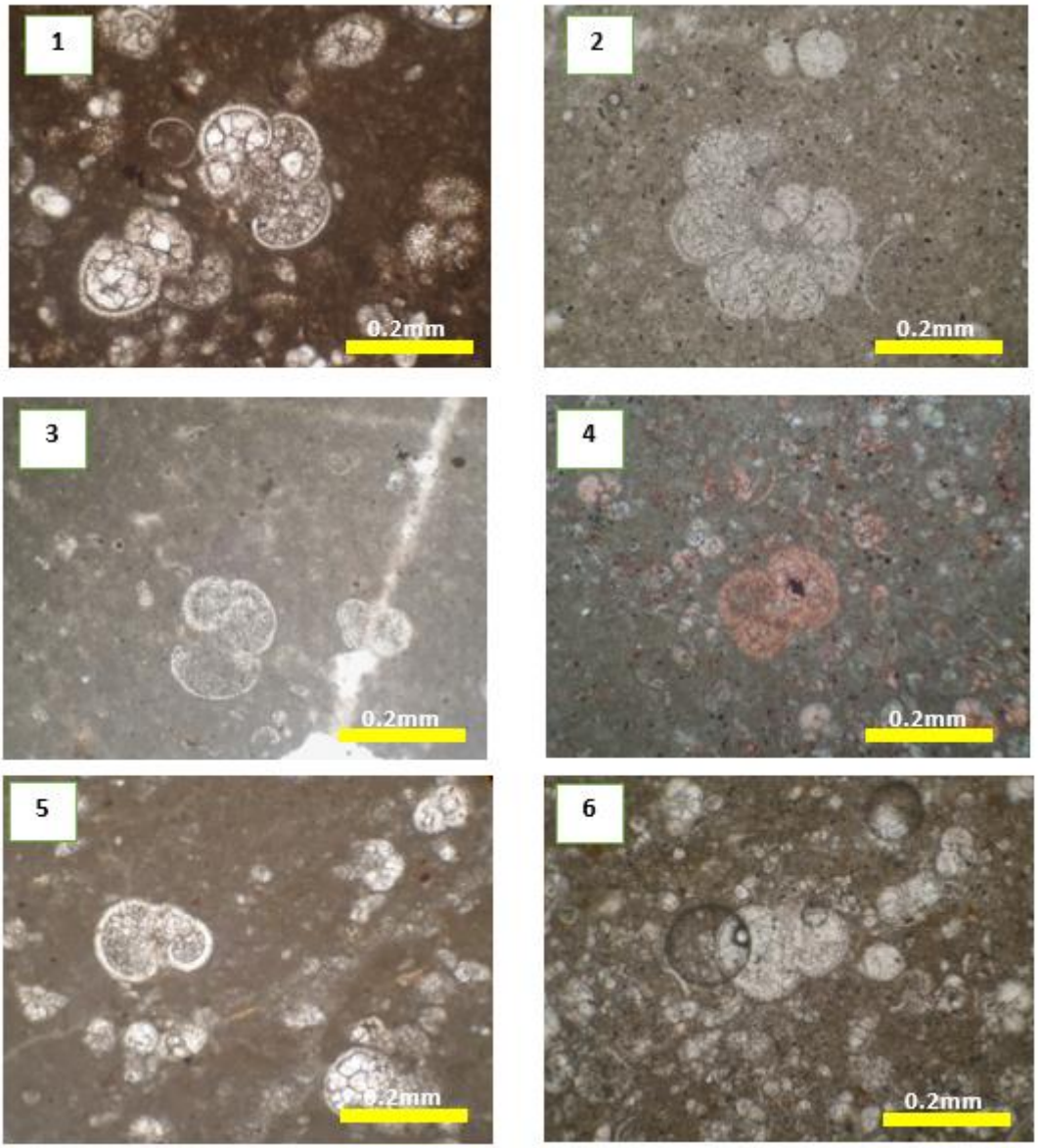
Plate 1



1. *Globigerina bulloides* d'ORBIGNY – Zt-4 (Depth 20.0 m.) Serikagni Fn.
2. *Globigerina subcretacea* LOMNICKI – Zt-4 (Depth 40.0 m.) Serikagni Fn.
3. *Globigerinoides rubra* (d'ORBIGNY) – Zt-4 (Depth 79.0 m.) Serikagni Fn.
4. *Globigerinoides triloba* (REUSS) – Zt-4 (Depth 80.0 m.) Serikagni Fn.
5. *Paragloborotalia siakensis* LEROY Zt-4 (Depth 79.0 m.) Serikagni Fn.
6. Globigerinoides altiapertura BOLLI Zt-4 (Depth 20.0 m.) Serikagni Fn.

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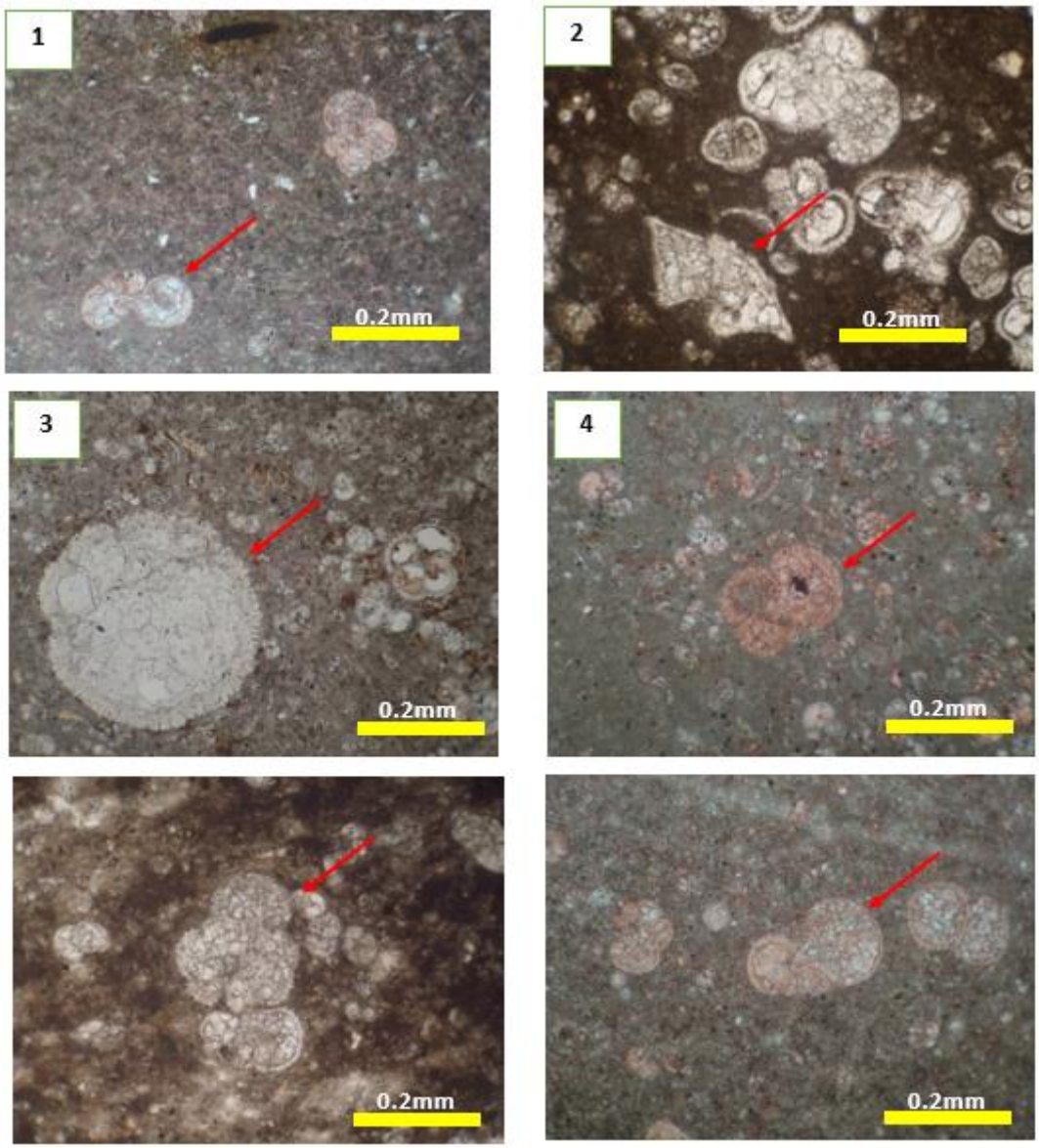
Plate 2



1. *Paragloborotalia kugleri* BOLLI Zt-4 (Depth 25.0 m.) Serikagni Fn.
2. *Globorotalia miocenica* PALMER Zt-4 (Depth 33.0 m.) Serikagni Fn.
3. *Globigerinatella insueta* (Cushman and Stainforth) Zt-4 (Depth 20.0 m.) Serikagni Fn.
4. *Globigerinoides quadrilobatas trilobus* Zt-4 (Depth 20.0 m.) Serikagni Fn.
5. *Globigerina angulisuturalis* BOLLI Zt-4 (Depth 44.0 m.) Serikagni Fn.
6. *Paragloborotalia Pseudokugleri* (BOLLI) Zt-4 (Depth 40.0 m.) Serikagni Fn.

Microfacies analysis

The geological properties of sedimentary rocks depend upon an interplay of tectonics, sea level, sediment supply, physical and biological processes of sediment transport and deposition, and climate. At the basin scale, these processes interact to produce the geometric arrangement of different depositional environments or systems tracts through time, known as the stratigraphic architecture of the basin [8].

Generally, the lithology of the studied section comprised of limestone, marly limestone. Three microfacies and one lithofacies were recognized. The lower boundary is not clear in the studied area, but the field observation supports the presence of the Ibrahim Formation (Oligocene) as an unconformable succession. But the upper contact was conformable with the Dhiban Formation, it is represented by dolostone bed about (1m) separated the basinal marl of Serikagni and gypsum of Dhiban Formation figure (5). This Formation consists mainly of planktonic carbonates which include fine grained globigerinal limestone partly dolomitized and recrystallized, this formation consists of four main microfacies:

Planktic foraminiferal packstone microfacies

The microfacies is composed of gray marly limestone with conchoidal fracturs and thickness ranging between 10-30 cm. The allochems percentage ranging between 50-60 % and represented by diverse Early Miocene planktonic foraminifera species belonging to Globigerinoids, and Globigerina, in addition to the rare occurrence of benthic foraminifera (Plt.3. a). All the paleontological attributes impose an upper bathyal environment with water depth ranging between 200 - 400 m and it is a mach to SMF3 within FZ1 [10]. The microfacies occurs in the lower and middle parts of the Zt-4 section figure (5).

Planktic Foraminiferal Wackestone/ Packstone

This is the most common facies in the Serikagni Formation. It is highly fossiliferous and interbedded limestone and marly limestone. The grains are solely skeletal making about 50% (plt-3. b) although it may reach 70% becoming packstone. The components are mostly planktic foraminifera such as Globigerina, Globigerinoids and Globorotalia with few benthic forams (such as Textularia and Rotalia), shell fragments, (and echinoderm plates. The

groundmass is micrite and clayey micrite with scattered fine and rhombic dolomite crystals. In addition, some non-carbonate components are frequent such as clay admixture, quartz, pyrite.Planktic Foraminiferal Wackestone Facies is equivalent to Wilson's [9] and Flugel's [10] Standard Microfacies 3 (SMF 3). It represents deposition at Facies Zone 2 (FZ 2) that is deep shelf figure (5).

Algal-foraminiferal lime mudstone microfacies

This microfacies occurs in the upper part of the Zt-4 section, it consists of pale brown marly limestone. Allochems attaining 10% of the total content; they consist of planktic foraminifera and green algae with rare benthic foraminifera (plt-3.c). In addition, echinoid is present, which indicate nearness to open marine outer shelf environment figure (5). It can be correlated with SMF8 within FZ2 [10].

Bioclastic Packstone

Bioclastic Packstone is described in the upper part of the Zt-4 near contact with Dhiban Formation (Plt-3. d) ranging in thickness from 20-80 cm. Its lower contact is gradational passing to other facies. Graded bedding and convolute and current laminations are common as well as occasional syndepositional faulting and folding. The grains are both litho- and bioclastic ranging from 75 – 85% and the matrix is both micrite and microsparite. The skeletal grains are Miogypsina, miliolids, Textularia, Rotalia, algae, planktic forams (such as Globigerina, Globigerinoids and Globorotalia). Some of the grains such as the Miogypsina and lithoclasts are broken, worn and rounded.

The Biolithoclastic Packstone Facies apparently contains a mixture of faunal assemblages of the Serikagni Formation and the lower Miocene shelf limestone the Euphrates Formation. Biolithoclastic Packstone Facies is equivalent to Wilson's [9] and Flugel's [10] Standard Microfacies 4 (SMF4). It represents deposition of turbidites (both proximal and distal) at Facies Zone 3 (FZ3) that is toe-of-slope and Facies Zone 4 (FZ 4) slope figure (5). The Dhiban Formation overlying of the Serikagni Formation which consists essentially of gypsum interbedded with partly crystalline limestone and dolomitized limestone.

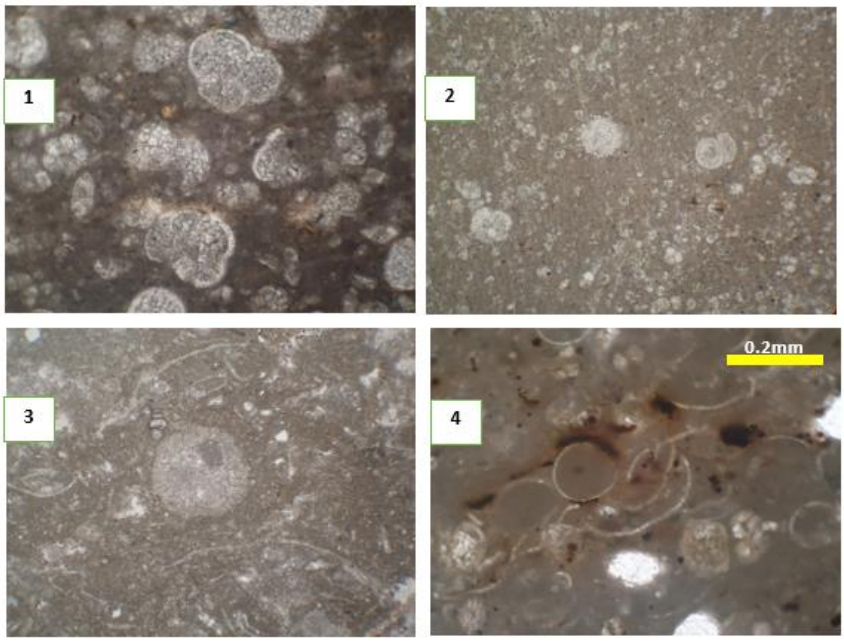
The formation consists of four main microfacies of:

1- Dolomitic mudstone (plt-4. a) and dolomitic wackstone sometimes with gypsum filling the pores (plt-18.2). This microfacies is represented the lower part of Dhiban Formation near the contact with Serikagni Formation. It represents deposition of semi restricted lagoon at Facies Zone 8 (FZ8). Miliolid mud to wackstone (plt-4. b). and Miliolid wackston to packston (plt.18.4) sometimes it consists of rare skeletal grains such as Gastropoda and echinoderm and non-skeletal grains such as peloids. It represents deposition of semi restricted shallow 1-marine at Facies Zone 7 (FZ7).

2- Stromatolite boundstone (plt.4. d) with gypsum fibrous filled the porous. It represents deposition of restricted lagoon at Facies Zone 9 (FZ8).

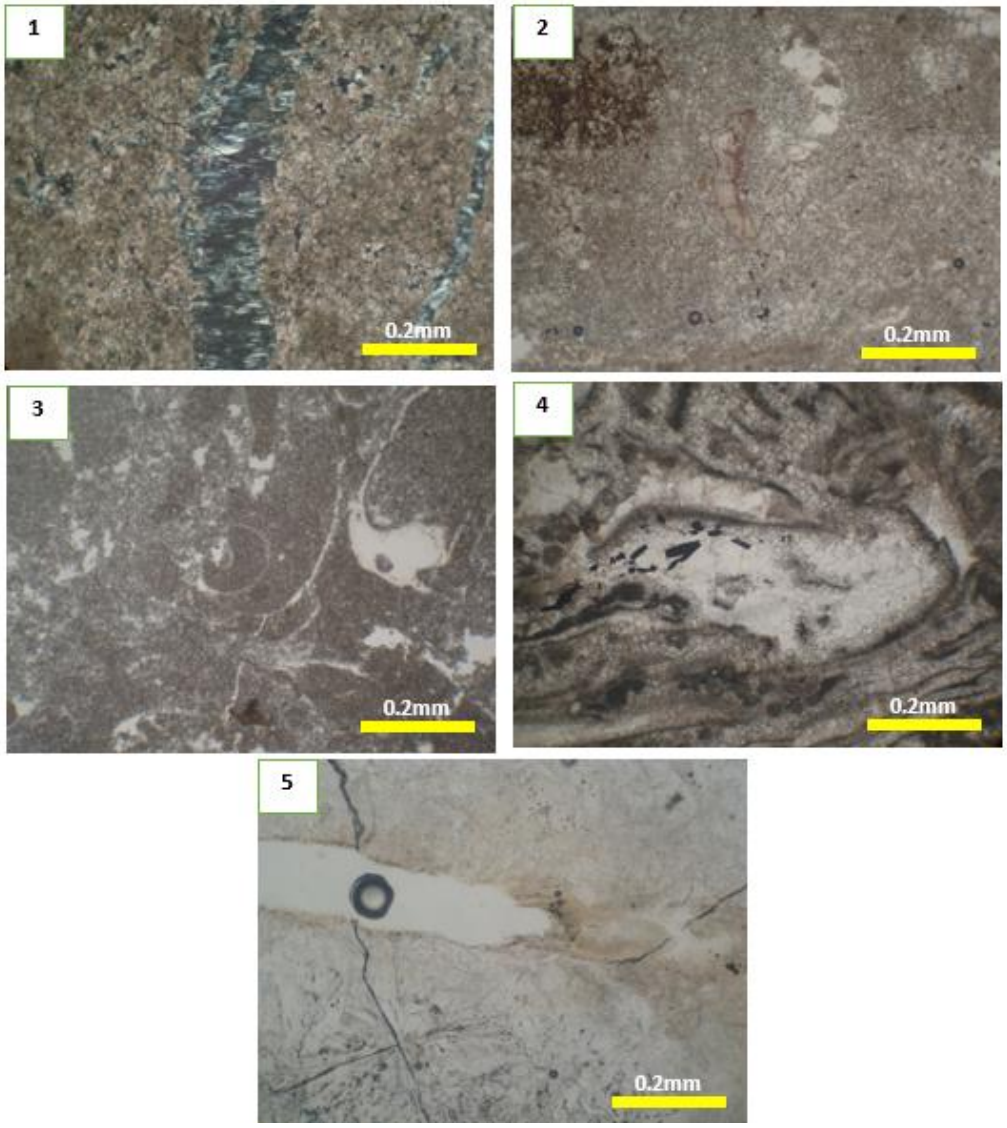
3- Massive gypsum (plt.4. e) is the main part of the formation, which represented the upper part. It represents deposition of restricted and evaporitic lagoon at Facies Zone 9 (FZ8).

Plate 3



1. Planktic foraminiferal packstone microfacies. Zt-4 (Depth 22.0 m.) Serikagni Fn.
2. Planktic Foraminiferal Wackestone/ Packstone. Zt-4 (Depth 54.0 m.) Serikagni Fn.
3. Algal-foraminiferal lime mudstone microfacies. Zt-4 (Depth 42.0 m.) Serikagni Fn.
4. Bioclastic Packstone. Zt-4 (Depth 102.0 m.) Serikagni Fn.

Plate 4



1- Dolomitic mudstone. Zt-4 (Depth 16.0 m.) Dhiban Fn.

2- Dolomitic wackstone. Zt-4 (Depth 15.0 m.) Dhiban Fn.

3- Miliolid mud to wackstone. Zt-4 (Depth 15.0 m.) Dhiban Fn.

4- Stromatolite boundstone. Zt-4 (Depth 17.0 m.) Dhiban Fn.

5- Massive gypsum. Zt-4 (Depth 12.0 m.) Dhiban Fn.

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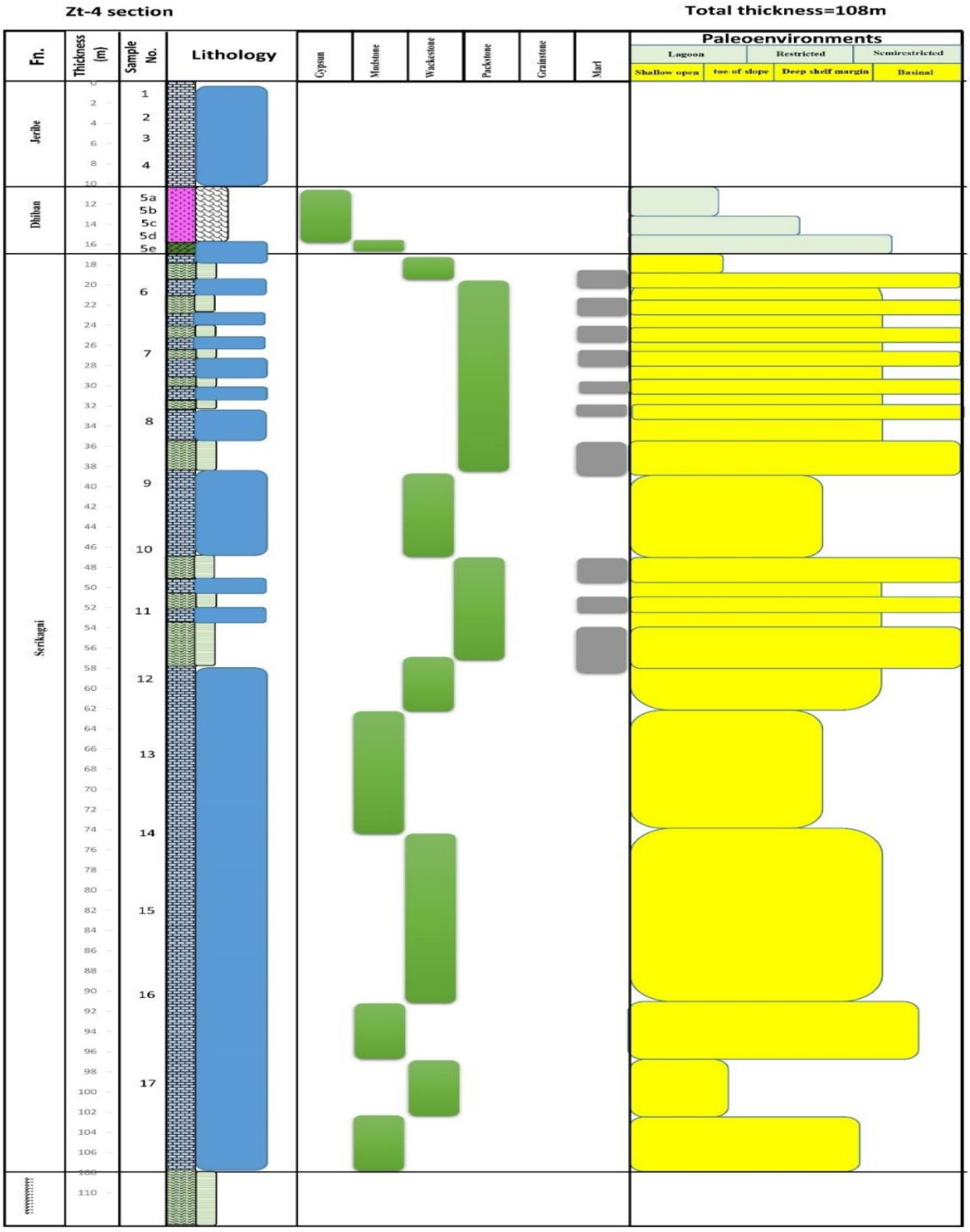

Figure 5: lithological columnar section shows microfacies and paleo-environments.

Paleoenvironment and basin development

The facies analysis for the studies succession was showing presence of four microfacies for the Serikagni Formation and four microfacies for the Dhiban Formation figure (5).

The lower Miocene succession was deposition during three stages of the sea level volatility such as the follow:

First stage

The sea level rise from the unconformable contact between the Miocene and Oligocene (according to Bellen *et al*, 1959[3]), therefor the shallow open marine and slope associated facies was distinguished the of this stage.

The Sea level continued to rise and to settle at the deposition of the deep shelf margin during the transgression stage. The sea level was settled with the deposition was continued to fill the basin by the sediments causing the shallowing upward figure (6).

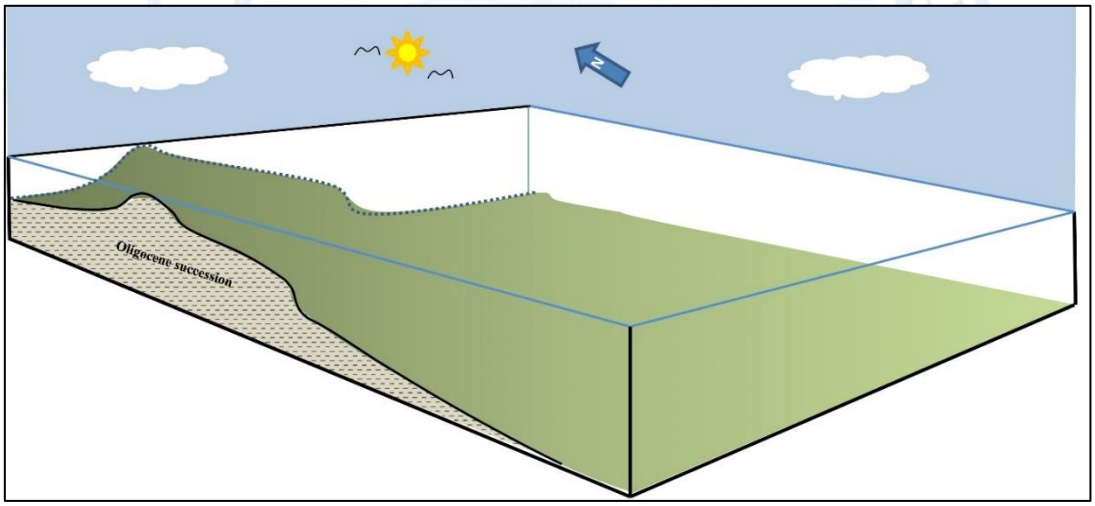

Figure 6: Depositional model for the first stage basin and paleoenvironment.

Second stage

the sea level during this stage reactivated to start a transgressive stage as a deepening upward. This stage is represented by the alternative of the basinal shale sediments and deep shelf margin. Near the contact with Dhiban Formation the environment was changed to became

shallow open marine, therefore the first show for these facies was recorded the sea level fall and end this stage figure (7).

Away from the study area to the west the Euphrates Formation deposited during the same stage of Serikagni Formation in the shallow marine environment.

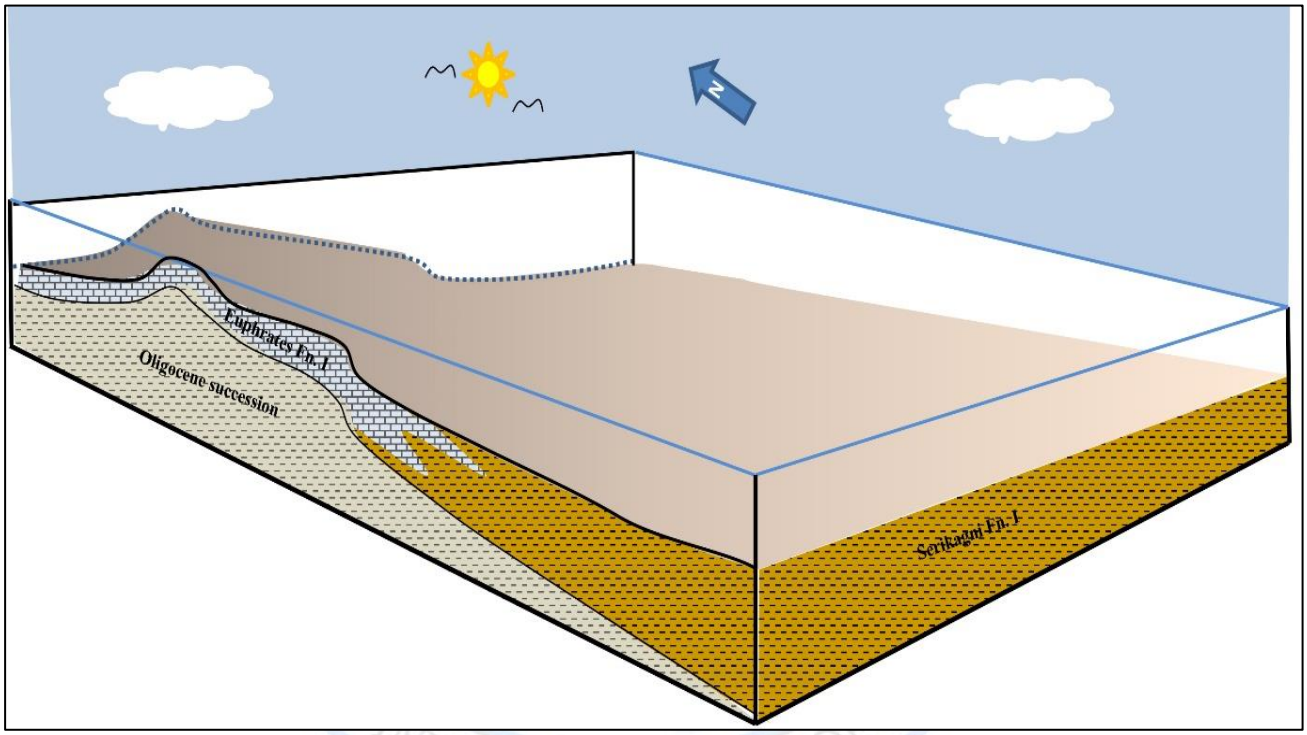

Figure 7: Depositional model for the second stage basin and paleoenvironment.

Third stage:

the fall stage of sea level and deposition the dolostone in the restricted environment which represent the bed contact (about 1 meter). Then the lagoon environment was deposited the massive gypsum overlying the dolomite unit for the Dhiban Formation figure (8). During this stage the deposition of Serikagni Formation was continued addition to Euphrates, with deposition the Dhiban Formation at the shallower environment.

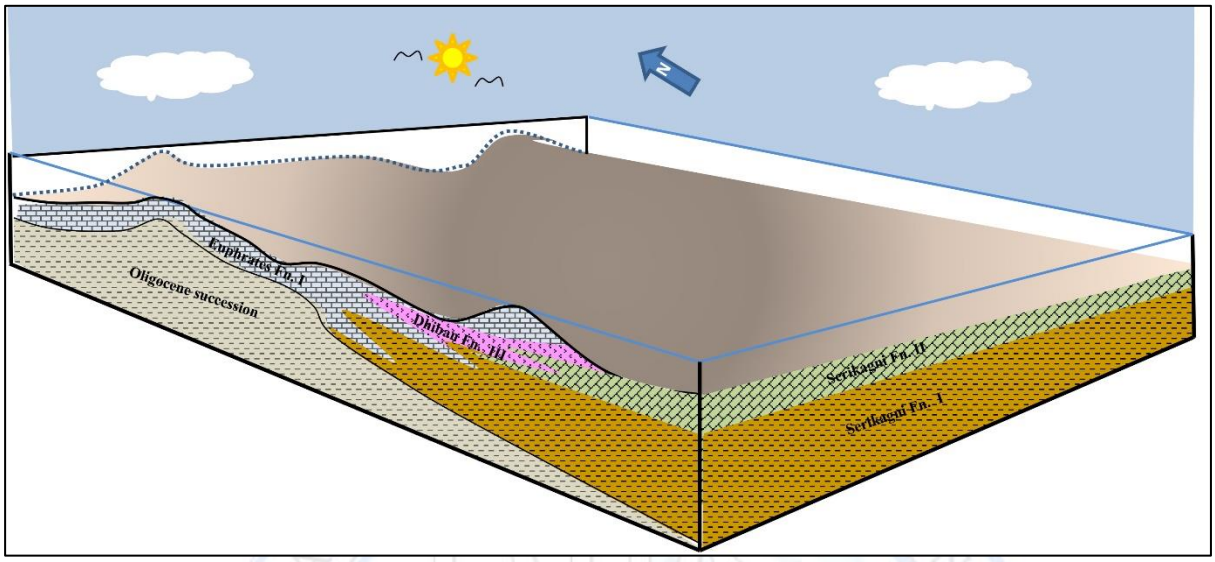

Figure 8: Depositional model for the third stage basin and paleoenvironment.

Conclusions

The studied succession which including the Serikagni and Dhiban Formations were deposited within four associated facies for the Serikagni Formation and four for the Dhiban Formation, as shown below:

Serikagni Formation

1- Planktic foraminiferal packstone microfacies (match to SMF1 within FZ1)

2- Planktic Foraminiferal Wackestone/ Packstone (match to SMF2 within FZ1)

3- Algal-foraminiferal lime mudstone microfacies (match to SMF8 within FZ2)

4- Bioclastic Packstone (match to SMF4 within FZ 4)

Dhiban Formation

1- Dolomitic mudstone and dolomitic wackstone (match to SMF8 within FZ8).

2- Miliolid mud to wackstone ((match to SMF7 within FZ5).

3- Stromatolite (match to SMF8 within FZ7).

4- Massive gypsum (match to SMF9 within FZ7).

These facies analysis for the studies succession showing three stages of deposition:-

The First stage was started during the sea level rise after the regression stage which marked by the unconformity between the studied succession and the Oligocene succession. The Sea level was continued to rise and to settle at the deposition of the deep shelf margin during the transgression stage. The sea level was settled with the deposition was continued to fill the basin by the sediments causing the shallowing upward. Second stage was shown the sea level during this stage reactivated to start a transgressive stage as a deepening upward. This stage is represented by the alternative of the basinal shale sediments and deep shelf margin. Near the contact with Dhiban Formation the environment was changed to became shallow open marine, therefore the first show for these facies was recorded the sea level fall and end this stage. Away from the study area to the west the Euphrates Formation deposited during the same stage of Serikagni Formation in the shallow marine environment.

At last, the fall stage of sea level and deposition the dolostone in the restricted environment which represent the bed contact (about 1 meter). Then the lagoon environment was deposited the massive gypsum overlying the dolomite unit for the Dhiban Formation.
During this stage the deposition of Serikagni Formation was continued addition to Euphrates, with deposition the Dhiban Formation at the shallower environment.

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