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A Study of Biostratigraphy of Sinjar Formation in selected sections from northern Iraq

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Abstract

Late Paleocene –Early Eocene algae and benthic foraminifera were identified from the Sinjar Formation that crop out in three selected section from northern Iraq. The selected sections: (Derbandikhan ,Qara dagh, Wara Mali has been measured in the field and closely sampled to undertake details. A number of (131) samples were collected illustrating all the lithological changes along the sections, The limestone in the studied section is rich in algae and large benthic foraminifera, The investigation of the thin sections allowed us to identify the (47) species of foraminifera and (34) species of algae , Five biozones were distinguished for algae which are :a- *Amphiroa iraquensis* range zone ,b- *Trinocladus perplexus* range zone ,c- *Lithothamnium – Pagodaporella wetzeli –Lithoporella melobesides* Assemblage zone ,d- *Cymopolia kurdistanensis- parkerella* Sp.- *Dissocladella deserta - Jania* Sp. Assemblage zone, e- *Clypeina merienda –Distichoplax biserialis - Mesophyllum* Sp,.-*Archaeolithothamnium cf dollonii* Assemblage zone. Five biozones were distinguished for large benthic foraminifera which are :- *a-Cuvillierina sireli – Cuvillierina vallensis - Cibicides nammalensis – Rotalia trochidiformis* Assemblage zone ,*b-Miscellane miscella –Discocylina varians* Assemblage zone , *c-Idalina sinjarica –Nummulites globulus –Spherogypsina globula –Somalina* Sp.- *Alveolina globosa* Assemblage zone, *d-Orbitolites* Sp. - *Assilina* Sp.- *Ovulites Sp.- Cribogoesella* Sp, Assemblage zone, *e-Opertorbitolites transitorius* range zone. The age of this formation is Late Paleocene-Early Eocene in the studied section.

Keywords: Biozone, Late Paleocene–Early Eocene, Sinjar Formation.

دراسة الطباقية الحياتية لتكوين سنجار في مقاطع مختارة من شمال العراق

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الخلاصة

تناولت هذه الدراسة تشخيص الطحالب و الفورامينيفيرا القاعية ضمن تكوين سنجار في مقاطع مختارة من شمال العراق،والتي تعود لعمر الباليوسين المتأخر– ألأيوسين ألمبكر.تم أختيار ثلاثة مقاطع لهذه الدراسة وهي : مقطع دربندخان (40) م ومقطع قره داغ (70) م ومقطع وره ملي (45) م .وقد تم جمع (131) نموذجا اعتماداعلى التغير في صخارية التكوين، كان الغرض منها تحديد عمر التكوين والبيئة الترسيبية لترسبات تكوين سنجار.لقد تمثلت ترسبات تكوين سنجار في هذه المقاطع بالحجر الجيري الصلد الحامل

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الطحالب و للفورامينيفيرا القاعية، بعد دراسة الشرائح الرقيقة لهذا التكوين تم تحديد (47) نوعا من الفورامينيفيرا القاعية و(34) أنواع من الطحالب . وقد تم تميز خمسة أنطقة حياتية للطحالب وهي:-

a- *Amphiroa iraquensis* range zone ,b- *Trinocladus perplexus* range zone , c- *Lithothamnium – Pagodaporella wetzeli –Lithoporella melobesides* Assemblage zone ,d-*Cymopolia kurdistanensis- parkerella* Sp.- *Dissocladella deserta-Jania* Sp. Assemblage zone, e- *Clypeina merienda –Distichoplax biserialis -Mesophyllum* Sp,.-*Archaeolithothamnium cf dollonii* Assemblage zone,

وخمسة انطقة حياتية للفورامنيفرا القاعية وهي:-

a- Cuvillierina sireli – Cuvillierina vallensis - Cibicides nammalensis – Rotalia trochidiformis Assemblage zone ,*b-Miscellane miscella –Discocylina varians* Assemblage zone , *c-Idalina sinjarica –Nummulites globulus –Spherogypsina globula –Somalina* Sp.- *Alveolina globosa* Assemblage zone, *d-Orbitolites* Sp. - *Assilina* Sp.- *Ovulites* Sp.- *Cribogoesella* Sp, Assemblage zone, *e-Opertorbitolites transitorius* range zone.

اما عمر التكوين فقد تم تحديده بعمر الباليوسين المتأخر–ألأيوسين المبكر ضمن المقاطع المختاره في هذه الدراسة اعتمادا على المتحجرات المتواجده فيه.

I. INTRODUCTION

This study is addressed towords the Biostratigraphy of the Sinjar Formation at North of Iraq Sinjar Formation represents the middle part of the Tectonostratigraphic AP 10 Megasequence of This megasequence is of Middle Paleocene – Eocene age and comprises six lithostratigraphic units in north of Iraq, namely Kolosh, Sinjar, Khurmala, Avanah, Gercus and Pila Spi formations There are several studies on the units of this megasequence concerning their stratigraphy, sedimentology and paleontology [1].

The Sinjar Formation belongs to the Late Paleocene-Lower Eocene Cycle. The cycle starts with a widespread transgression, most probably throughout the whole area of Iraq [2].Sinjar Formation consists of limestone, showing elements of algal reef facies, a lagoonal miliolid facies and nummulitic shoal facies and usually recrystallized .Underlying formation at the type locality is the upper Cretaceous Shiranish Formation with in unconformable boundary , the unconformity marked by a complete faunal and facies change [3]. The break between the Maastrichtian and Paleocene ,claimed by [3] has been recently proved by the detail investigations of (Kassab ,1972&1976) in [2] , who shows that the uppermost parts of the Maastrichtian as well as the lower Paleocene (Danian),are absent in the shelf areas in Iraq. The end of the cycle is marked by another uplift, connected in some areas with an erosion, too. In Kurdistan this formation usually underlies the Gercus Formation and it is generally found to interfinger with Kolosh Formation, it marks a reef – like facies of the palaeocene and "lower" Eocene, separating rather ineffectively the off-shore Aaliji Formation from the near-shore Kolosh Formation Sinjar reefs and shoals did not form a continuous wall but rather a number of separate reef-banks and islands which controlled the irregular distribution of the shoal and lagoonal facies. Gaps between the reef-banks and shoals allowed admission of Kolosh clastic –type sediment to the zone of off-shore sedimentation in which the globigerinal Aaliji Formation was deposited [3]. Thickness of Sinjar Formation is variable as in the Derbendikhan area of NE Iraq, the formation is 120 m thick [4]. The formation is probably the thickest near the Iraq-Syria-Turkey triple border point [5].

II. Locality of the studied sections

Tectonically the studied area is located in the Unstable shelf within the High Folded Zone. The Outcrop sections are located within the High Folded Zone from the Sulaimaniya city to Dohuk city,Three sections are described and studied : Darbandikahn section ,Wara Milli section and Qara Dagh section, exactly at the following coordinate, as it shown at Fig(1) :1-Darbandikahn section: E45 ˚35' 30" And N 35˚ 6' 10" , 2-Wara Milli section : E43˚ 12' 55" And N 37˚ 10' 60", 3- Qara Dagh section : E45◦ 25' 10" And N 35˚ 20' 44".

III. BIOSTRATIGRAPHY

The Cretaceous –Palaeogene crisis wiped out over 80% of the Maastrichtian larger benthic foraminifera .The Early Palaeocene was a recovery period for larger foraminifera. As was the case during the recovery stage after previous extinction, larger foraminifera morphologically small and rare, and even the newly evolved foraminifera exhibited a morphological manifestation of post-crisis ecological stress.

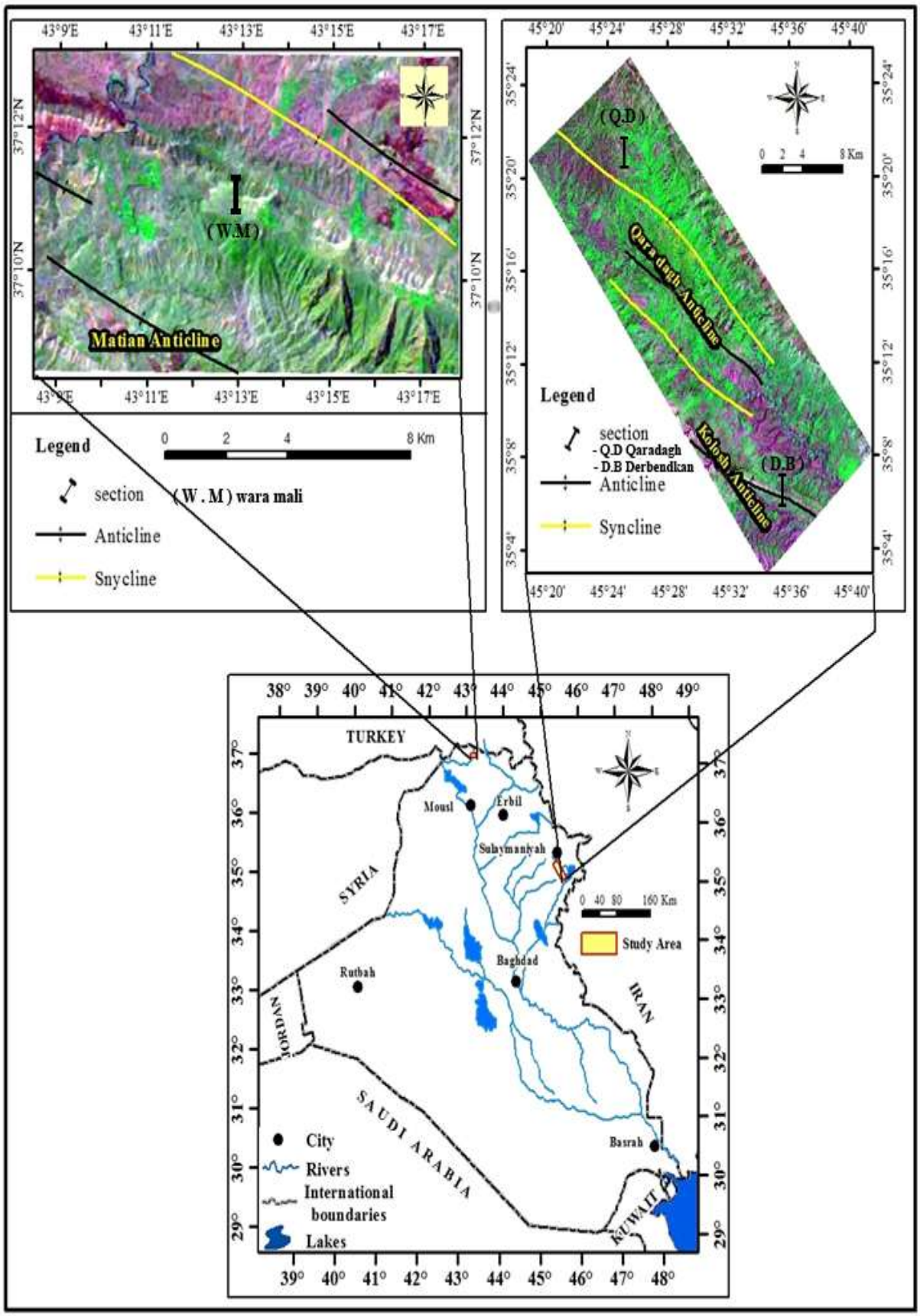


Figure1-Location of the studied section

It was not before the Late Palaeocene that morphologically larger miliolids and rotaliines (especially nummulitids and orthophragmiids) appeared and spread throughout Tethys [6].

According to [7], the Upper Paleocene –Lower Eocene interval included two phases in a global community maturation cycle, which consists of five phases of continuous, and gradual biotic change. The Upper Paleocene represents phase 2 of this cycle, in which an increase in generic diversity occurred. The Lower Eocene represents phase 3, which is characterized by an abrupt diversification of different species and marks the full recovery after the collapse at the Cretaceous /Palaeogene (K/p) boundary. Apart from the recorganization of larger foraminifera after K/P boundary, long- term and short- term paleoenvironmental trends was responsible for the success of larger foraminifera within this time interval. These trends include increasing oligotrophy higher sea surface temperatures which led to the demise of coral in low latitudes and created new niches for larger foraminifera [8].

However the present study of Sinjar Formation at three selected geological sections has studied the biostratigraphy of the formation depending on the algae fossils and its accompanying benthonic foraminifera in specific and some microfossils in general.

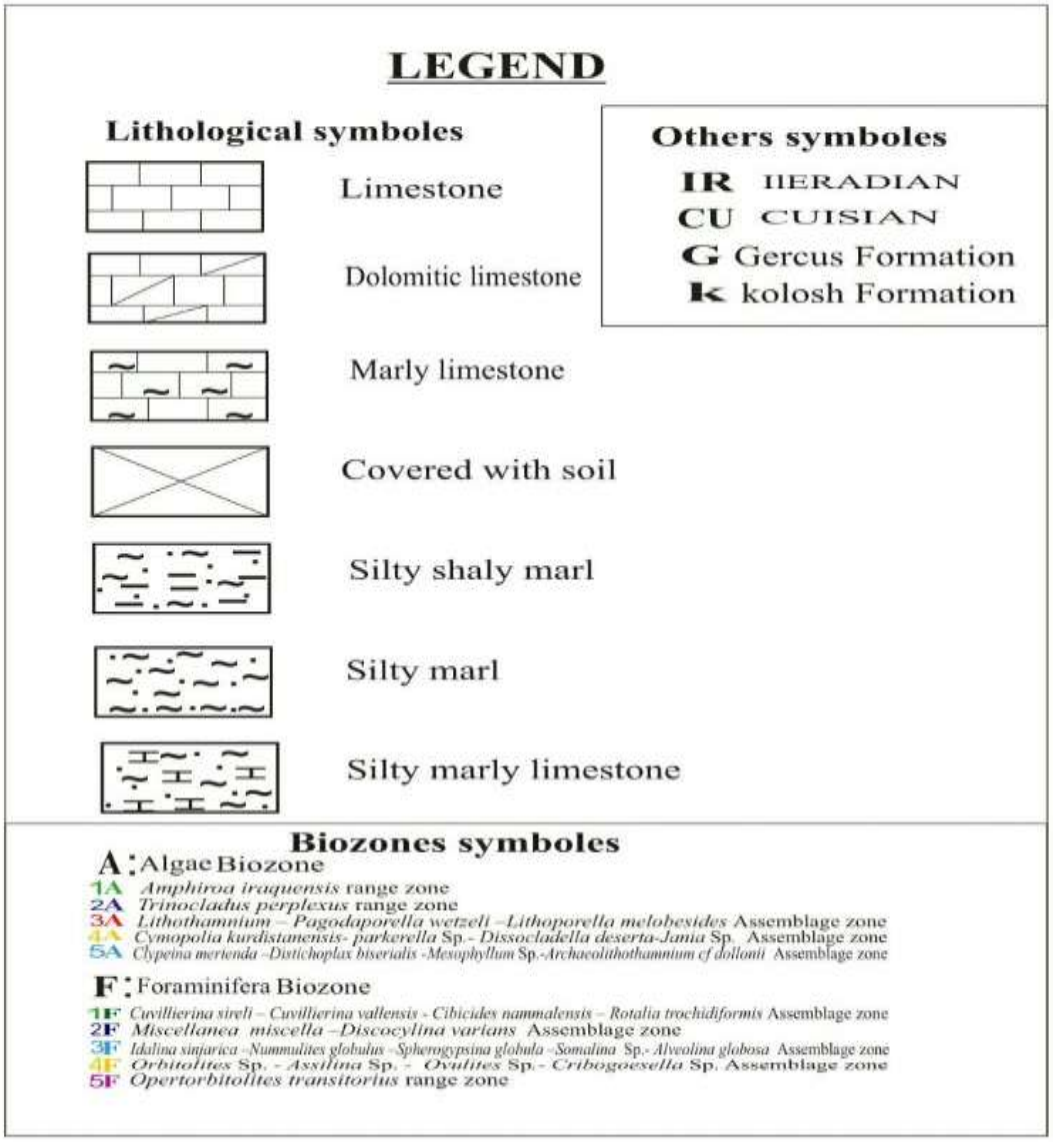
In the studied sections, according to the observation and investigation of thin sections, Sinjar Formation consists largely algae, coral, associated with larger benthic foraminifera. The following is a description of the recorded fossils in each section:

a- Biostratigraphy of Derbandikhan section: The following microfauna are identified in the sediments of Sinjar Formation at the Derbandikhan section (Figure-2) These include the following red and green Algae:

Acicularia Sp. (Plate-4, Figure-4), *Acroporella* Sp. (Plate-2, Figure-2), *Amphiroa iraquensis* Johnson (Plate-1, Figure-1), *Amphiroa* Sp. (Plate-5, Figure-3), *Archaeolithothamnium cf dollonii* (Plate-5 , Figure-1), *Belzungia* Sp. (Plate-2, Figure-5), *Clypeina merienda* (Plate-1 , Figure-8), *Cymopolia ellongata* (Plate-3 , Figure-4), *Cymopolia Kurdistanensis* (Plate-1, Figure-3), *Dissocladella deserta* (Plate-1, Figure-6), *Dissocladella* Sp. (Plate-3, Figure-2), *Distchoplax biserialis* (Plate-3, Figure-8), *Indopolia styovavti* (Plate-4, Figure-8), *Irmocladus* Sp.(Platr-4, Figure-5), *Jania* SP (Plate-2, Figure-1*), Lithothamnium of montainvillenes* (Plate-5, Figure-2), *Mesophyllum* Sp. (Pl.2, Fig.4), *Mizzia* Sp. (Pl.4, Fig.6), *Pagodaporella Wetzeli* (Pl.1 , Fig.5), *Parachaetetes asvapatii* (Plate-4, Figure-5), *Parkerella* SP.(Plate-1, Figure-4), *Pseudolithothamnium* (Plate-3, Figure-6), *Pycnoporidium* Sp. (Plate-2, Figure-3), *Rostroporella oviformis* (Plate-4, Figure-2), *Solenomeris o'gormani* (Plate-4 , Figure-7), *Trincladus perpleux*s (Plate-2 , Figure-8), In addition to the following foraminifera that were identified in this section : *Alveolina globsa* (Plate-10, Figure-3), *Assilina* Sp. (Plate-7, Figure-7), *Athecocyclina cf cookie* (Plate-8, Figure-4), *Cibicides Nammalensis* (Plate-9, Figur-.1), *Cuvillierina Sireli* (Plate-8 , Figure-8), *Daviesina* Sp. (Plaatr-7, Figure-1),), *Dictyoconus* Sp. (Patr-.8, Figure-6), *Dictyokthina simplex* smout (Plate-7, Figure-8), *Discocyclina* Sp. (Plate-7, Figure-5), *Discocylina varians* (Plate-9, Figure-5), *Discorinopsis* Sp. (Plate-8 , Figure-3), *Globanomalina pseudoiota* (Plate-7, Figure-6), *Cribrogoesella* Sp. (Plate-8 , Figure-5), *Idalina sinjerica* (Plate-9, Figure-6), *Kathina majar* smout (Plate-7, Figure-2), *Lagenids* Sp. (Plate- 7, Figure-4),*Lockhartia conditi* Nuttall (Plate-6, Figure-3), *Lockhartia diversa* (Plate-6, Figure-6), *Lockhartia* Sp. (Plate-7 , Figure-3), *Miscellanea meardina* (Plate-9, Figure-4), *Miscellanea miscella* (Plate-9, Figure-3),*Nodosariids* Sp. (Plate-8, Figure-2),*Nummulites faasi* (Plate-8, Figure-1), *Nummulite globulus* (Plate-9, Figure-8), *Opertorbitolites transitorius* (Plate-10, Figure-5), *Orbitolites* Sp. (Plate-10, Figure-4), *Ovulites* Sp. (Plate-8, Figure-7), *Pyrgo* SP. (Plate-6, Figure-2) *Qunquloculina* Sp. (Plate-6 , Figure-4) , *Ranikothalia antillea* (Plate-6 , Figure-8), *Rotalia Perovalis* (Plate-6, Figure-5), *Rotalia* Sp. (Plate-6, Figure-7), *Rotalia trochidiformis* (Plate-9, Figure-2), *Somalina* Sp. (Plate-10, Figure-2), *Spherogypsina globula* (Plate-10, Figure-1), *Textularia* Sp. (Platre-6, Figure-1), *Triloculina* Sp. (Plate-6, Figure-5),. In addition to the above fauna, corals, Echinoids (Plate-5, Figure-5,7,8)also occur in Derbandikhan section.

b- Biostratigraphy of Wara Mali section: The following microfauna are identified in the sediments of Sinjar Formation at the Wara Mali section (Figure- 3). These include the following red and green

Algae: *Acroporella* Sp. (Plate-2, Figure-2) *Amphiroa iraquensis* Johnson (Plate-1, Figure-1) *Belzungia* Sp. (Plate-2, Figure-5) *Clypeina merienda* (Plat-1, Figure-8) *Cymopolia* SP. (Plate-1, Figure-7) *Cymopolia Kurdistanensis* (Plate-1, Figure-3) *Dissocladella* Sp. (Plate-3, Figure-2) *Jania* Sp. (Plate-2, Figure-1) *Lithothamnium* Sp. (Plate-1, Figure-2) *Mesophyllum* Sp. (Plate-2, Figure-4) *Pagodaporella Wetzeli* (Plate-1, Figure-5) *Parkerella SP.*(Plate-1, Figure-4) *Pycnoporidium* Sp. (Plate-2, Figure-3). In addition to the following foraminifera that were identified in this section : *Austrotrilline conica* (Plate-11, Figure-6). *Cuvillierina* SP. (Plate-11, Figure-5). *Cuvillierina vallensis* (Plate-11, Figure-3), *Pyrgo* SP. (Plate-6, Figure-2) ,*Ranikothalia* SP .(Plate- , Figure.) *Rotalia Perovalis* (Plat-6, Figure-5), *Spherogypsina globula* (Plate-10, Figure-1), *Textularia* Sp. (Plate-6, Figure-1) *Triloculina* Sp. (Plate-6 , Figure-5),*Tritaxia* Sp. (Plate-11, Figure-4) *Valvulina* Sp. (Plate-9, Figure-7). In addition to the above fauna, corals, Echinoids (Plate-5, Figure-5,7,8) also occur in Wara Mali section.



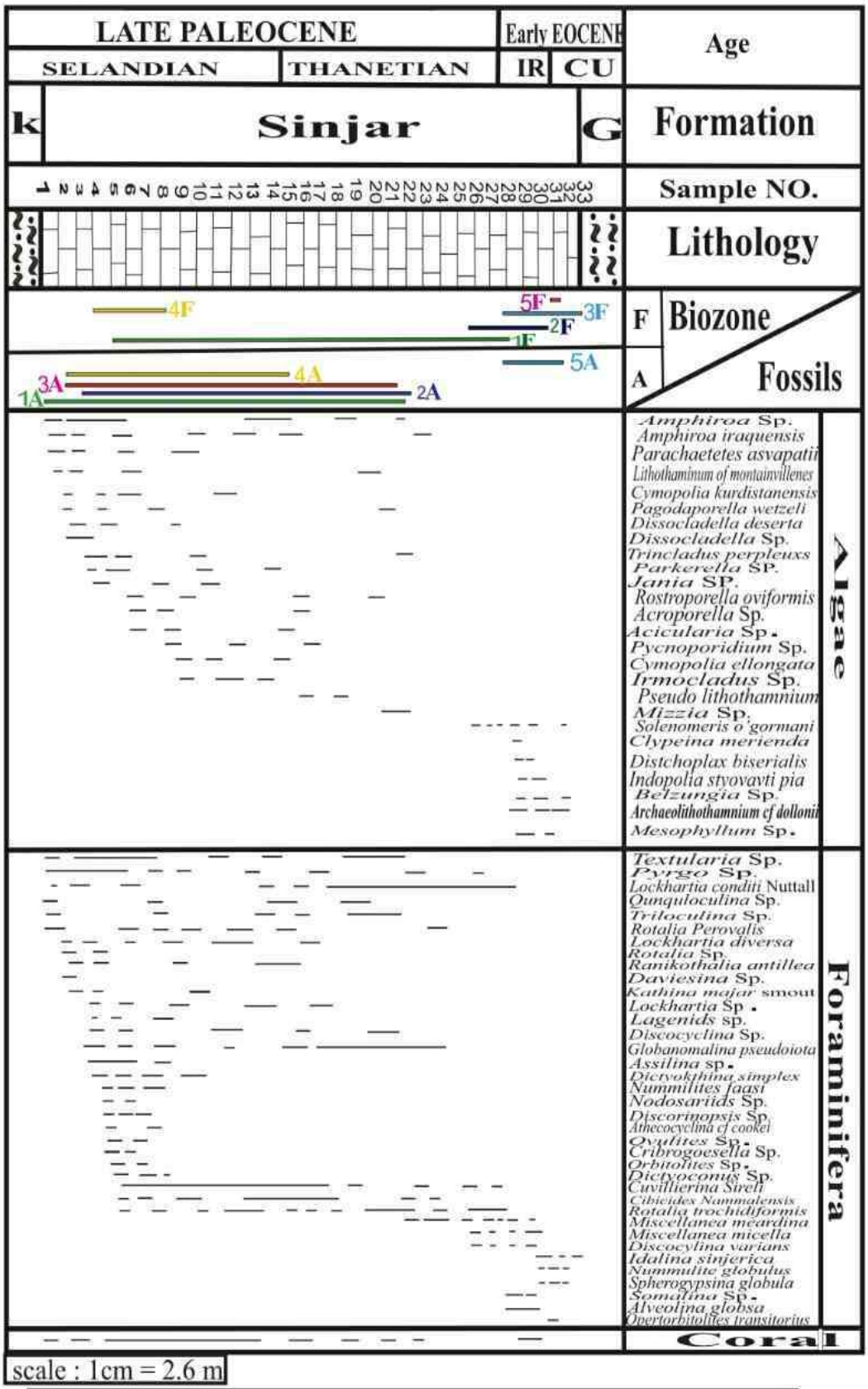


Figure (2) : Distribution of Algae & Foraminifera & Coral / Sinjar Formation /Derbandikhan section.

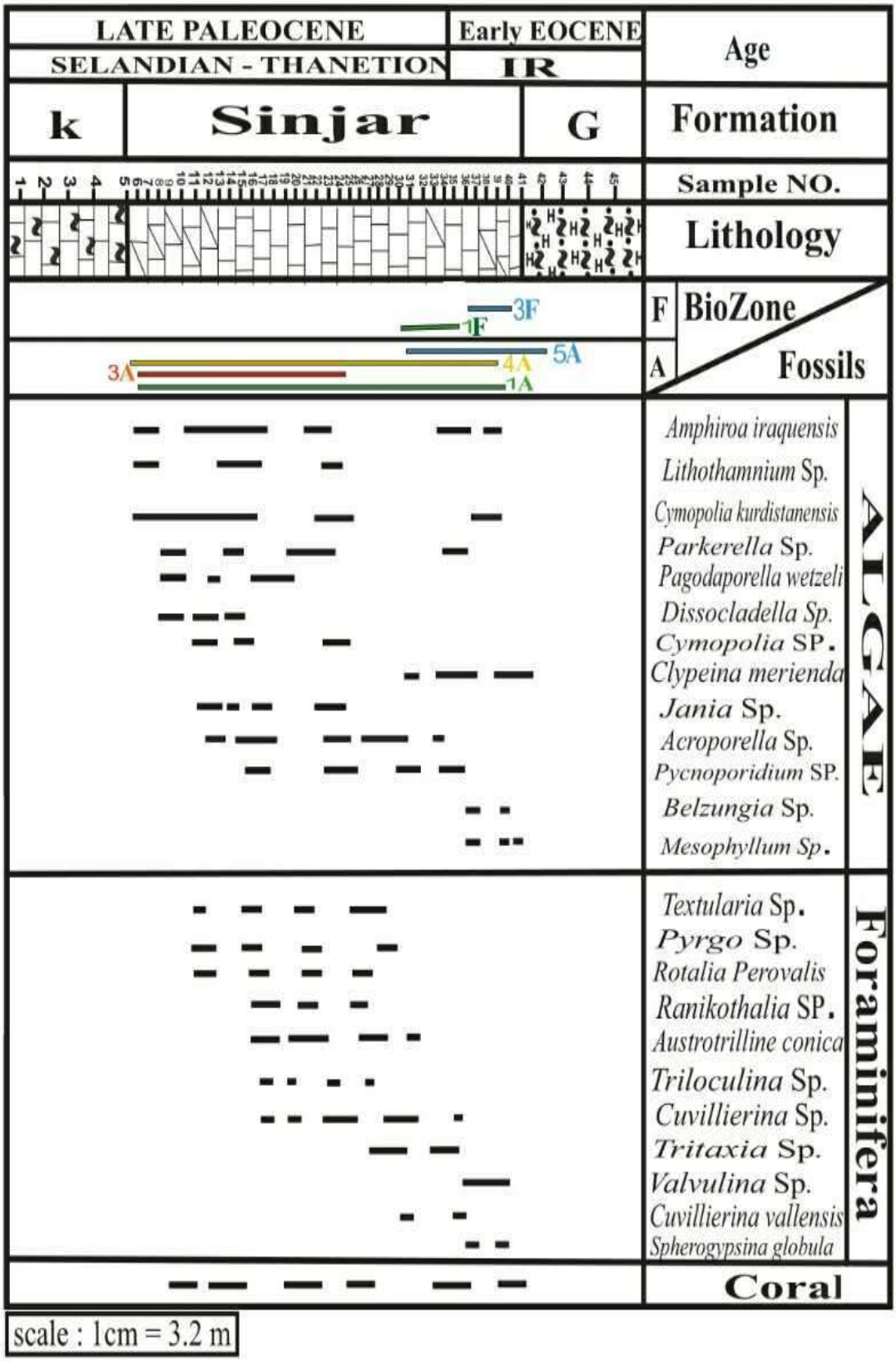


Figure (3) : Distribution of Algae & Foraminifera & Coral / Sinjar Formation / Wara Mali section.

Biostratigraphy of Qara dagh section: The following microfauna are identified in the sediments of Sinjar Formation at the Qara dagh section (Figure- 4) These include the following red and green Algae: *Amphiroa iraquensis* Johnson (Plate-1, Figure-1), *Archaeolithothaninum* Sp. (Plate-3, Figure-7), *Clypeina merienda* (Plate-1, Figure-8), *Cordilites* Sp. (Plate-3, Figure-5), *Cymopolia ellongata* (Plate-3, Figure-4), *Cymopolia Kurdistanensis* (Plate-1, Figure-3), *Dissocladella* Sp. (Plate-3, Figure-2), *Distchoplax biserialis* (Plate-3, Figure-8), *Jania* Sp. (Plate-2, Figure-1), *Lithophyllum* sp. (Plate-2, Figure-7), *Lithoporella melobesioides* (Plate-3, Figure-3), *Parachaetetes asvapatii* (Plate-4, Figure-1), *Parachaetetes* Sp. (Plate-3, Figure-1), *Pseudo lithothamnium* (Plate-3, Figure-6), *Pycnoporidium levantimum* (Plate-2, Figure-6), *Trincladus perpleux*s (Plate-2 , Figure-8). In addition to the following foraminifera that were identified in this section : *Assilina* Sp. (Plate-7 , Figure-7), *Cibicides Nammalensis* (Plate-9, Figure-1), *Cribrogoesella* Sp. (Plate-8, Figure-5), *Cuvillierina vallensis* (Plate-11, Figure-3), *Daviesina* Sp. (Plate-7, Figure-1), *Dictyoconus* Sp. (Plate-8, Figure-6), *Discocylina varians* (Plate-9, Figure-5), *Kathina delseote* (Plate-10, Figure-7), *Kathina* Sp. (Plate-11, Figure-8), *Lagenids* Sp. (Plate- 7, Figure-4), *Lockhartia* Sp. (Plate-7 , Figure-3), *Miscellanea miscella* (Plate-9, Figure-3), *Nummulite Chavannesi* (Plate-10, Figure-6), *Operculina subsalia* (Plate-10 , Figure-8), *Orantamalina* Sp. (Plate-11, Figure-7), *Orbitolites* Sp. (Plate-10, Figure-4), *Ovulites* Sp. (Plate-8, Figure-7), *Penachaias glynnjones* (Plate-11, Figure-2), *Pyrgo* SP. (Plate-6, Figure-2), *Qunquloculina* Sp. (Plate-6, Figure-4), *Ranikothalia antillea* (Plate-6, Figure-8), *Ranikothalia merinda* (Plate-11, Figure-1), *Rotalia trochidiformis* (Plate-9, Figure-2), *Spherogypsina globula* (Plate-10, Figure-1), *Textularia* Sp. (Plate-6, Figure-1) ,*Triloculina* Sp.(Plate-6,Figure-5) ,*Valvulina* Sp. (Plate-9, Figure-7). In addition to the above fauna, corals, Echinoids (Plate-5, Figures-5,7 and 8) also occur in Qara dagh section.

IV. Biozone of Sinjar Formation

Through the detailed biostratigraphic study of Sinjar Formation, depending on the presence of algae and benthonic foraminifera, Biozones were concerned, Five biozones with algae and Five biozones with benthonic foraminifera . The thickness and appearance of these biozones varies among the Three described sections. The description and discussion of the biozones are manifested below:-

1. Algal biozones of Sinjar Formation:

1.1 *Amphiroa iraquensis* range zone:

The lower limit of this zone is set with accordance of the first appearance of this species and its upper limit coincides with disappearance of the species. This zone occurs within all three described sections of the study. The thickness of the zone is 30 m in the Derbandikhan section , 40 m in the Wara mali section, 62.5 m in Qara dagh section.

1.1.1 The age of the *Amphiroa iraquensis* range zone;

The age of this zone was determined depending on its occurrence among late Paleocene deposit according to this study occurrences were recorded in the northern of Iraq**.**

1.2 *Trinocladus perplexus* range zone:

The lower limit of this zone is set with accordance of the first appearance of this species and its upper limit coincides with disappearance of the species This zone occurs was found only in Derbandikhan and Qara dagh sections The thickness of the zone is 21 m in the Derbandikhan section , 35 m in Qara dagh section.

1.2.2 The age of *Trinocladus perplexus* range zone;

The age of this zone is determined to be of late Paleocene , The *Trinocladus perplexus* species was recorded from strata belonging to Paleocene age of the northern of Iraq [9] indicate shallow tidel open plate forms (late Paleocene) [10].

1.3 *Lithothamnium – Pagodaporella wetzeli –Lithoporella melobesides* Assemblage zone:

This zone is identified depending on the range of extension of the three species. The upper limit of the zone was determined by the last appearance of the three species.

The species *Lithothamnium* and *Pagodaporella wetzeli* species were found only in Derbandikhan section and Wara mali section, while *Lithoporella melobesides* species was found only in Qara dagh section .The thickness of this zone is 27.5 m at Derbandikhan section and 47 m at Qara dagh section and 25m at Wara mali section.

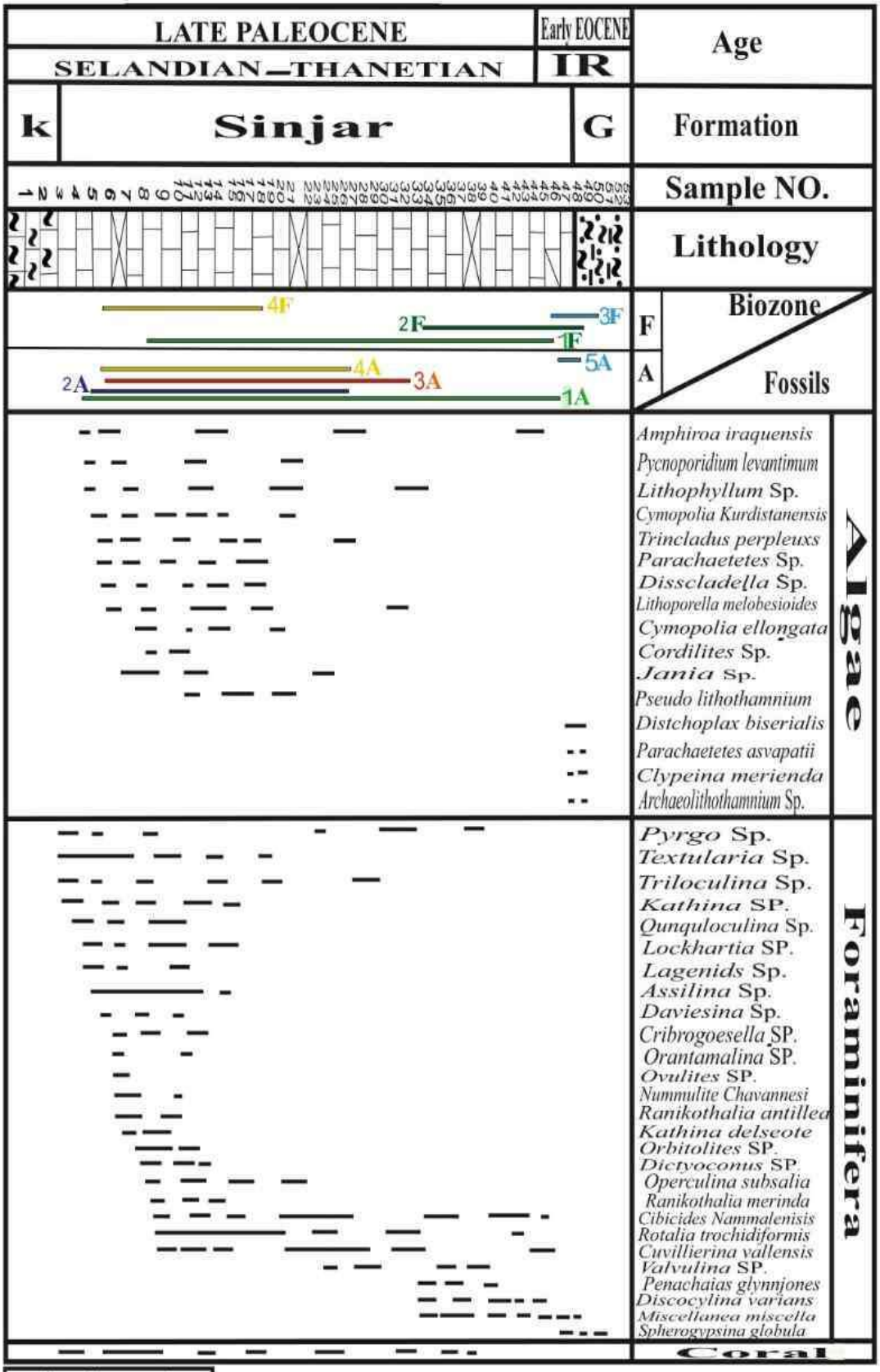


Figure (4) : Distribution of Algae & Foraminifera & Coral / Sinjar Formation /Qara dagh section.

PLATE-1
Figure 1- ***Amphiroa iraquensis*** **Johnson** sample no.2 , Derbandikhan section **.**
Figure 2- ***Lithothamnium*** **Sp. ,**sample no.24 **,** Wara Mali section**.**
Figure 3- ***Cymopolia kurdistanensis ,*** sample no. 12 , Derbandikhan section.
Figure 4- ***Parkerella*** **Sp.** sample no.14 , Derbandikhan section.
Figure 5- ***Pagodaporella wetzeli*** ,sample no.18 , Wara Mali section **.**
Figure 6- ***Dissocladella deserta*** ,sample no.5 , Derbandikhan section .
Figure 7- ***Cymopolia*** **Sp**., sample no.12 , Wara Mali section .
Figure 8- ***Clypeina merienda ,*** sample no. 47 , Qara dagh section .
PLATE-2
Figure 1- ***Jania*** **Sp.** ,sample no.9 , Qara dagh section.
Figure 2- ***Acroporella*** **Sp. ,** sample no.15 , Derbandikhan section.
Figure 3- ***Pycnoporidium*** **Sp.** , sample no.31 , Wara Mali section.
Figure 4- ***Mesophyllum*** **Sp.** ,sample no.29 , Derbandikhan section.
Figure 5- ***Belzungia*** **Sp.** , sample no.37 , Wara Mali section.
Figure 6- ***Pycnoporidium levantimum*** , sample no. 11 ,Qara dagh section.
Figure 7- ***Lithophyllum*** **sp.**, sample no. 20 , Qara dagh section.
PLATE-3
Figure 1- ***Parachaetetes*** **Sp.** , sample no.10 , Qara dagh section.
Figure 2- ***Dissocladella*** **Sp.** , sample no. 4, Derbandikhan section.
Figure 3- ***Lithoporella melobesioides*** , sample no.31 , Qara dagh section**.**
Figure 4- ***Cymopolia ellongata,*** sample no.12 , Derbandikhan section.
Figure 5- ***Cordilites*** **Sp. ,** sample no.9 , Qara dagh section.
Figure 6- ***Pseudolithothamnium*** **Sp. ,** sample no.22 , Derbandikhan section.
Figure 7- ***Archaeolithothamnium*** **Sp.**, sample no.31, Derbandikhan section.
Figure 8- ***Distchoplax biserialis*** , sample no.29 , Derbandikhan section.
PLATE-4
Figure 1- ***Parachaetetes asvapatii*** , sample no.4, Derbandikhan section.
Figure 2- ***Rostroporella oviformis ,*** sample no.7, Derbandikhan section.
Figure 3- ***Acroporella*** **Sp. ,** sample no. 25 ,Wara Mali section.
Figure 4- ***Acicularia*** **Sp. ,** sample no.15 , Derbandikhan section.
Figure 5- ***Irmocladus*** **Sp.** , sample no. 19 , Derbandikhan section.
Figure 6- ***Mizzia*** **Sp.**, sample no. 27 , Derbandikhan section.
Figure 7- ***Solenomeris o'gormani,***sample no.29, Derbandikhan section.
Figure 8- ***Indopolia styovavti ,*** sample no.30 , Derbandikhan section.
PLATE-5
Figure 1- ***Archaeolithothamnium cf dollonii*** ,sample no.29 , Derbandikhan section.
Figure 2- ***Lithothamnium of montainvillenes ,*** sample no.20, Derbandikhan section **.**
Figure 3- ***Amphiroa*** **Sp. ,** sample no.5 , Derbandikhan section .
Figure 4- ***coral fragment*** , sample no. 11 , Derbandikhan section **.**
Figure 5- ***Echinoids spine*** , sample no. 22 , Derbandikhan section.
Figure 6- ***Echinoids spine,*** sample no.45 , Qara dagh section.
Figure 7- solitary coral , sample no. 36 ,Wara Mali section.
Figure 8- solitary coral , sample no.8 ,Qara dagh section.
PLATE-6
Figure 1- ***Textularia*** **Sp.** sample no.5, Qara dagh section.
Figure 2- ***Pyrgo*** **SP.** sample no.9 , Derbandikhan section.
Figure 3- ***Lockartia conditi*** **Nuttall .** sample no. 20, Derbandikhan section.
Figure 4- ***Qunquloculina*** **Sp.** sample no.10 ,Qara dagh section.
Figure 5- ***Triloculina*** **Sp. (A),** ***Rotalia Perovalis*** **(B).** sample no. 25,Wara Mali section**.**
Figure 6- ***Lockhartia diversa ,*** sample no.13 , Derbandikhan section.
Figure 7- ***Rotalia*** **Sp.**, sample no.6 , Derbandikhan section.
Figure 8- ***Ranikothalia antillea ,*** sample no.10 ,Qara dagh section .

PLATE-7

Figure 1- ***Daviesina*** **Sp.**, sample no. 5, Derbandikhan section**.**
Figure 2- ***Kathina majar*** **smout ,** sample no. 6, Derbandikhan section.
Figure 3- ***Lockhartia*** **Sp.,** sample no.11, Qara dagh section.
Figure 4- ***Lagenids*** **Sp.** , sample no.5, Qara dagh section.
Figure 5- ***Discocyclina*** **Sp. ,**sample no. 22 , Derbandikhan section.
Figure 6- ***Globanomalina pseudoiota***, sample no. 24 , Derbandikhan section.
Figure 7- ***Assilina*** **Sp.** sample no. 8, Qara dagh section.
Figure 8- ***Dictyokthina simplex*** **smout**, sample no.7, Derbandikhan section.

PLATE-8

Figure 1- ***Nummulites faasi*** , sample no.6, Derbandikhan section.
Figure 2- ***Nodosariids*** **Sp.**, sample no.5, Derbandikhan section.
Figure 3- ***Discorinopsis*** **Sp.**, sample no.8, Derbandikhan section.
Figure 4- ***Athecocyclina cf cookei*** , sample no. 8, Derbandikhan section.
Figure 5- ***Cribrogoesella*** **Sp.,** sample no. 6, Derbandikhan section.
Figure 6- ***Dictyoconus*** **Sp.**, sample no. 12, Qara dagh section.
Figure 7- ***Ovulites*** **Sp.,** sample no. 8 ,Qara dagh section**.**
Figure 8- ***Cuvillierina Sireli,*** sample no.19, Derbandikhan section

PLATE-9

Figure 1- ***Cibicides Nammalensis,*** sample no.22, Derbandikhan section**.**
Figure 2- ***Rotalia trochidiformis,*** sample no.36, Qara dagh section.
Figure 3- ***Miscellanea miscella,*** sample no.40, Qara dagh section.
Figure 4- ***Miscellanea meardina,*** sample no.30, Derbandikhan section.
Figure 5- ***Discocylina varians,*** sample no.42, Qara dagh section.
Figure 6- ***Idalina sinjerica***, sample no.32, Derbandikhan section.
Figure 7- ***Valvulina*** **Sp.,** sample no.40, Wara Mali section.
Figure 8- ***Nummulite globulus***, sample no.33, Derbandikhan section**.**

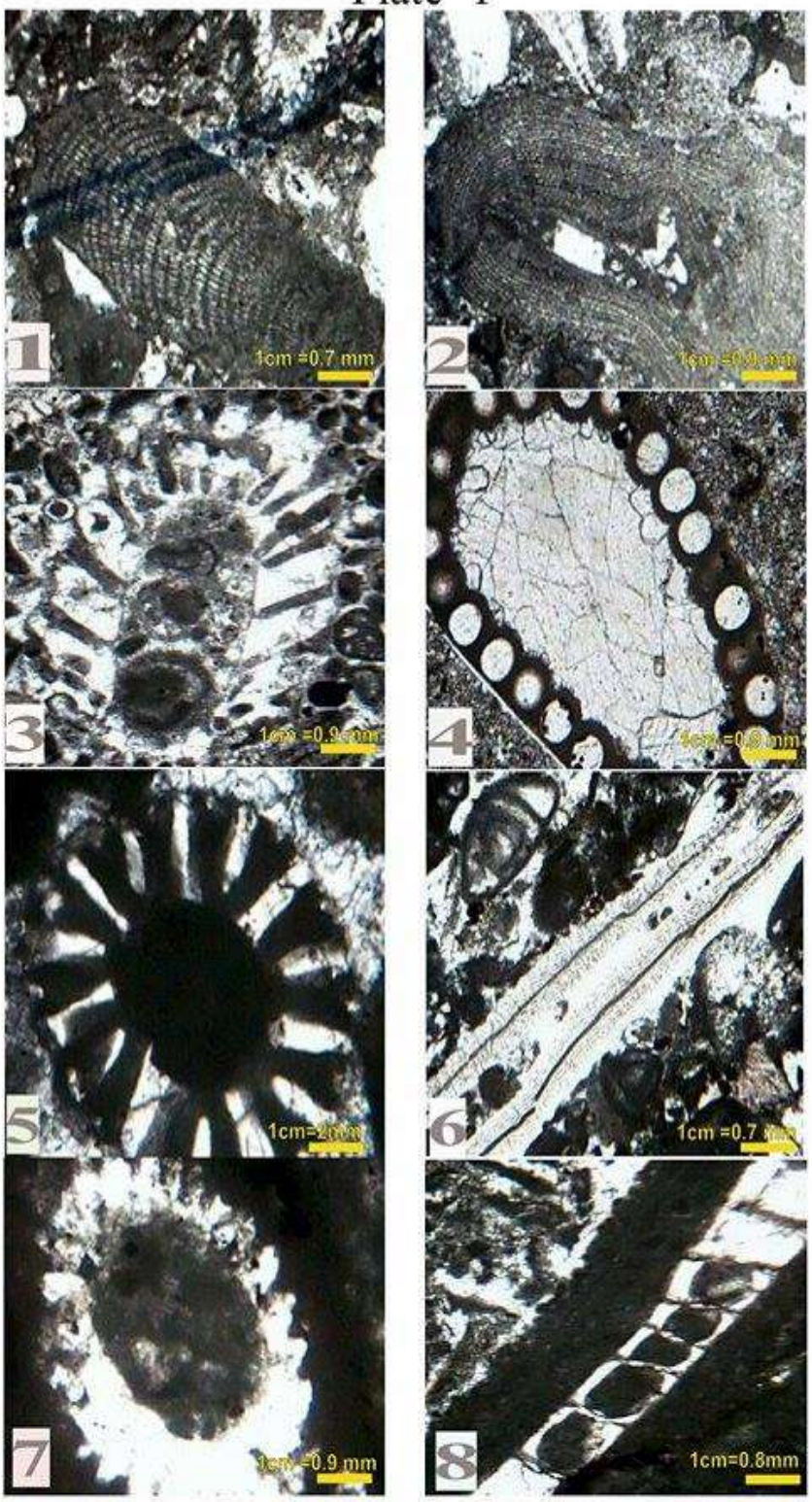
PLATE-10

Figure 1- ***Spherogypsina globula,*** sample no.40,Wara Mali section.
Figure 2- ***Somalina*** **Sp.** , sample no.29, Derbandikhan section.
Figure 3- ***Alveolina globsa ,*** sample no.30, Derbandikhan section.
Figure 4- ***Orbitolites*** **Sp.,** sample no.9, Qara dagh section.
Figure 5- ***Opertorbitolites transitorius,*** sample no.33, Derbandikhan section.
Figure 6- ***Nummulite Chavannesi*** , sample no.8, Qara dagh section.
Figure 7- ***Kathina delseote*** sample no.9, Qara dagh section.
Figure 8- ***Operculina subsalia***, sample no.15,Qara dagh section **.**

PLATE-11

Figure 1- ***Ranikothalia merinda***, sample no.11,Qara dagh section.
Figure 2- ***Penachaias glynnjones***, sample no.33,Qara dagh section.
Figure 3- ***Cuvillierina vallensis***, sample no.37 ,Wara Mali section.
Figure 4- ***Tritaxia*** **Sp.**, sample no.29, Wara Mali section.
Figure 5- ***Cuvillierina*** **Sp.**, sample no.19, Wara Mali section.
Figure 6- ***Austrotrilline conica***, sample no.21, Wara Mali section.
Figure 7- ***Orantamalina*** **Sp.**, sample no. 12, Qara dagh section.
Figure 8- ***Kathina*** **Sp**., sample no.14, Qara dagh section.

Plate -1-



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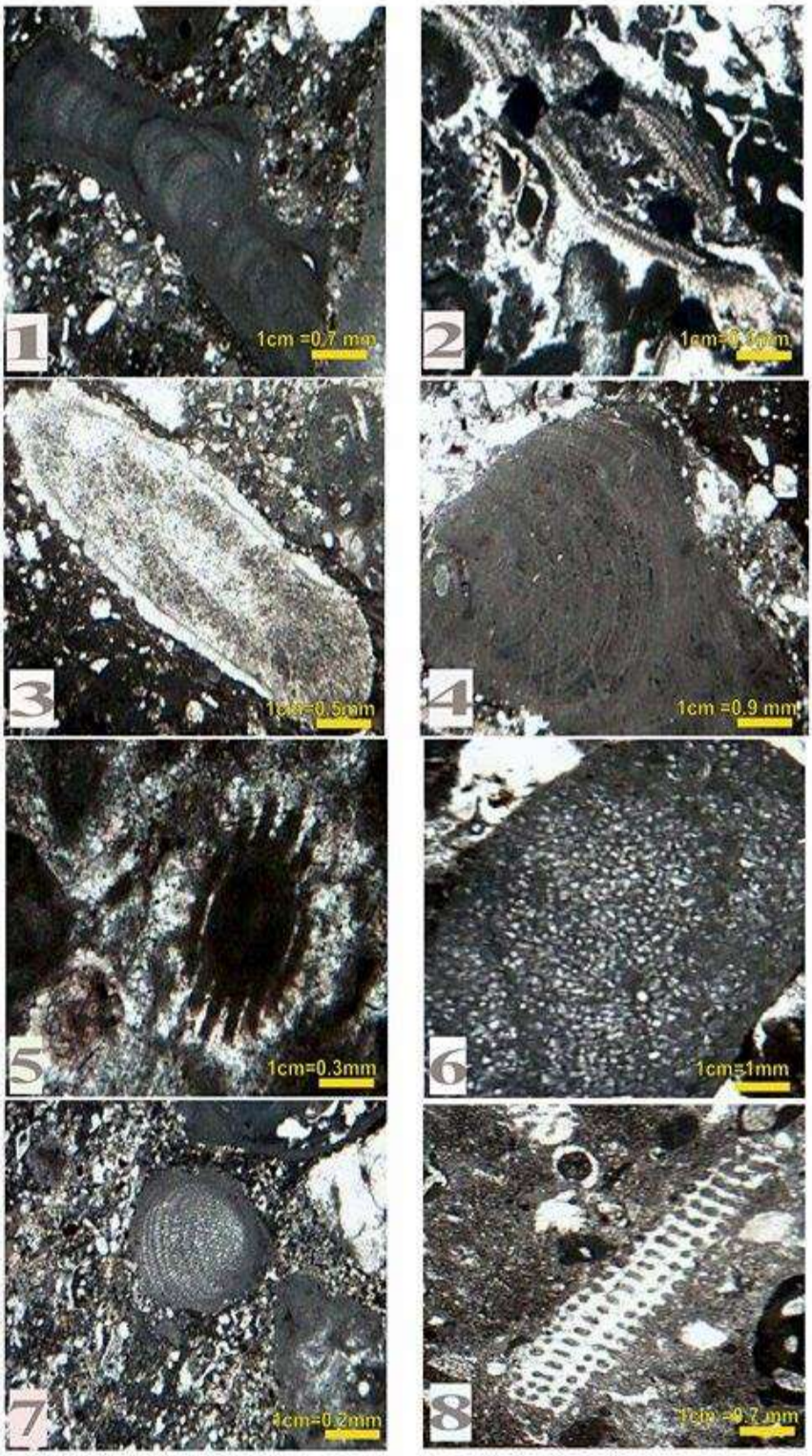

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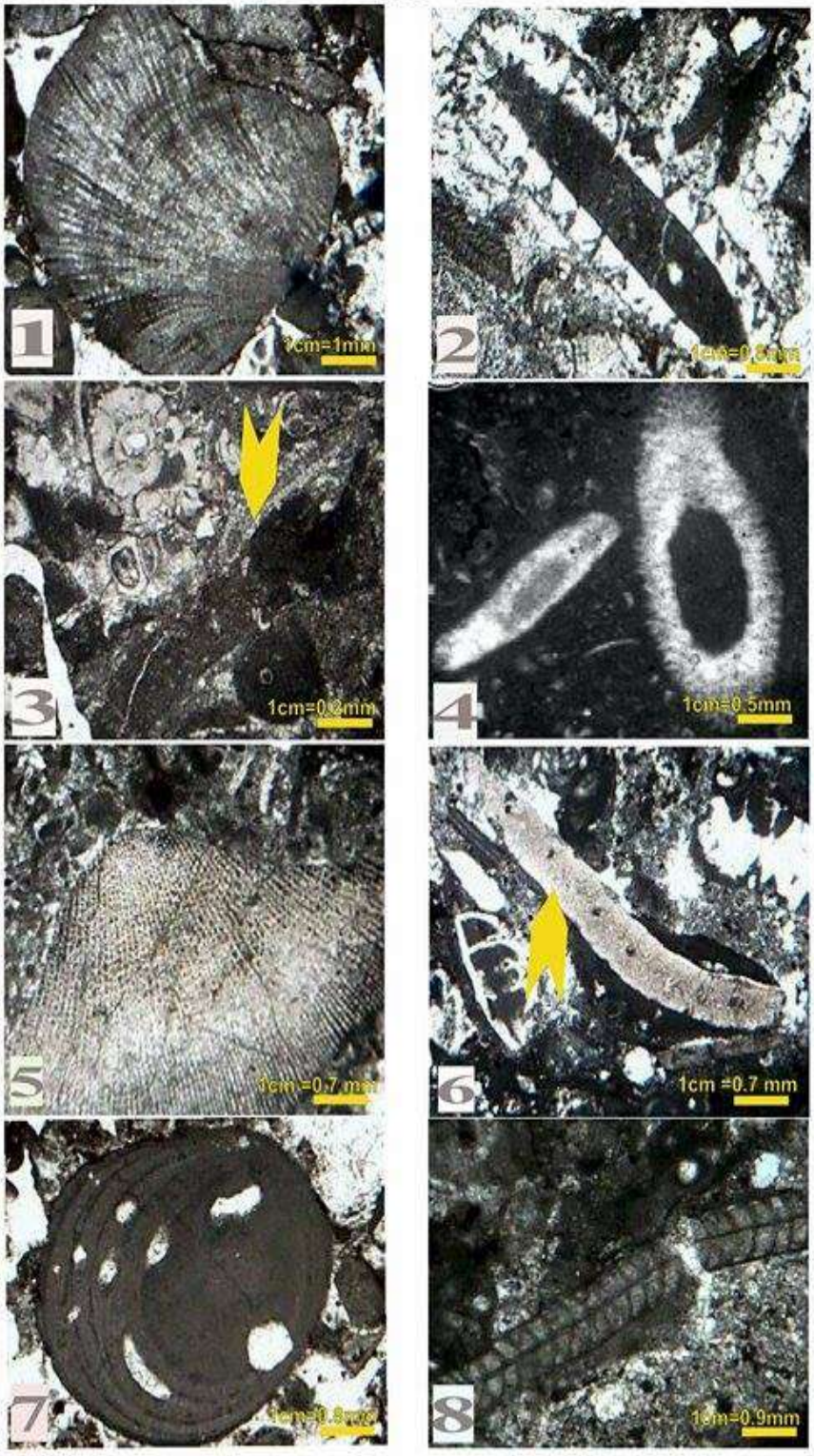

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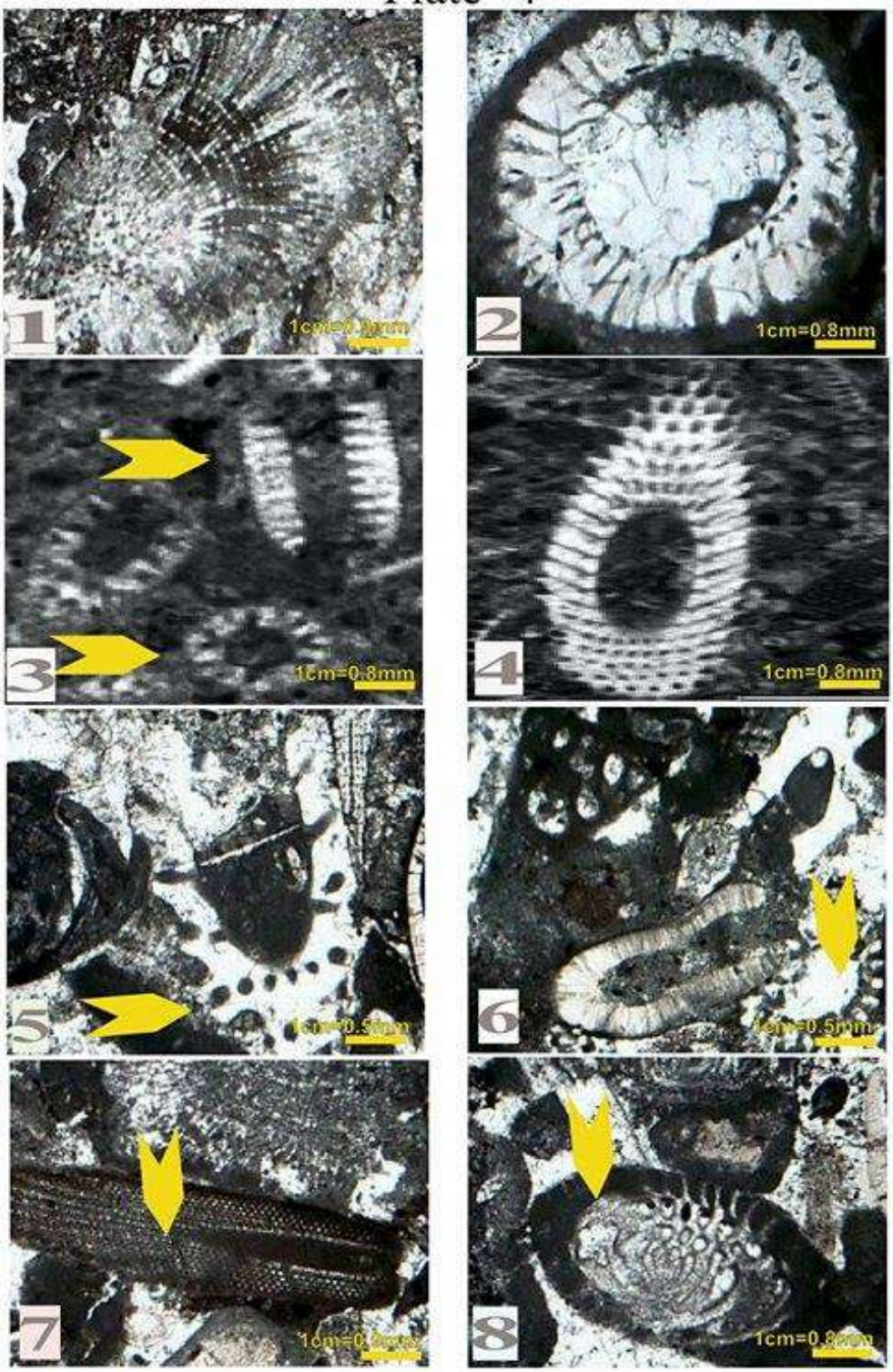

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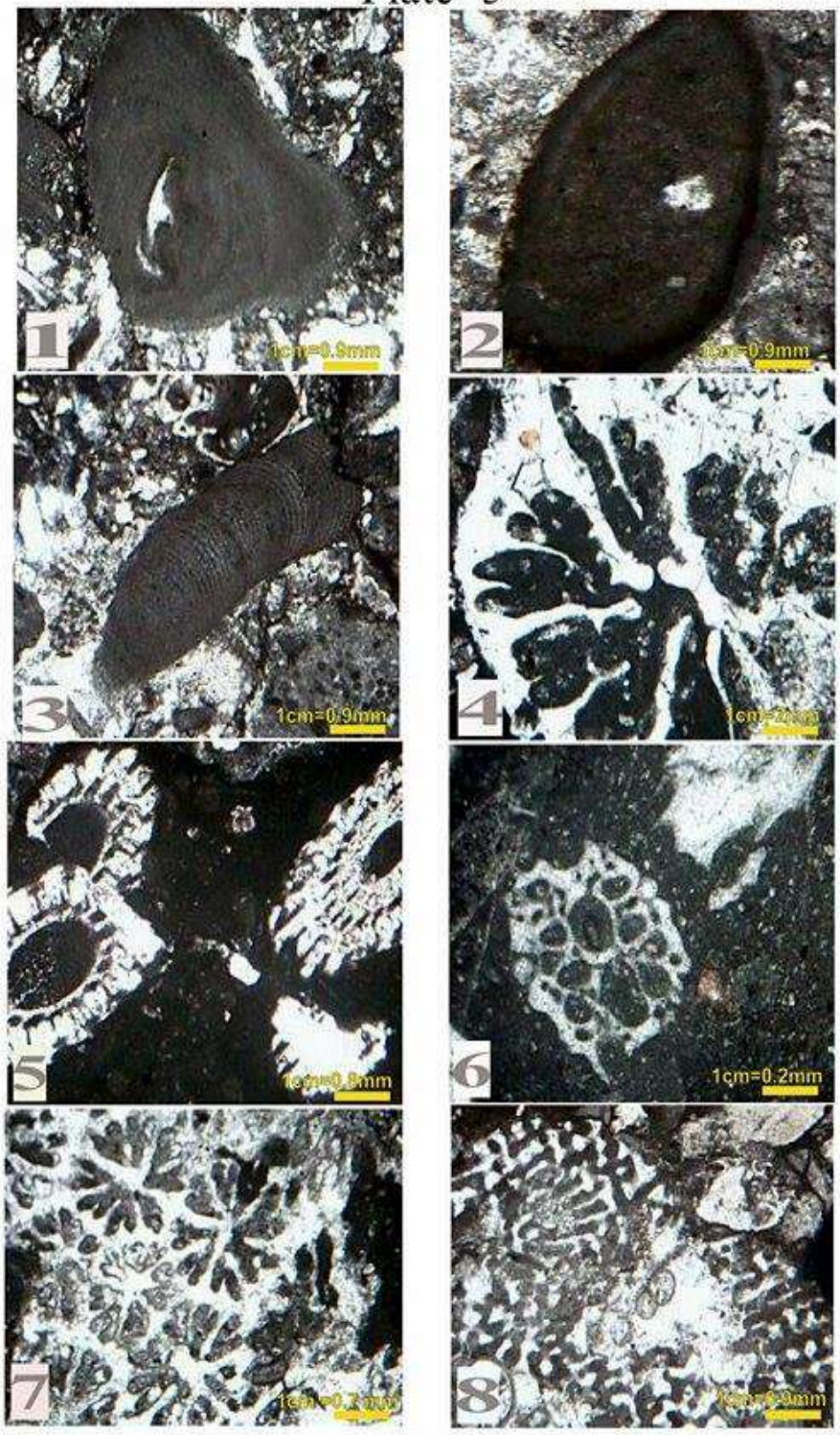

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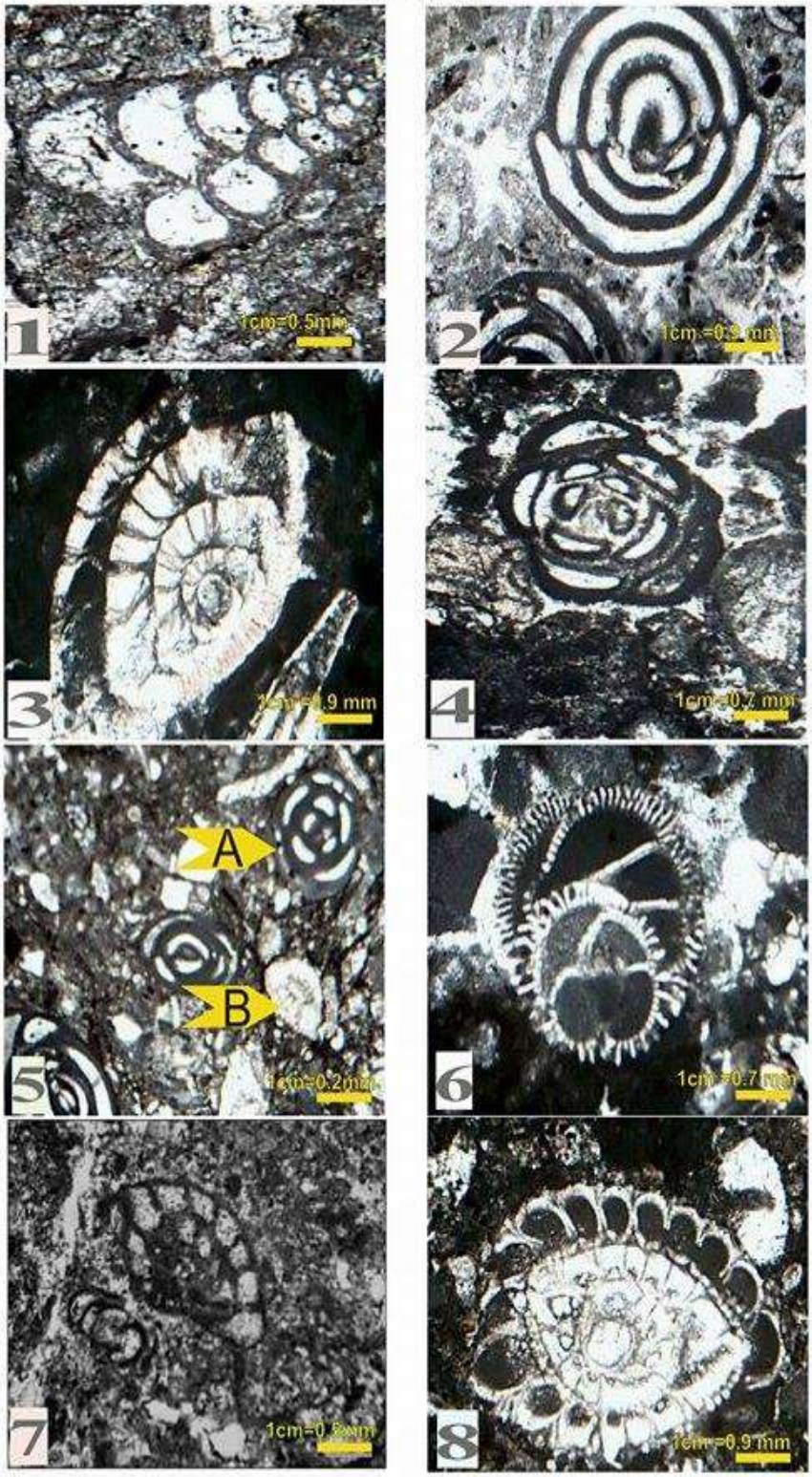

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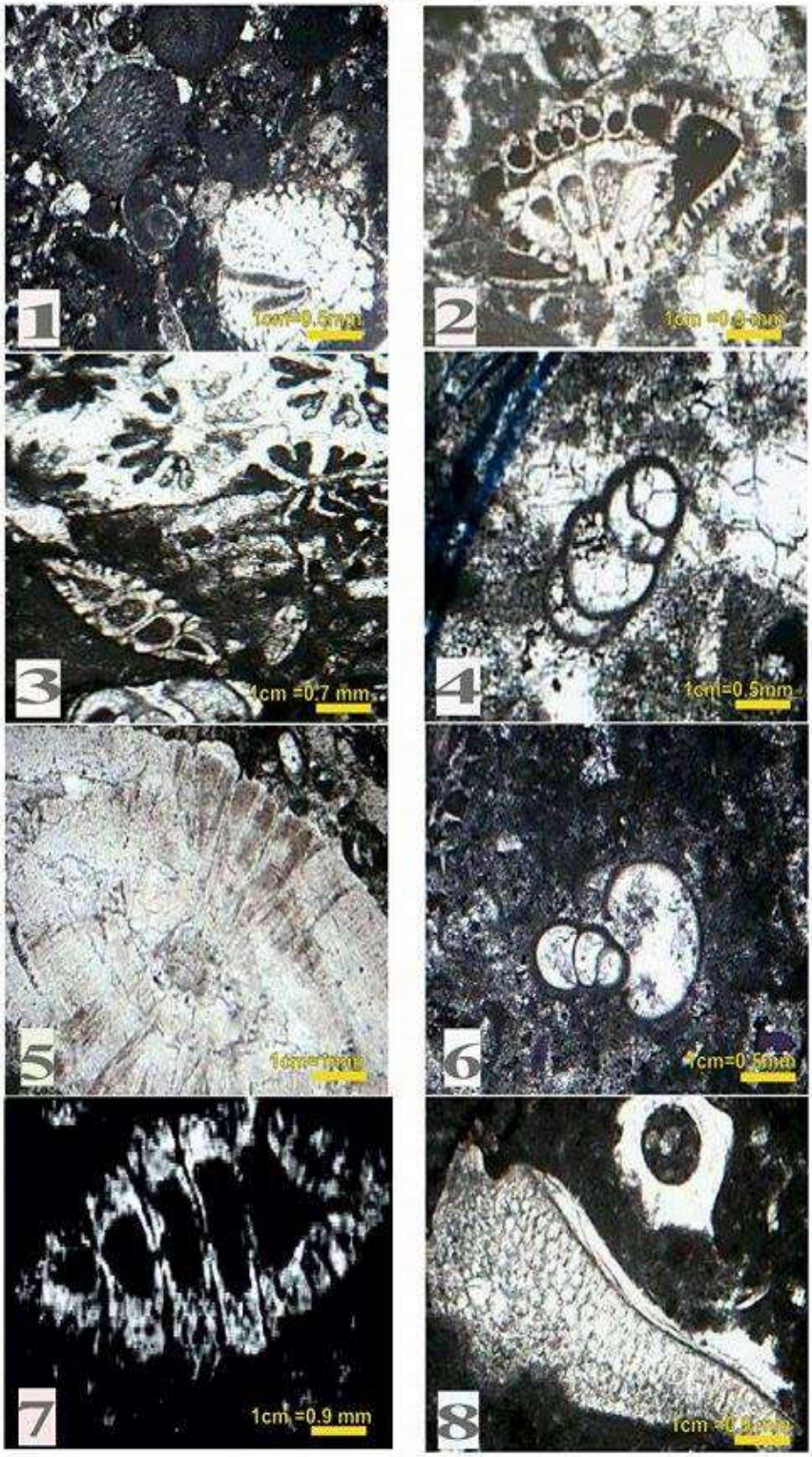
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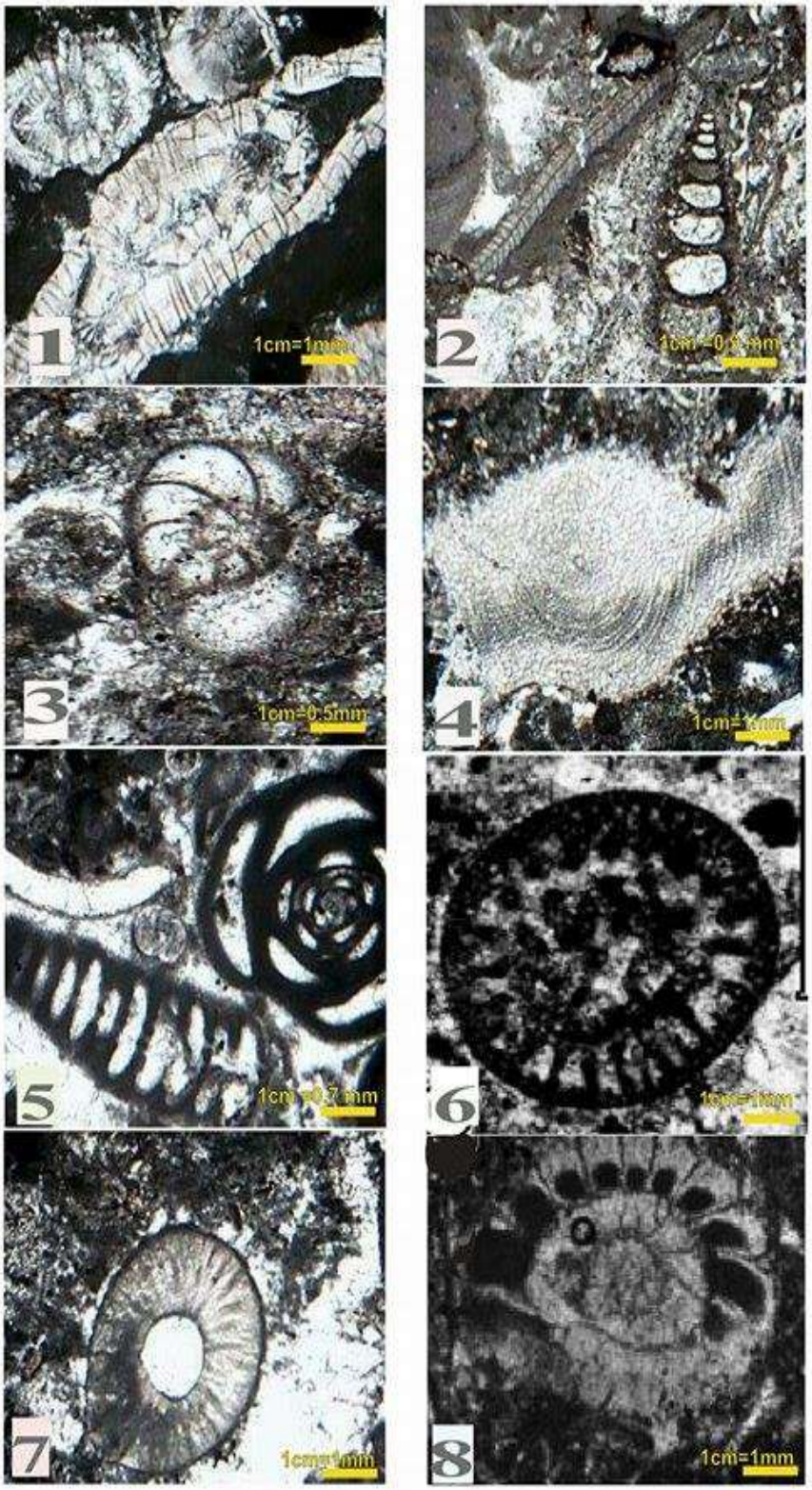

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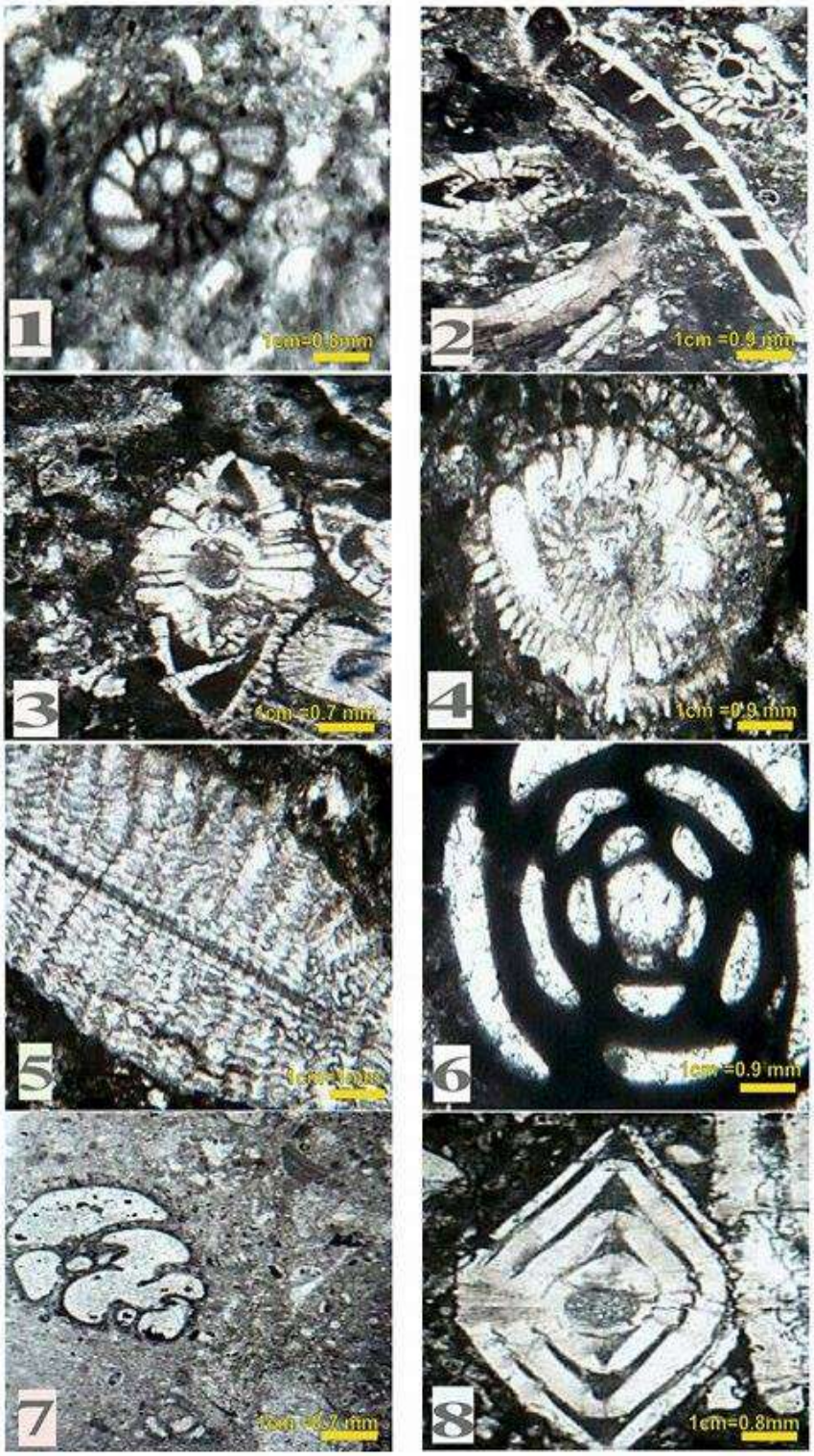
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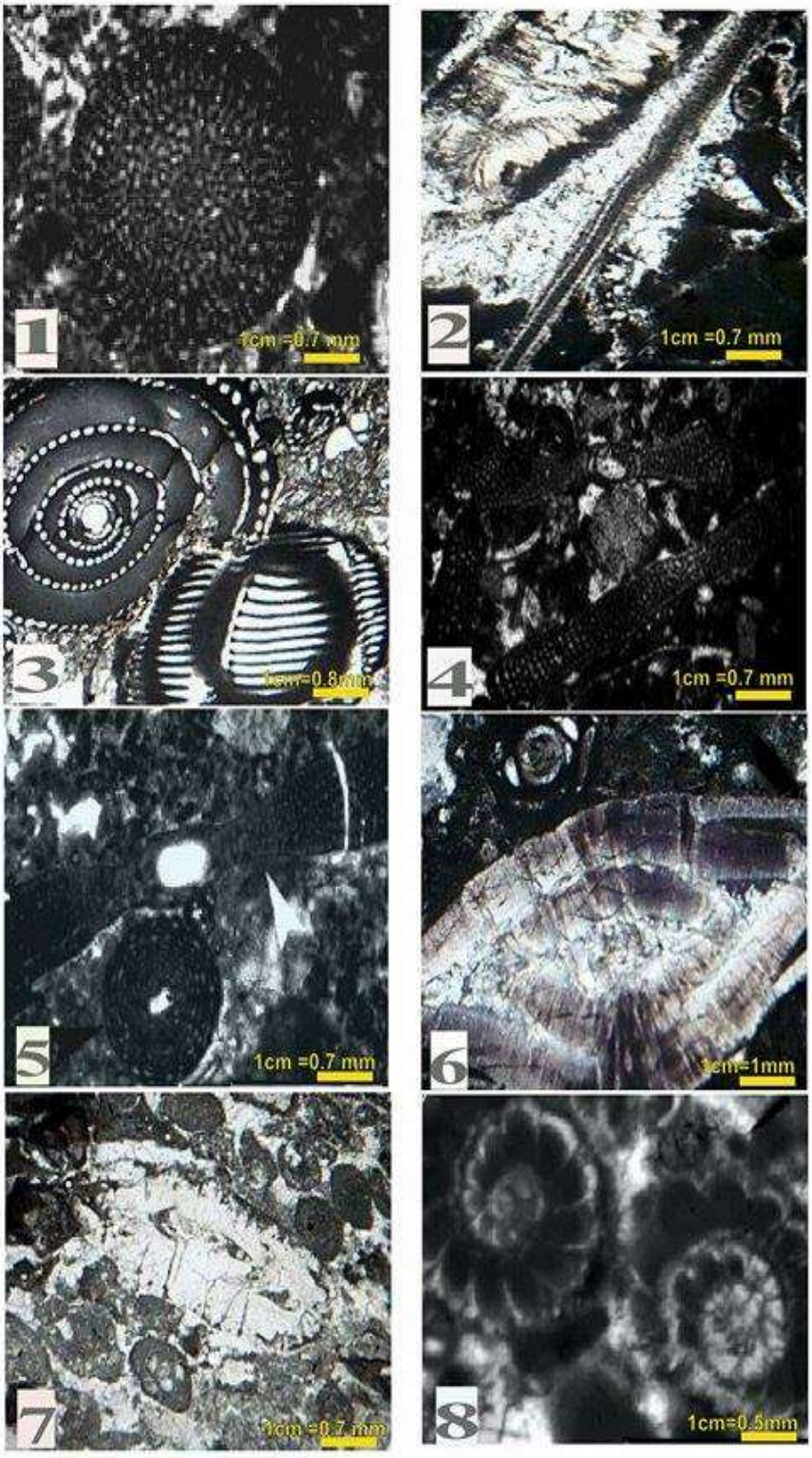
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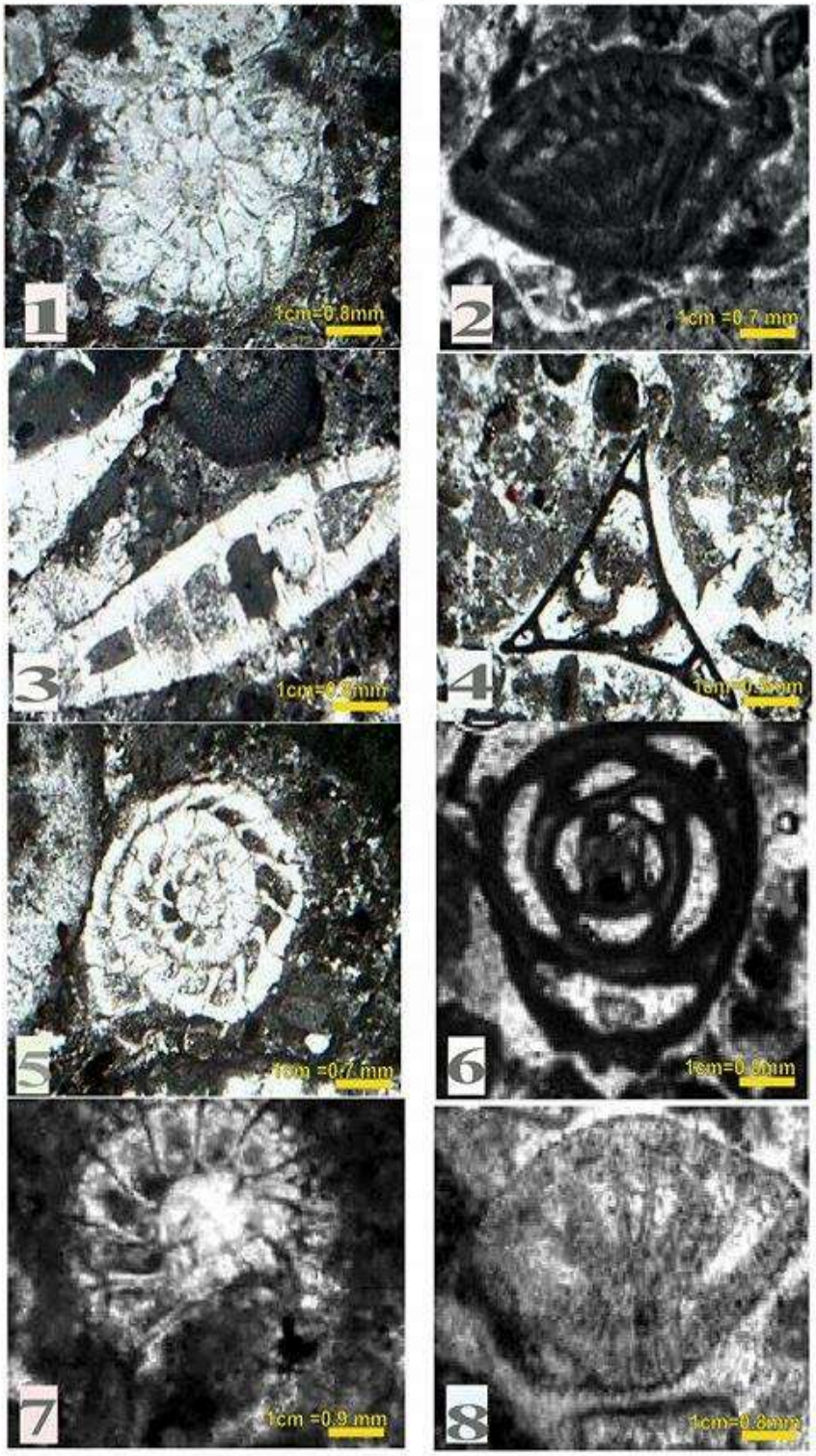

1.3.1 The Age of *Lithothamnium – Pagodaporella wetzeli–Lithoporella melobesides* Assemblage zone:

The age of this zone is determined to be of late Paleocene , depending on the age of the three species and the age of the accompanying species. The age and location of each species are given below:

The species *Pagodaporella wetzeli* was recorded from strata belonging to Paleocene age of the northern of Iraq [11], and *Lithoporella melobesides* species was recorded from strata belonging to Paleocene age of the northern of Iraq [9].

1.4 *Cymopolia kurdistanensis- parkerella* Sp.- *Dissocladella deserta-Jania* Sp. Assemblage zone:

This zone is identified depending on the range of extension of part of the above species and the accompanying species . The upper limit of the zone was determined by the last appearance of these species.

The species *Cymopolia kurdistanensis , parkerella*, *Dissocladella deserta , Jania* were found in all three sections Derbandikhan , Wara mali and Qara dagh while *Parachaetetes* species and *Cymoplia ellongata* were found only in Derbandikhan section and Qara dagh section while *Irmocladus* species found only in Derbandikhan section. The thickness of this zone is 17.5 m at Derbandikhan section and 35 m at Qara dagh section and 40 m at wara mali section.

1.4.1 The Age of *Cymopolia kurdistanensis- parkerella* Sp.- *Dissocladella deserta-Jania* Sp. Assemblage zone:

The age of this zone was determined depending on its occurrence among late Paleocene deposit located world wide. Some of these occurrences were recorded by number of researchers as:

Cymopolia kurdistanensis Species was recorded from strata belonging to Paleocene age of the northern of Iraq [12]. The most frequently recognized dasycladacean are: *Cymopolia ellongata* Defrance *Cymopolia sp*. These species of *Cymopolia* were identified in the Adriatic carbonate platform along the Dubrovnik Coast that known age from Paleocene-Lower Eocene deposits. Cymopolia has the most numerous species particularly during Paleocene and Middle Eocene [13].

Dissocladella deserta species recorded from strata from Paleocene to Lower Eocene south western of Iraq [14] ,*Dissocladella* species indicates a Paleocene age [13], *parkerella* species indicate a Paleocene age [13]. *Parachaetetes* Species was recorded from strata belonging to Paleocene age of the northern of Iraq [9], red algae represented by *Parachaetetes* were identified The foraminifera assemblages consists of: *Orbitolites complanatus, Mardinella shirazensis* Rahaghi which has first been found in Thanetian sedimentary rocks from the Shiraz area, West Iran; however, the same forms have been observed in the benthic foraminifer-rich limestones of Thanetian age in the NE Mardin area, SE Turkey [13].

1.5 *Clypeina merienda –Distichoplax biserialis -Mesophyllum* Sp.-*Archaeolithothamnium cf dollonii* Assemblage zone:

This zone is identified depending on the range of extension of part of the four species and the accompanying species It was recorded in the three sections.The lower limit of the zone was identified according to the coexistence of the four species even through that appearance of *Mesophyllum* Sp. And *Belzungia* Sp. found in Derbandikhan and Wara mali sections while *Archaeolithothamnium cf dollonii* and *Distichoplax biserialis* and *Clypeina merienda* found in Derbandikhan section and Qara dagh section while *Indopolia styavanti pia* found in Derbandikhan section only.The thickness of this zone is 5 m at Derbandikhan section and 4 m at Qara dagh section and 5 m at Wara mali section.

1.5.1 The age of *Clypeina merienda –Distichoplax biserialis - Mesophyllum* Sp.- *Archaeolithothamnium cf dollonii* Assemblage zone:

The age of this zone was determined depending on its occurrence in the late Paleocene-early Eocene deposit located world wide. Some of these occurrences were recorded by number of researchers as:

Clypeina merienda –Distichoplax biserialis Species were recorded from strata belonging to Paleocene age of the northern of Iraq [12].

2. Foraminifera biozones of Sinjar Formation:

2.1 *Cuvillierina sireli – Cuvillierina vallensis - Cibicides nammalensis – Rotalia trochidiformis* Assemblage zone:

This zone is identified depending on the range of extension of part of the four species. The upper limit of the zone was determined by the last appearance of the three species.

The species *Cibicides nammalensis – Rotalia trochidiformis* were found in Derbandikhan and Qara dagh section while *Cuvillierina sireli* species was found in Derbandikhan and wara mali sections and *Cuvillierina vallensis* was found in Qara dagh and wara mali sections .

The thickness of this zone is 28.5 m at Derbandikhan section and 52 m at Qara dagh section and 27.5 m in Wara mali section.

2.1.1 The age of *Cuvillierina sireli – Cuvillierina vallensis - Cibicides nammalensis – Rotalia trochidiformis* Assemblage zone:

The age of this zone is determined to be of late Paleocene , depending on the age of the five species and the age of the accompanying species. The age and location of each species are given below**:**

[15] described the *Alveolina globosa* Leymerie ,*Idalina sinjarica* Grimsdale,*Miscelleanea miscella*(d,Archiac and Haime),*Rotalia trochidiformis* Lamarck ,from Paleocene of Sinjar Formation Iraq , *Rotalia trochidiformis* age Selandian ranging up in to the Thanetian [16].

[17] and [18] recorded the *Cuvillierina vallensis* from the lower Eocene of Damascus (Syria) but in this study recorded from Late Paleocene. *Cuvillierina sireli* Inan ,*Idalina sinjarica* Grimsdale , *Koskinolina , Operculina heberti* Munier-Chalmas has also been found in the Late Paleocene deposits of the Hayamana-Polatli Basin, central Turkey by [19]. The species *Cuvillierina sireli* İNAN was identified in Sierra Espuna area (Spain) and Eastern Pontides (Turkey) [20]. According to[21] this species indicates Early Paleocene age (Selandian) *Cuvillierina sireli* İNAN is in Selandian and they range up into the Thanetian [20]. The species *Cibicides nammalensis* has been recorded from the Late Paleocene of Salt Range [22] and Hazara area [23] from Pakistan.

2.2 *Miscellanea miscella –Discocylina varians* Assemblage zone:

This zone is identified depending on the range of extension of part of

the two species. It was recorded in both Derbandikhan section and Qara dagh section but not exist in Wara mali section .The lower limit of the zone was identified according to the coexistence of the two species. The upper limit of the zone was determined by the last appearance of the two species. The thickness of this zone is 11m at Derbandikhan section and 20 m at Qara dagh section.

2.2.1 The age of *Miscellanea miscella –Discocylina varians* Assemblage zone:

The age of this zone is determined to be of Late Paleocene –early Eocene , depending on the age of the two species and the age of the accompanying species. Also depending on their age correlation with those similar found in the neighboring and other countries. The age and location of each species are given below. The species *Miscellanea miscella* was recorded from strata belonging to Paleocene age in each of the following countries :- [21] and [16] described *Miscelleanea miscella* from Late Paleocene. [15] described the *Alveolina globosa* Leymerie, *Idalina sinjarica, Miscelleanea miscella, Rotalia trochidiformis* Lamarck ,from Paleocene of Sinjar Formation Iraq.

2.3 *Idalina sinjarica –Nummulites globulus –Spherogypsina globula –Somalina* Sp.- *Alveolina globosa* Assemblage zone: This zone is identified depending on the range of extension of part of

the six species. It was recorded in all sections. The lower limit of the zone was identified according to the coexistence of the six species. Even through, that appearance of *Idalina sinjarica –Nummulites globulus –Somalina* Sp.- *Alveolina globosa* were found only in Derbandikhan section while *Spherogypsina globula* found in the three sections.The upper limit of the zone was determined by the last appearance of the six species.. The thickness of this zone is 3.5m at Derbandikhan section and 5.5 m at Qara dagh section and 5 m at Wara mali section .

2.3.1 The age of *Idalina sinjarica –Nummulites globulus -Spherogypsina globula –Somalina* Sp.- *Alveolina globosa* Assemblage zone: The age of this zone is determined to be of early Eocene , depending on the age of the six species and the age of the accompanying species. Also depending on their age correlation with those similar found in the neighboring and other countries. The age and location of each species are given below:

Nummulites globules Leymerie described from Lower Eocen of Qater, Afghanistan, Algeria and Iraq [18]. *Alveolina globosa* Leymerie described from Upper Paleocene of France and Iraq [18]. *Idalina sinjarica* Grimsdale , has also been found in the Late Paleocene deposits of the Hayamana-Polatli Basin, central Turkey by [19].

2.4 *Orbitolites* Sp. - *Assilina* Sp. - *Ovulites* Sp.- *Cribogoesella* Sp, Assemblage zone:

This zone is identified depending on the range of extension of part of the four species. It was recorded in Derbandikhan section and Qara dagh section and not found in Wara mali section .The

lower limit of the zone was identified according to the coexistence of the four species. And there are more species have the same age found in Derbandikhan section such as (*Athecocyclina of cookie ,Disconinopsis , Nodosariids, Nummulites faasi , Dictyokathina simplex smout*) while in Qara dagh section (*Orantomalina , Nummuliteschavannesi, Ranikothalia antillea, Kathina delseote*). The upper limit of the zone was determined by the last appearance of the four species. The thickness of this zone is 7.5m at Derbandikhan section and 10 m at Qara dagh section .

2.4.1 The age of *Orbitolites* Sp. - *Assilina* Sp. - *Ovulites Sp.- Cribogoesella* Sp. Assemblage zone:

The age of this zone is determined to be of Paleocene , depending on the age of the four species and the age of the accompanying species. Also depending on their age correlation with those similar found in the neighboring and other countries. The age and location of each species are given below**:**
[24] & [25] recorded the *Ranikothalia antilea* Hanzawa from the Paleocene of Venezuela he mentioned that it was also described from the Paleocene of Haiti Trinded and Maxico , and [18] recorded the above species from Paleocene of Iraq. *Athecocyclina cf cookei* (Vaughan and cole) from the Paleocene of Venezuela, he mentioned that it was also found in the Paleocene of Alabama , Florida.[26] described the *Dictyokathina simplex* smout from the Paleocene of Qatar and from the upper Paleocene of northern Iraq .

2.*5 Opertorbitolites transitorius* range zone;

The lower limit of this zone is set with accordance of the first appearance of this species and its upper limit coincides with disappearance of the species. This zone found in Derbandikhan section only , The thickness of the zone is 1m.

2.*5*.1 *The age of Opertorbitolites transitorius* range zone:

The age of this zone is determined to be, depending on the age of this species in this study Early Eocene (the boundary between the Iletdian and Cursin). According to (16*) Opertorbitolites transitorius* belongs to Uppermost Ilerdian.

V.Conclusion

1- The age of Sinjar Formation is Late Paleocene-Early Eocene on the present Biostratigraphic study
2- The Biozones were concerned in this study , Five with algae and Five with benthonic foraminifera . The thickness and appearance of these biozones varies among the three described sections as shown above, and the five biozones were distinguished for algae .

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