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Biostratigraphy of Eocene Sediments from Naopurdan Group, Chwarta Area, Kurdistan Region, NE Iraq: Paleogeographic Implication

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ABSTRACT

The main purpose of the present work is to describe the microfossils and biostratigraphy of marine Eocene deposits, which are described and studied in detail from carbonates of the Naopurdan Group, Chwarta area, Kurdistan Region, Northeastern Iraq. In order to define the main index fossils and to establish the biostratigraphy and age constraints of the exposed unit in the study area. A total of thirty-eight samples, spaced ca 0.5 to 1 m apart, have been collected from the field, approximately 60 thin sections are examined and the microfossils have been identified using the polarized microscopes. Three main biozones are recorded in the studied section, these zones are: *(Nummulites globulus - Nummulites planulatus* zone, at the bottom of the section and assigned to the Early Eocene (Ypressian) age, *Nummulites mamillatus - Nummulites alsharhani* zone, collected from the middle part of the section is assigned to the Middle Eocene (Lutetian) age, and *Nummulites fabianii - Assilina exponens* zone collected from the upper part of the section is assigned to the Early Bartonian age. So, the studied section of the Naopurdan Group is suggested to be Ypressian - Early Bartonian age. These three biozones are correlated with the other zones inside and outside Iraq.

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الطباقية الحياتية لترسبات الايوسين ضمن مجموعة ناوبردان في منطقة جوارتا، اقليم كردستان، شمال شرق العراق: تضمين الجغرافيا القديمة

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الملخص

الهدف الرئيسي من العمل الحالي هو وصف المتحجرات الدقيقة والطباقية الحياتية لرواسب الأيوسين، التي تم وصفها ودراستها بالتفصيل من كربونات مجموعة ناوبردان البحرية، في منطقة جوارتا، اقليم كردستان، شمال شرق العراق، من أجل تحديد المتحجرات الدالة والرئيسية لاعطاء الطباقية الحياتية وتحديد العمر لمنطقة الدراسة. تم جمع ثمانية وثلاثين عينة من الحقل بمسافة بين 0.5 إلى 1 متر، وفحص ما يقرب من 60 من الشرائح الرقيقة وتم التعرف على المتحجرات الدقيقة باستخدام المجاهر المستقطبة. بالاعتماد على المتحجرات الدقيقة و خاصة المنخربات الكبيرة الحجم، تم تسجيل ثلاث أنطقة حياتية رئيسية في منطقة الدراسة، وهذه الانطقة هي:

1- *Nummulites globulus - Nummulites planulatus* zone

نطاق (Ypressian) في الجزء السفلي من المقطع ويعود للعصر الأيوسيني المبكر

2 –*Nummulites mamillatus –Nummulites alsharhani* zone.

(Lutetian) تم جمعها من الجزء الأوسط للمقطع ويعود لعصر الأيوسين الأوسط

3–*Nummulites fabianii - Assilina exponens* zone.

و نطاق (Early Bartonian) التي تم جمعها من الجزء الأعلى للمقطع ويعود للبارتونين المبكر

لذلك يُقترح بأن يكون منطقة الدراسة لمجموعة ناوبردان يعود الى عمر يبريشين الى بارتونين المبكر (Ypressian - Early Bartonian age)

تم مضاهاة هذه الأنطقة مع الأنطقة الحياتية الاخرى داخل وخارج العراق.

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Introduction

One selected section at Chwarta area (Lat. 35°43'28.31" N and Long. 45°35'27.98" E) is studied for foraminiferal analysis. It is located at the northwestern corner of Chwarta town, which lies between Lat. 35°43'28.31" N and Long. 45°35'27.98" E in the Imbricate/Thrust Zone (Fig. 1). The area consists of dark, white and milky grey fossiliferous limestone with 38m thick and its lower boundary is with Walash Group and its upper boundary is with Red Bed Series. The description of the lithological constituents and fieldwork investigation is inferred as shown in figure (2). Bolton (1958d) was the first who described the Naopurdan Shaly Group at Naopurdan village in Rawanduz River Valley (type locality) and he determined the age of this group as Paleocene–Oligocene or possible Miocene. Naopurdan Group is subdivided into two subgroups (Naopurdan-Type Subgroup and Sidekan-Type Subgroup) (Buday, 1980). Eocene –Oligocene age of the group was recorded by Polnikov and Nikolajev (1962) in Jassim and Goff 2006). Ghafor (1988), studied the Early Eocene strata from Sinjar area, NW Iraq. According to Jassim and Goff (2006), the Naopurdan Group was deposited in the Paleogene. The Eocene rocks were described from Northeastern Iraq by Ghafor and Karim (1999). Ghafor (2000) has described the Early to Late Danian rocks in Shaqlawa area, NE Iraq, using spores and pollen. The fossils of Eocene rocks in North and Northeastern Iraq were described by Sharbazheri, et al. (2009) and Sharbazheri, et al. (2011),

who gave Early Eocene age to the Eocene rocks by using planktic and benthic foraminiferas. Al Nuaimy, et al. (2020) separated the Eocene sediments from Northeastern Iraq, based on the planktic and benthic foraminifera. Ghafor and Qadir (2009) have described three groups of larger foraminifera from the Red Bed Series, which more likely belong to Walash−Naopurdan group. early Eocene (Ypressian) age was recorded for the group by Al Qayim, et al. (2013). Mirza, et al. (2016) studied the Walash−Naopurdan group from Northeastern Iraq and give Middle Eocene in age. Ali, et al. (2017) recorded Eocene to Oligocene age of the Walash and Naopurdan group in Northeastern Iraq. Al Fattah, et al. (2018), Al Fattah, et al. (2020a) and Al Fattah, et al. (2020b), studied the Early Eocene rocks in Sinjar, Shaqlawa and Dhock areas. Kharajiani, (2018) assigned the middle Eocene age for the Betwata section, NE Iraq, based on the Calcareous nannofossils. Daoud (2019), studied the Nummulitic limestone of Naopurdan Group, and he recorded Late Paleocene-Early Eocene age. Finally, Ahmad, et al. (2022) studied the condensed section within the Naopurdan Group, and they confirm the Lutetian age of succession. This work aims to reformulate the study of microfossils and the biostratigraphy of the study section.

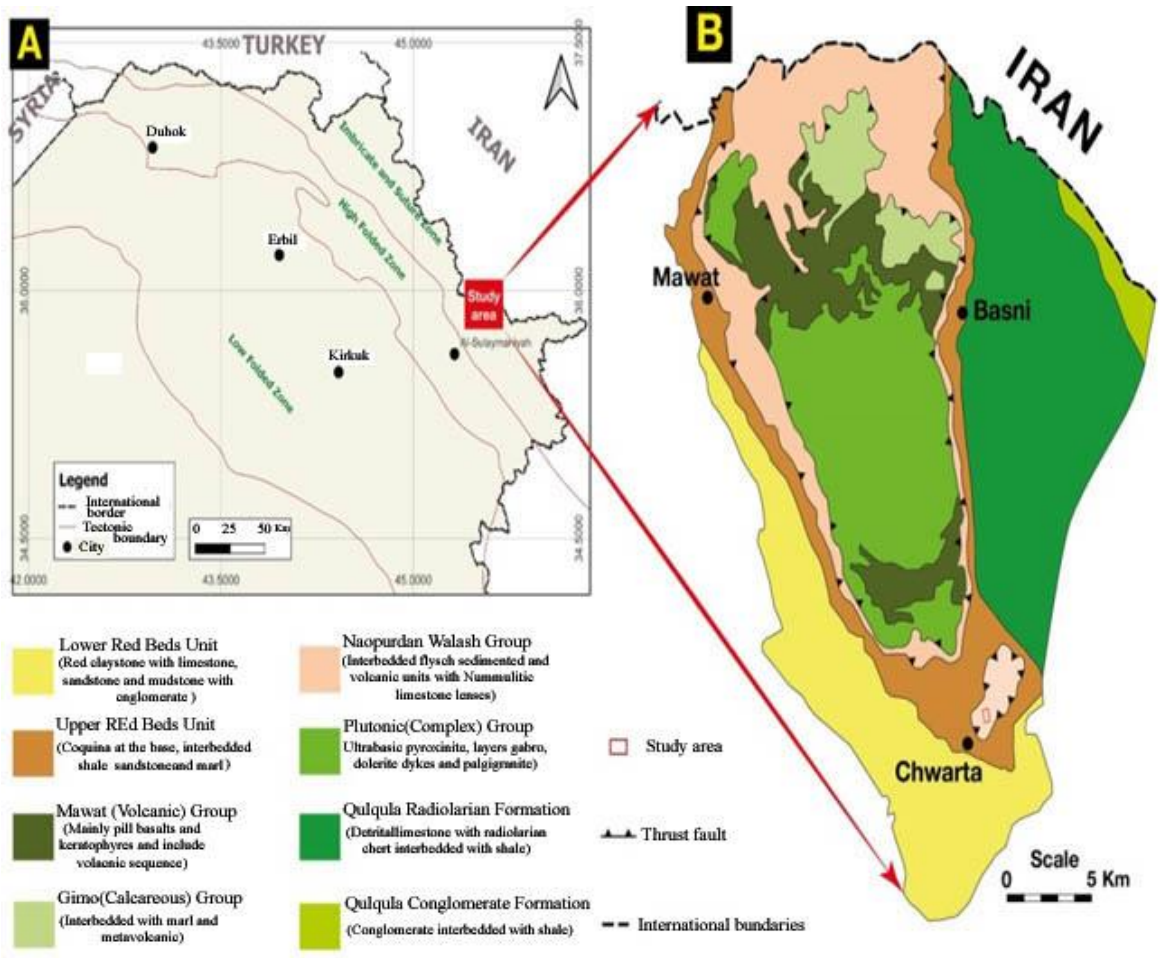

Fig. 1. Location, tectonic and geological map of the study area, northeast Iraq. A. tectonic map. (Al-Kadhimi, et al. 1996). B. Geologic and location map.

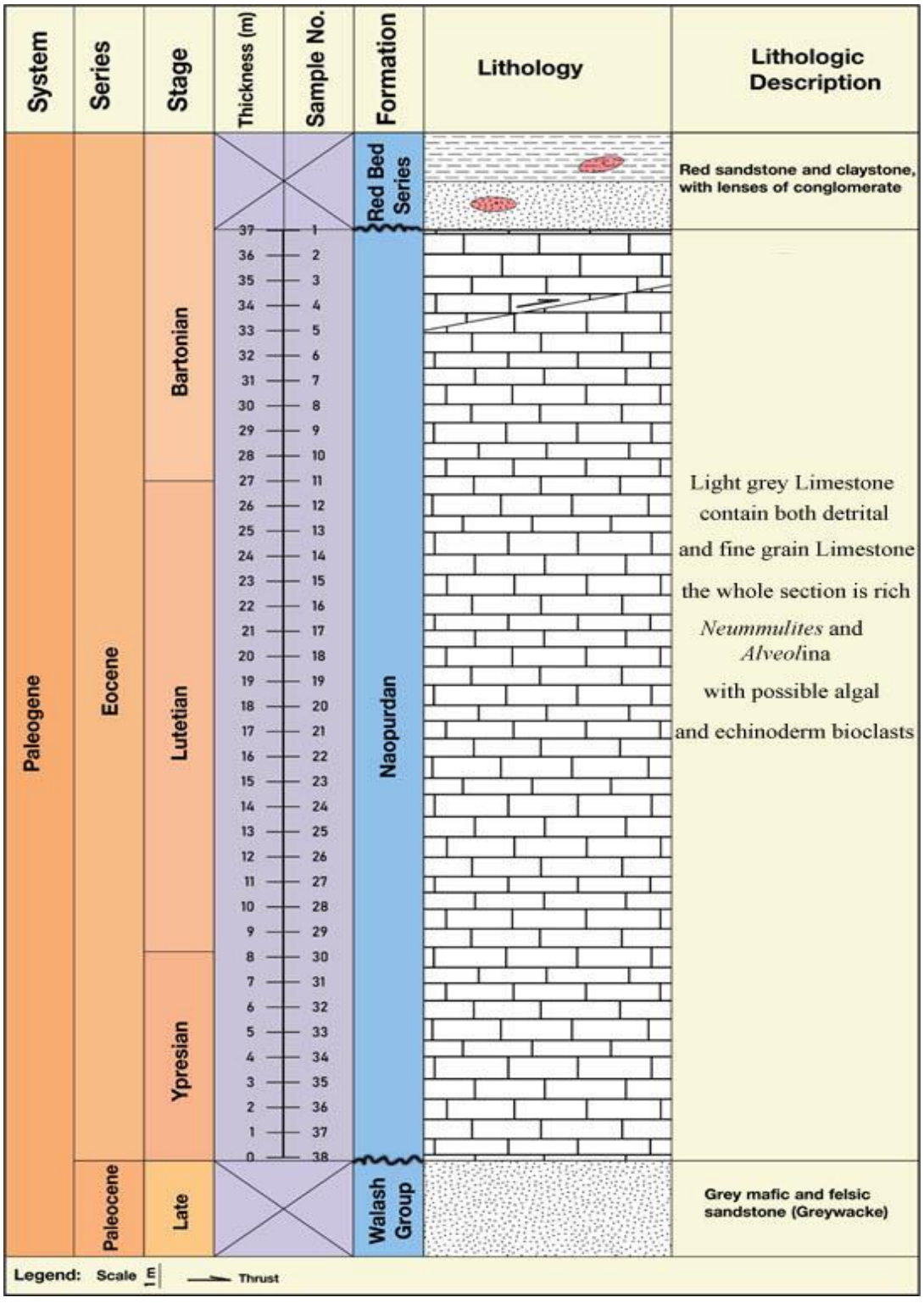

Fig.2. Lithostratigraphic column of Late Paleocene-Early-Middle Eocene rock units from the studied section.

Materials and Methods

The idea of the present work is reconstructed after four reconnaissance trips field works and mapping during one year for the outcrops of Chuwarta area, NE Iraq (Fig. 3). Thirty-eight samples are collected from the Nummulitic limestone layers, and then microfossils are identified from the seventy-thin sections by the polarized microscope. The studies by Loeblich and Tappan (1988), and Bolli (1966) are adopted for planktic foraminiferal identification and the studies of Seyrafian and Mojikhalifeh 2005; Sirel, et al. 2013; Gedik 2014; Serra-Kiel, et al. 2016; Roozpeykar and Moghaddam 2016; Ferrandez-Canadell) and Bover-Arnal (2017) are adopted for identification of benthic foraminifera.

Fig. 3. General view of studied section (Chuwarta), view toward the northwest.

Geological setting

According to Buday (1980), and Buday and Jassim (1987), the studied section is within the Imbricate / Thrust Zone. The area represents partial area where the continental sides of the Iranian and Arabian plates collide during the Eocene (Numan, 1997; Surdashi, 1997) or Upper Cretaceous (Karim, 2004). Heron and Lees (1943) clarified that the name Naopurdan is a part of the Lower Division of the Nappe Zone and is underlain by Cretaceous rocks and Red Bed Series. Al-Mehaidi (1975), Karim (2004), Numan (1997), and Surdashy (1997) show that the area is of Upper Cretaceous and Eocene age and is a part of the continental sides of the Iranian and Arabian plates.

Results

Biostratigraphy

The studied sequence yields enrichment in large benthic foraminiferal assemblages (59 species belonging to 14 genera of large benthic foraminifera and 2 species of planktic Foraminifera belonging to 2 genera) (Plates 1, 2, 3 and 4). Benthic foraminifera has been used for biostratigraphic analysis for the studied section. The stratigraphic distribution of the Early - Middle Eocene larger foraminifera recorded from the Naopurdan Group permits the recognition of three biozones (Fig. 4) and by correlation with different studies; the recognized biozones are described below, starting from older to younger.

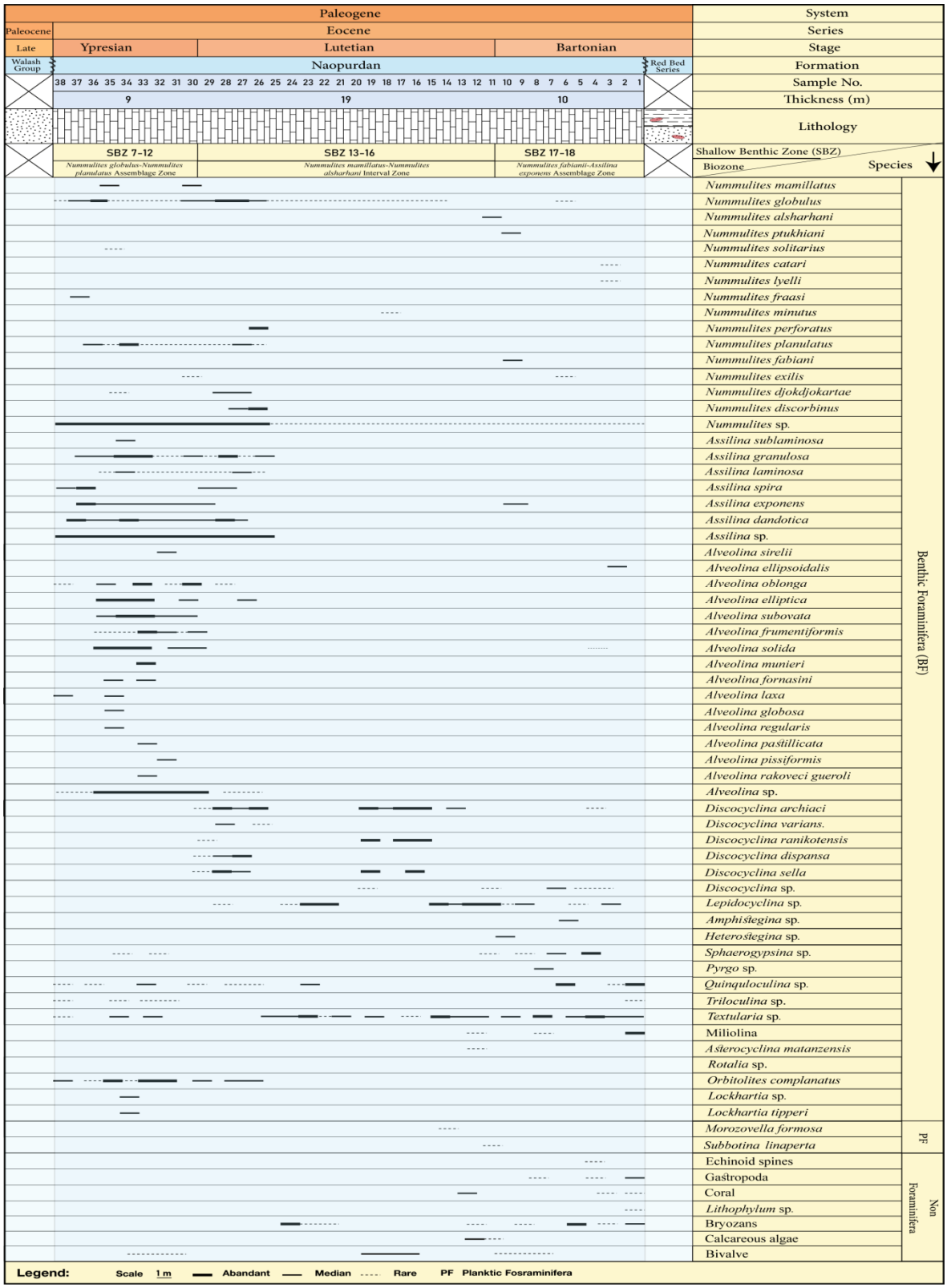

Fig. 4. Biostratigraphy of the Naopurdan Group at the Chuwarta area of the studied section.

1- *Nummulites globulus* - *Nummulites planulatus* Assemblages Zone (Ypressian). SBZ 7-12

Definition: It is characterized by the association of the taxa *Nummulites mamillatus, Nummulites globulus* and *Nummulites planulatus*).

Boundaries:The lower boundary of this zone is marked by the First Appearance Datum (FAD) of Nummulites globulus and Nummulites planulatus., whereas its upper boundary is marked by the Last Appearance Datum (LAD) of *Nummulites mamillatus.*

Thickness: 9m represented by the samples (30–38).

Remarks: The most diagnostic species include: *Nummulites globulus, Nummulites planulatus, Nummulites exilis, Nummulites djokdjokartae, Nummulites mamillinus, Nummulites fraasi, Nummulites solitaries, Nummulites minutus, Nummulites* sp., *Alveolina oblonga, Alveolina laxa, Alveolina globula, Alveolina regularis, Alveolina globosa, Alveolina pastillicata, Alveolina pissiformis, Alveolina munieri, Alveolina* sp., *Assilina spira, Assilina exponens, Assilina dandotica, Assilina sublaminosa, Assilina granulosa, Assilina laminosa, Assilina elliptica, Assilina subovata, Assilina frumentiformis, Assilina solida, Assilina fornasinii, Assilina laxa, Assilina* sp., *Sphaerogypsina* sp., *Quinqueloculina* sp., coral, pelecypods, gastropods, echinodermata, bryozoan and algae.

Correlation and Age Determination: This zone is equivalent to *mossoluensis-carbarica-trempina-oblonga-dainelli-violae* zone of Hottinger (1960) of Ypressian age, and correlated to the SBZ 7-12 Zone of Serra Kiel, et al.(1998), to the BFZK1A - BFZK2- BFZK 3A-BFZK 3B zone of Ahmad (2010) (Fig. 5), who considered it of Ypressian age.

Age: Early Eocene (Ypressian).

2- *Nummulites mamillinus - Nummulites alsharhani* Interval zone (Lutetian) SBZ 13-16

Definition: This zone represents the stratigraphic range of the index species *Nummulites mamillinus* which precedes the appearance of *Nummulites alsharhani*.

Boundaries: The lower boundary of this zone is marked by the Last Appearance Datum of *Nummulites mamillatus*, whereas its upper boundary is marked by the Last Appearance Datum (LAD) of *Nummulites alsharhani.*

Thickness: 19m represented by the samples (11–29).

Remarks: This zone is recorded from the middle part of the studied section, and the most diagnostic species include*: Nummulites alsharhani, Nummulites globulus, Nummulites perforates, Nummulites planulatus, Nummulites djokdjokartae, Nummulites discorbinus, Assilina granulosa, Assilina laminosa, Assilina spira, Assilina exponens, Assilina dandotica, Alveolina oblonga, Alveolina elliptica, Discocyclina archiaci, Discocyclina varians, Discocyclina ranikotensis, Discocyclina sella, Discocyclina dispansa, Discocyclina* sp., *Lepidocyclina, Sphaerogypsina* sp., miliolina, *Asterocyclina matanzensis, Quinquloculina* sp., *Morozovella formosa, Subbotina linaperta,* coral, bryozoans and calcareous algae.

Correlation and Age Determination: This zone is apparently equivalent to *stips-munieri-proerecta* zone which is described by (Hottinger 1960), of Lutetian age, and correlated to the SBZ13-to lower part of SBZ17 zone of Serra-Kiel, et al. (1998), to the BFZK 4- the BFZK5- the BFZK 6 zone of Ahmad (2010). Locally in Iraq, this zone is correlated with *Hantkenina alabamensis-Acaranina bulbrooki* zone of Karim and Al-Kubaysi (2015), to the *Acaranina bulbrooki-Catapsydraz dissmilis-Morozovella lehneri* zone of Ghafor and Al-Qayim (2021) and finally it is correlated to the *Nummulites gizehensis- Nummulites mouculatus* zone of Al-Qayim and Ghafor (2022). (Fig. 5), who considered it of Lutetian age.

Age: Middle Eocene (Lutetian)

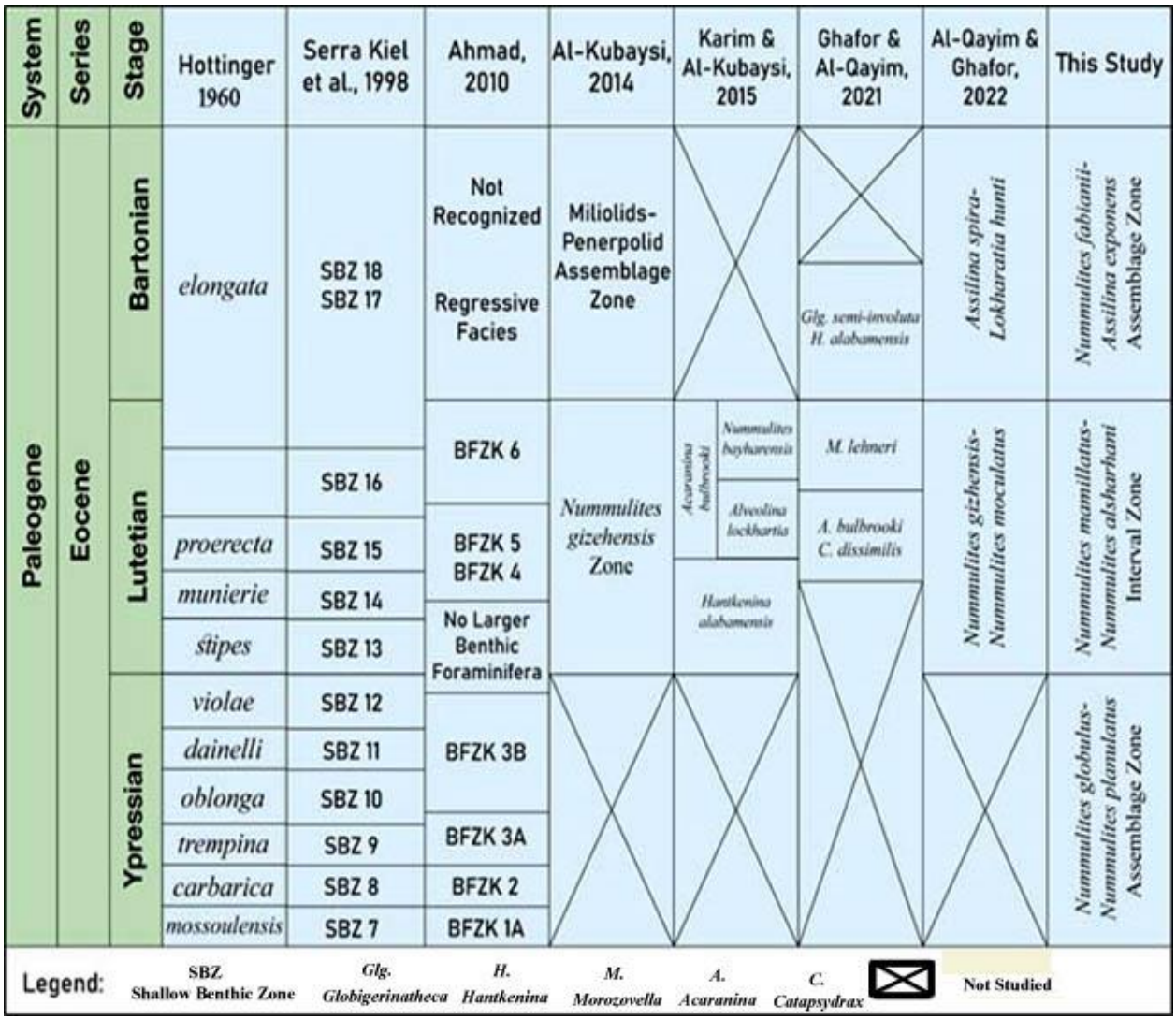

Fig. 5. Comparisons of zonal schemes of the studied section with those proposed by some authors.

3- *Nummulites fabianii - Assilina exponens* Assemblages Zone (Early Bartonian) SBZ 17-18

Definition: This zone represents the stratigraphic range and association of the taxa *Nummulites fabianii, Nummulites catari* and *Assilina exponens*.

Boundaries: it is represented by the First Appearance Datum (FAD) of *Nummulites fabianii* and *Assilina exponens*), and the Last Appearance Datum (LAD) of *Alveolina ellipsoidalis*. Thickness: 10m represented by the samples (1–10).

Remarks: The zone is recorded from the upper part of the section, and the most diagnostic species include*: Nummulites ptukhiani, Nummulites fabianii, Nummulites alsharhani, Assilina exponens, Alveolina ellipsoidalis, Discocyclina* sp., *Lepidocyclina* sp., *Heterostegina* sp., *Sphaerogypsina* sp., *Quinqueloculina* sp., *Pyrgo* sp., Miliolina, coral, bryozoans, *Lithophyllum* sp., and gastropods shell.

Correlation and Age Determination: This zone is apparently equivalent to elongate zone which is described by Hottinger (1960), of early Bartonian age, and correlated to the SBZ 17-18 zone of Serra-Kiel, et al. (1998), Locally in Iraq, this zone is correlated with Miliolids-peneroplid zone of Al-Kubaysi (2014), to the *Globigerina semiinvoluta- Hantkenina alabamensis* of Ghafor and Al-Qayim (2021), and finally it is correlated to the *Assilina spira- Lokharatina* hunti zone of Al-Qayim and Ghafor (2022), who considered it of early Bartonian age.

Age: Middle Eocene (Early Bartonian)

Discussion

The difference in age-dating of the studied area is explained by that the stratigraphic succession of the Naopurdan Group at Chwarta has difference in age; whereas at Chwarta, the Nummulitic limestone of the Naopurdan Group is considered as the lower part of the Naopurdan Group, which overlays the Red Bed Series of the Paleocene. The depositional sediments of the Iraqi red-bed basin were oriented NW–SE and bordered by the sea to the SW and a continental block to the NE (Bellen, et al. 1959). The palaeogeography of the continental block that acted as the source for most of the red-bed components is composed of three main units: (1) the Zagros Fold Belt; (2) the narrow Zagros Thrust Zone; and (3) the Sanandaj– Sirjan Zone that forms the western area of the Iranian plate.

The general larger benthic foraminifera in the section implies shallowing of the depositional environment. According to the previous studies Upper Paleocene–Middle Eocene was determined for Walash-Naopurdan Group sediments. Al-Qayim, et al. (2013) recorded the Early Eocene age of the group by direct dependence on the assemblages of foraminifera. Middle Eocene (Lutetian) age was recorded for Walash-Naopurdan Group by Al-Banna and Al-Mutwali (2008), and Kharajiany (2018). Daoud (2019) studied the Nummulitic Limestone of the group and determined the Late Paleocene - Early Eocene age. Finally Ahmad, et al. (2022), recorded the middle Eocene/Lutetian age of the group. But the interpretation of the present work at Chwarta section which is studied for the first time in detail with the viewpoint of microfossils and biostratigraphy is interpreted as that the studied area is rich in large benthic foraminifera with few planktic foraminiferas in addition to microfossils of non-foraminifera and the age of Naopurdan Group is shown to be close to Ypressian-Early Bartonian, as follows:-

a- *Nummulites globulus -Nummulites planulates* assemblage Zone. Ypressian age:

(Ghazi, et al. 2010; Racy, 2016; Shreif, et al. 2019; Hadi, et al. 2021; Okur and Kutluk 2020) recognized these benthic foraniminifera from the Ypressian age *Alveolina laxa, Alveolina globula, Alveolina regularis, Alveolina globosa, Alveolina pastillicata, Alveolina pissiformis, Alveolina rakoveci gueroli, Alveolina sirelii, Nummulites fraasi, Nummulites solitaries, Nummulites minutus, Lockhartia tipperi Davies, Lockhartia conditi.*

b- *Nummulites mamillatus- Nummulites alsharhani* Interval Zone. Lutetian age:

According to Olempska (1973) and Boukhary et. al. (2002), these benthic foraminifera (*Nummulites alsharhani, Discocyclina varians, Discocyclina ranikotensis*), are the index fossils of the Lutetian age.

c- *Nummulites fabianii - Assilina exponens* assemblage Zone. Bartonian age:

Bartonian age is defined based on these index benthic foraminifera (*Nummulites ptukhiani, N. perforatus, Nummulites catari*), (Kövecsi, et al. 2015; Saraswati, et al. 2017).

Conclusion

The examination of the early Eocene section from the Naouprdan Group at the Imbricate/Thrust Zone from the Kurdistan region of northeast Iraq reveals important conclusions which can be summarized as follows:

a. The sequence generally consists of shallow marine carbonates depending on the large number of benthic foraminifera.

b- Three Larger benthic foraminiferal biozones are recognized that unified from old to young: *Nummulites globulus-Nummulites planulatus* Assemblage Zone; *Nummulites mamillatus-Nummulites alsharhani* Interval Zone and *Nummulites fabianii-Assilina exponens* Assemblage Zone. From this it is concluded that the age of the section extends from Early to Middle Eocene (Ypressian to Early Bartonian).

c- Biostratigraphic correlations with other biozones from other parts inside and outside of Iraq.

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Plate 1

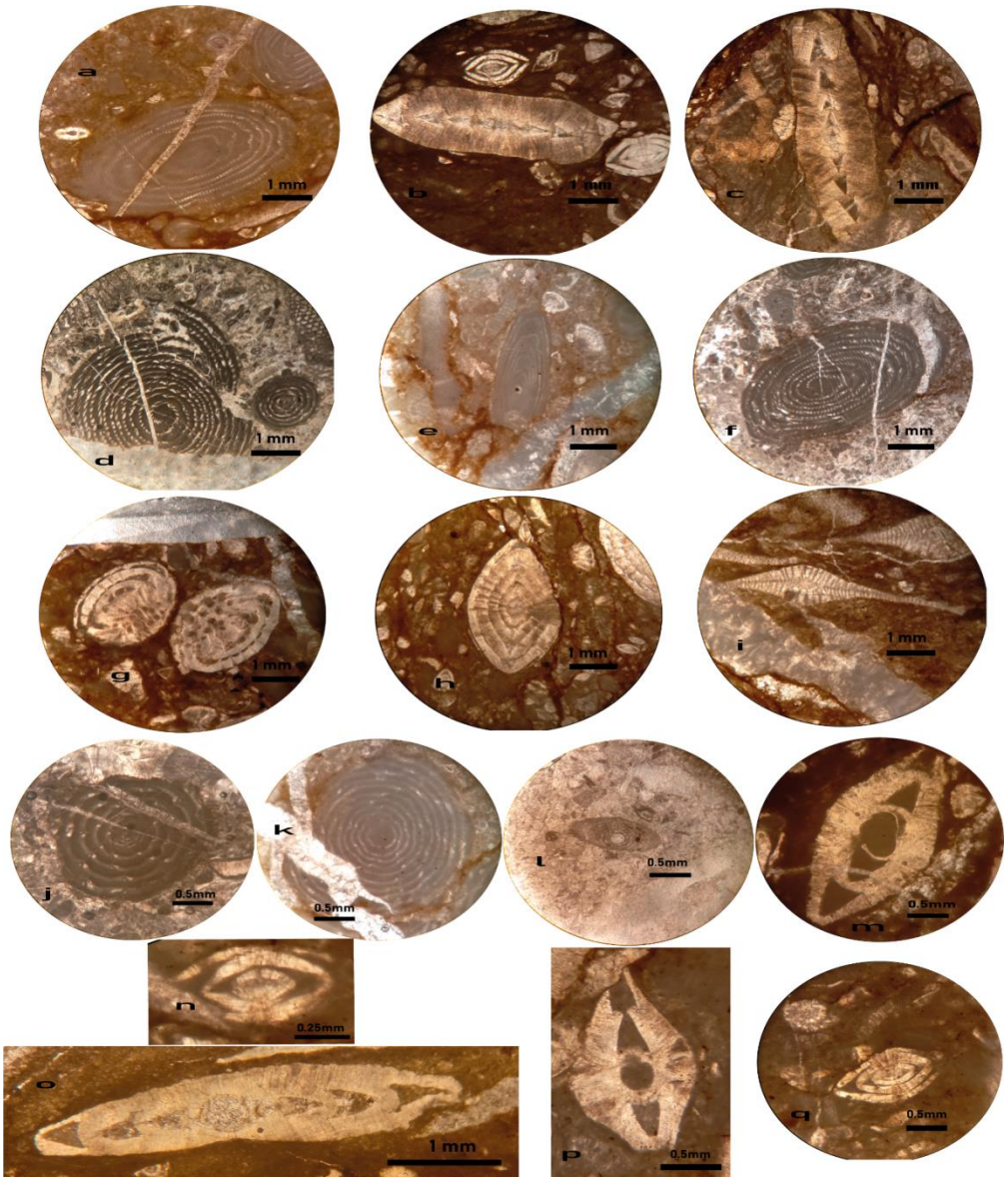

Plate 1: a. *Alveolina elliptica* (Sowerby, 1840), oblique section, sample 33; b. *Assilina granulosa* (d'Archiac, 1850), axial section, sample 26; c. *Assilina dandotica* (Davies, 1937), axial section, sample 32; d. *Alveolina solida* (Hottinger, 1960), axial section, sample 35; e. *Alveolina frumentiformis* (Schwager, 1883), oblique section, sample 33; f. *Alveolina subovata* (Wan, 1990), oblique section, sample 35; g. *Nummulites planulatus* (Lamarck, 1804), equatorial section, sample 34; h. *Nummulites globulus* (Leymerie, 1846), axial section, sample 30; i. *Discocyclina ranikotensis* (Davies, 1927), equatorial section, sample 38; j. *Alveolina laxa* (Hottinger, 1960), axial section, sample 1; k. *Alveolina oblonga* (d'Orbigny, 1826), axial section, sample 33; l. *Alveolina fornasinii* (Checchia-Rispoli, 1907), axial section, sample 35; m. *Assilina laminosa* (Gill, 1953), axial section, sample 36; n. *Nummulites exilis* (Douvillé, 1919), axial section, sample 30; o. *Assilina spira* (Roissy, 1805), axial section, sample 37; p. *Assilina dandotica* (Davies, 1937), axial section, sample 27; q. *Nummulites mamillinus* (Douvillé, 1924), axial section, sample 30.

Plate 2

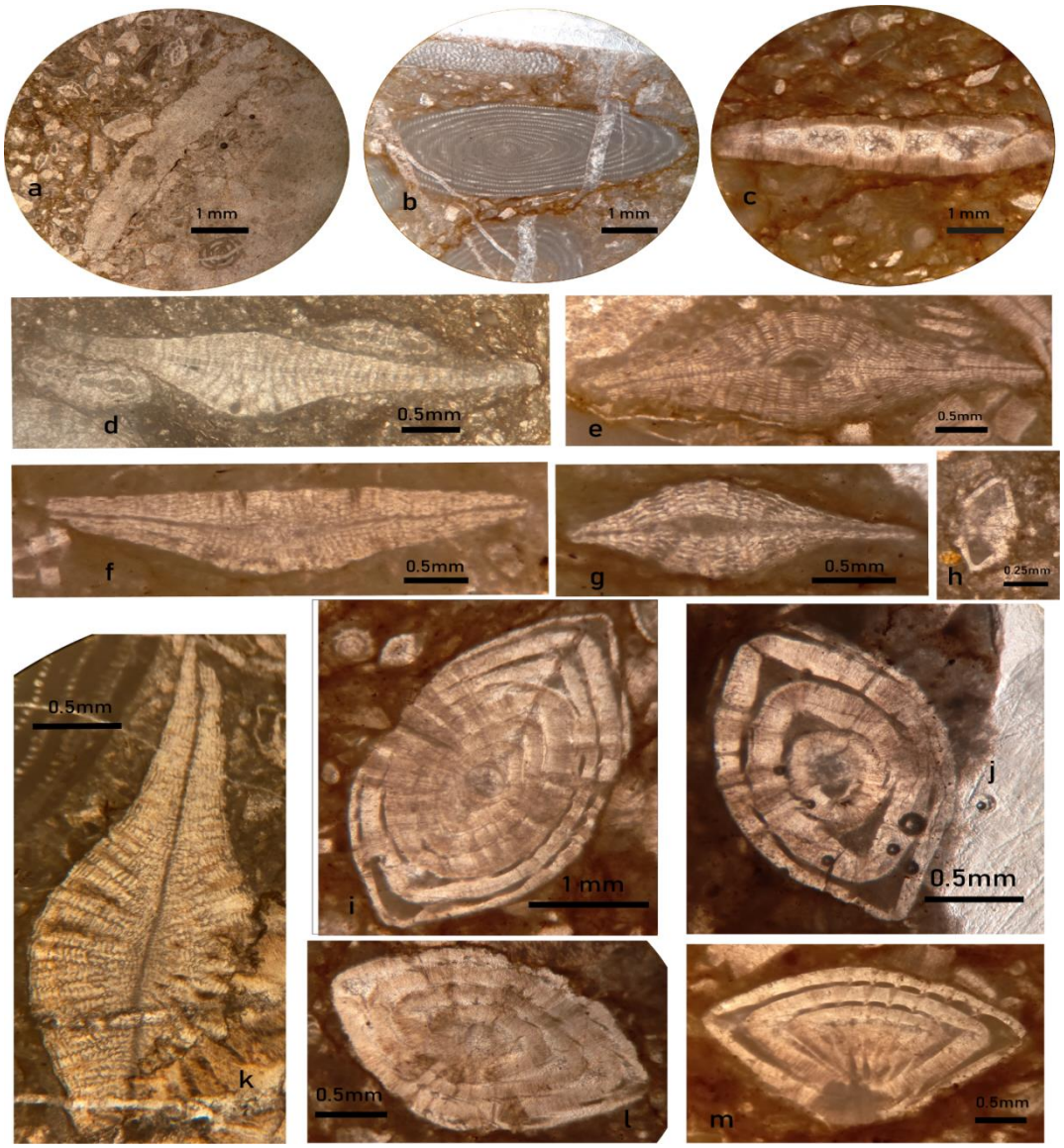

Plate 2: a. *Discocyclina sella* (d'Archiac, 1850), equatorial section, sample 27; b. *Alveolina munieri* (Hottinger, 1960), axial section, sample 33; c. *Assilina exponens* (Sowerby, 1840), axial section, sample 34; d. *Discocyclina archiaci* (Schlumberger, 1903), equatorial section, sample 18; e. *Lepidocyclina* sp., equatorial section, sample 28; f. *Discocyclina varians* (Kaufmann, 1867), equatorial section, sample 28; g. *Discocyclina* sp., equatorial section, sample 26; h. *Morozovella formosa* (Bolli 1957), axial section, sample 14; i. *Nummulites perforatus* (Montfort, 1808), axial section, sample 26; j. *Nummulites discorbinus* (Schlotheim, 1820), sub-axial section, sample 26; k. *Discocyclina dispansa* (Sowerby, 1840), equatorial section, sample 28; l. *Nummulites globulus* (Leymerie, 1846), sub-axial section, sample 34; m. *Nummulites djokdjokartae* (Martin, 1881), sub-axial section, sample 27.

Plate 3

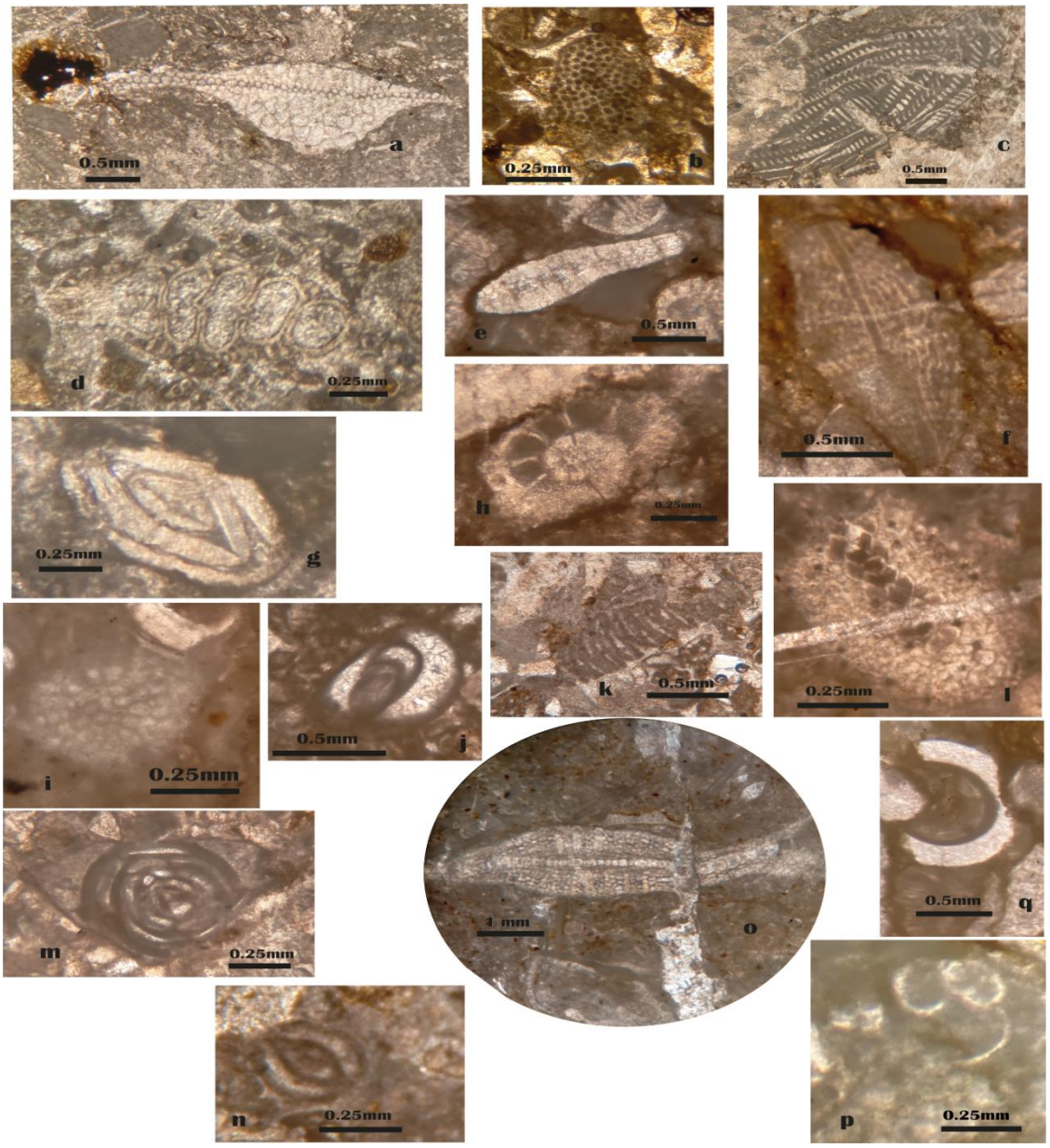

Plate 3: a. *Discocyclina archiaci* (Schlumberger, 1903), axial section, sample 4; b. Coral, equatorial section, sample 1; c. *Alveolina ellipsoidalis* (Schwager, 1883), oblique section, sample 2; d. Gastropoda, axial section, sample 4; e. *Heterostegina* sp., axial section, sample 10; f. *Asterocyclina matanzensis* (Cole 1957), equatorial section, sample 12; g. *Nummulites fabianii* (Prever, 1905), sub-axial section, sample 10; h. *Heterostegina* sp., equatorial section, sample 10; i. *Sphaerogypsina* sp., equatorial section, sample 5; j. *Pyrgo* sp., oblique section, sample 8; k. *Lithophylum* sp., oblique section, sample 1; l. Bryozoan, equatorial section, sample l3; m. *Quinqueloculina* sp., equatorial section, sample 6; n. Miliolina, equatorial section, sample 1; o. *Discocyclina* sp., equatorial section, sample 5; p. *Subbotina linaperta*, equatorial section, sample 11; q. calcareous algae, oblique section, sample 11.

Plate 4

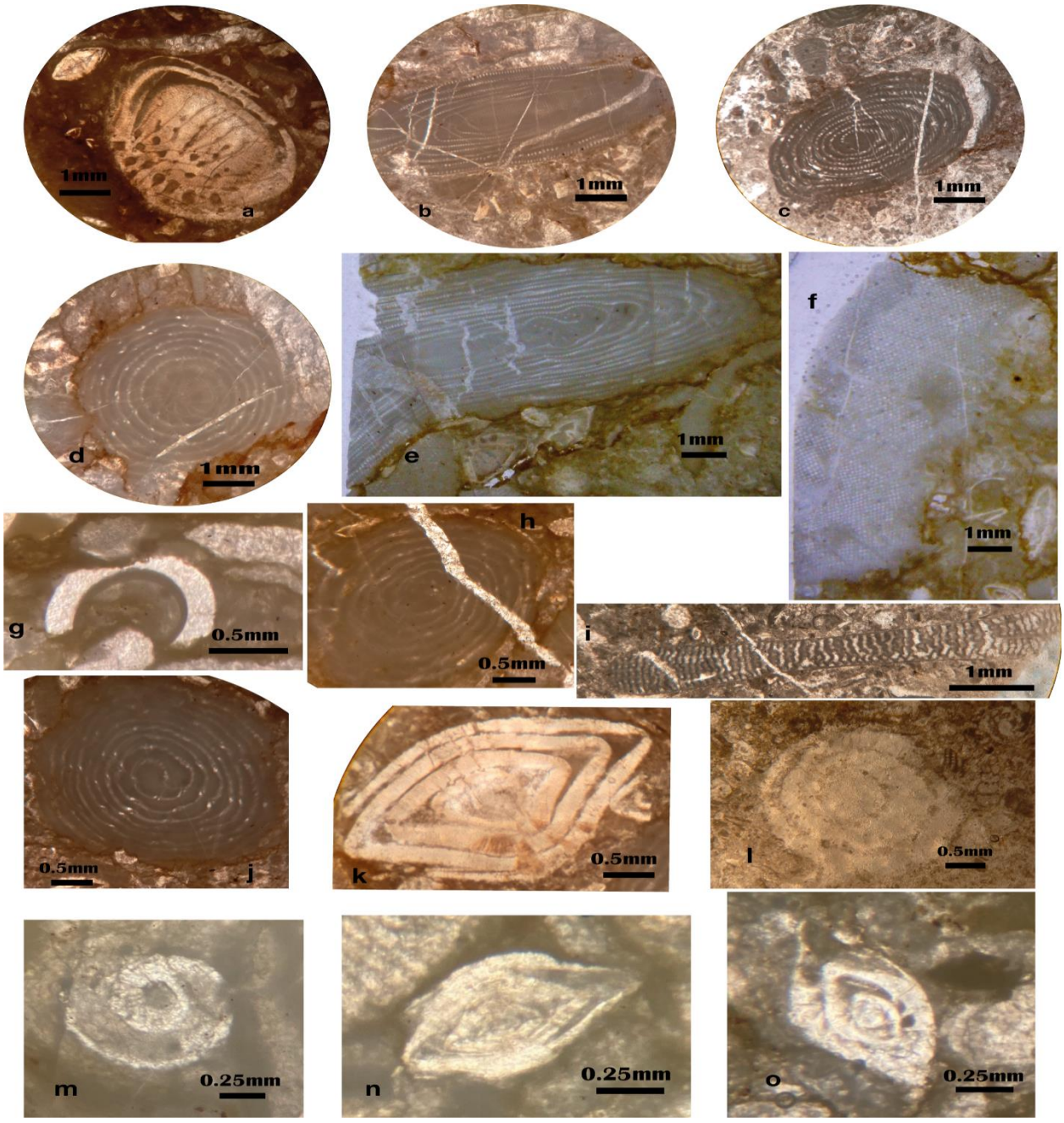

Plate 4: a. *Lockhartia tipper*, equatorial section, sample 34; b. *Alveolina sirelii*, oblique section, sample 32; c. *Alveolina regularis* (Hottinger, 1960), oblique section, sample 35; d. *Alveolina pissiformis*, axial section, sample 32; e. *Alveolina rakoveci gueroli* (Drobne, 1977), oblique section, sample 33; f. *Orbitolites complanatus* (Lamarck), axial section, sample 33; g. Calcareous algae, sample 11; h. *Alveolina pastiliicata*, oblique section, sample 33; i. *Orbitolites complanatus* (Lamarck), equatorial section, sample 35; j. *Alveolina globosa* (Leymerie), oblique section, sample 35; k. *Nummulites mamillatus* (Fichtel and Moll, 1798), sub-axial section, sample 35; l. *Nummulites solitaries*, equatorial section sample 35; m. *Nummulites catari*, equatorial section, sample 3; n. *Nummulites ptukhiani* (Z.D. Kacharava, 1969), sub-axial section, sample 10; o. *Nummulites alsharhani*, sub-axial section sample 11.