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Research Article

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New Contribution to the Biostratigraphy of Naopurdan Limestone Formation (Eocene), Sulaimaniyah, Kurdistan Region, Northeastern Iraq

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Abstract

Forty- nine samples were collected for a biostratigraphic study of the Naouprdan Formation to determine the age of its strata. The studied section is located within the Zagros High Fold and Thrust Belt, from the Bulfat area, Sulaimaniyah, Kurdistan Region/northeastern Iraq. The lithology of the succession here is composed of grey fine-grain of limestone with Nummulites and Alveoloina, the whole section is highly deformed and fractured. Hence, for the first time, this limestone unit is described in detail; it is a 48 m bed of grey fine-grain, Alveolinidae-Nummulitidae limestone. It bears a frequent number of large benthic foraminifera that are concentrated within the limestone bed. The identified benthic foraminifera are of the groups: Nummulitidae; Alveolinidae; Acervulinidae; Rotaliidae; Linderinidae; Linderinidae; Hauerinidae; Textulariidae; Textulariidae. A detailed study of the microfossil assemblages of the Naouprdan Formation revealed the occurrences of (53) species of benthic foraminifera belonging to (23) genera. The stratigraphic distribution of benthic foraminifera permits the recognition of four biozones. These are from the bottom to the top of the section: Alveolina oblonga-Nummulites djokdjokartae Interval Zone, Nummulites djokdjokartae Total Range Zone, Nummulites fabiani Total Range Zone, and Alveolina leupoldi-Alveolina elliptica Interval Zone. This section is described for the first time.

Keywords: Stratigraphy, Benthic Foraminifera, Naouprdan Formation, Early Middle Eocene, Kurdistan Region, Northeastern Iraq

1. Introduction

According to Hamza, the Naopurdan Group now known as the Naopurdan Formation is cropped out in different localities in northeastern Iraq, among different outcrops the well-exposed and distant location is selected to study [1]. The studied area is the Dawzhan section, which is located within Sulaimaniyah Governorate, geologically at the periphery of the Bulfat complexes. Dawzhan section, which is located 5 Km at NE of Issewa Sub-District directed to the north of Dawzhan village at latitude (N: 36° 3'0.87") and longitude (E: 45°21'10.83") nearly 68 km northwest of Sulaimaniyah city (Fig. 1).

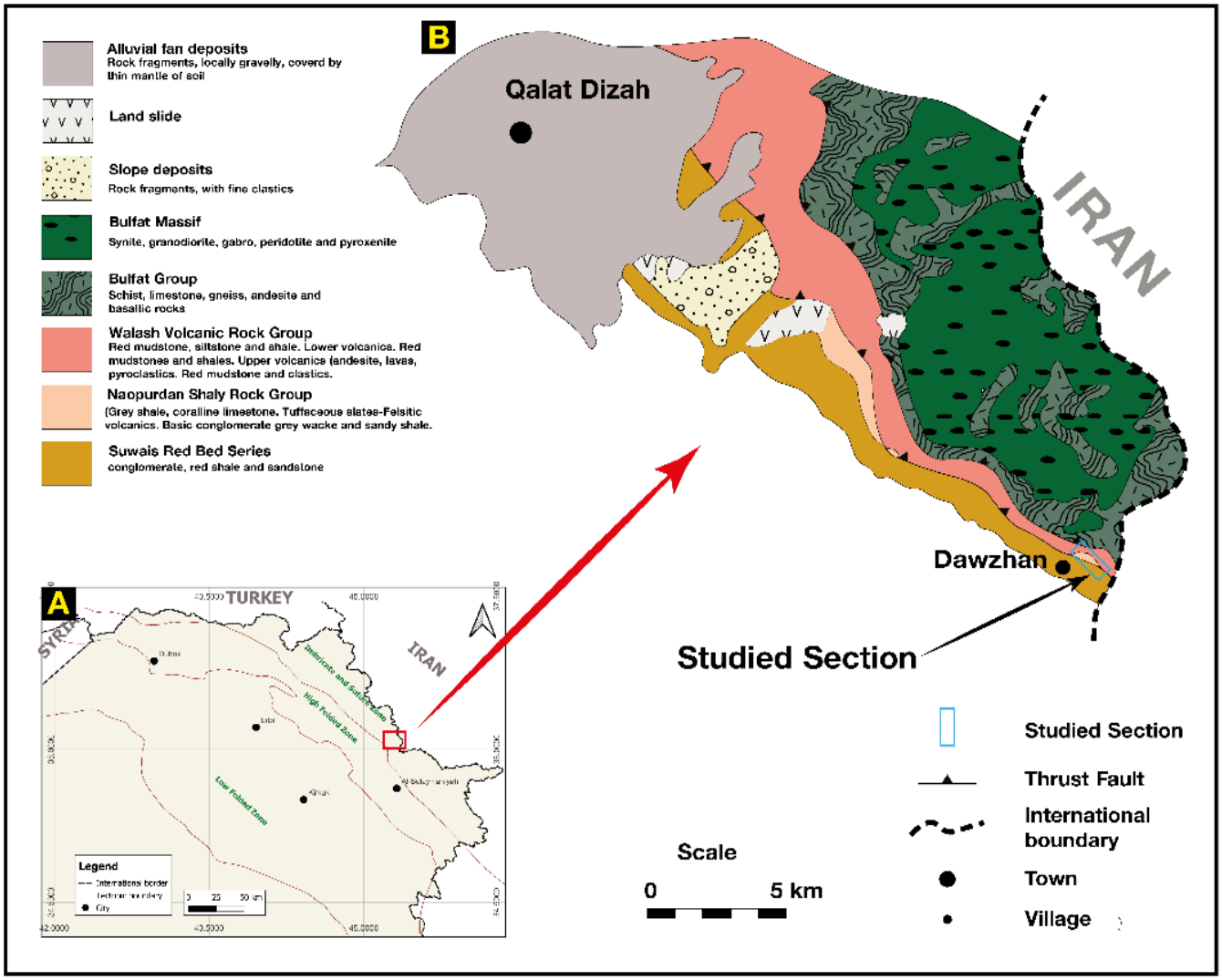


Figure 1: Location Map of the Studied Section; **(A)** Tectonic Map of Iraq after **(B)** Location Map of the Study Area [2].

Bolton, defined these two groups in the Thrust Zone of Iraq in the Suture Zone between Arabian and Iranian Plates in the northern part of the Erbil Governorate, near Choman Town. According to the latter author, each group has more than 1000m of thickness, but this study considered that this thickness is apparent and the true thickness is not more than 400 m [3]. This high apparent thickness is most possibly due to intense deformations such as folding and faulting. Buday and Jassim and Goff, discussed in detail the problems and controversy of these groups regarding their distribution, age, lithology, stratigraphy, and mutual relationship. According to these authors, the Naopurdan Group consists of fossiliferous limestone, and clastic sedimentary rocks (shale, greywackes, and conglomerate) with a minor share of volcanic rocks [5 ,6]. The Naopurdan Formation is resemblance in age and stratigraphic setting to the Sinjar Formation [1].

2. Lithostratigraphy

The Naopurdan Formation lithologically holds many varieties of rock types. They are divided into the Naopurdan-type subgroup, which comprises intercalated sedimentary and volcanic units, and the Sidekan-type subgroup, which is composed only of sedimentary rocks. The Naopurdan-type subgroup from the type locality was subdivided into six units according to Buday and Jasim, from the bottom [6]:

1. 500 m of grey shales with thin beds of green greywacke. Lenticular conglomerates (with pebbles of basic volcanic), Lenticular limestone, and sills of basic volcanic are associated with red mudstones, jaspers, limestones, and radiolarites.
2. 150 m of coralline limestone overlying by massive lenticular Nummulitic limestones capped by red shales; the Nummulites indicate a Paleocene-Early Eocene age.
3. 250 m of tuffaceous slates and shales with occasional basic pillow lavas.
4. 200 m of andesite volcanic, comprising lavas, agglomerates, and tuffaceous beds; this unit is laterally discontinuous.
5. 400 m of thin-bedded argillaceous conglomerates and grit, the pebbles and grains of which consist almost entirely of basic volcanic rocks.
6. An upper unit (thickness not measured) of thin-bedded, grey gritty greywacke alternating with sandy shale referred to as the Choman Clastics. The pebbles are mostly of volcanic origin. This unit is dated as the Late Paleogene-Miocene age by Bolton,

but he did not provide a fossil list [3].
The Sidekan-type subgroup was described by on the north slopes of Jabal Hasr-i-Rust near Sidekan Town. This subgroup is also subdivided into six units in ascending order:

1. Multicolor grit and sandstone.
2. Purple and green silty shales and marls with subordinate sandstone beds with Nummulites of Paleocene-Eocene age. This unit may be equivalent to the grey Shaly beds (1) of the Naopurdan-type locality
3. Black bituminous limestones with Paleocene-Early Eocene fossils, Stevenson,)1957) may correlate with the coralline limestone horizon (2) of the Naopurdan-type area.
4. Reddish and greenish grits and slate with limestone and limestone breccia. These beds may correlate partly with the coralline limestone horizon and partly with the transitional horizon between units (1) and (2) of the type locality.
5. Naopurdan Needle Slate which may be equivalent to the slates of unit (3) of the Naopurdan type locality.
6. A Conglomerate, grit, and limestone unit. This unit is probably equivalent to the Choman clastics and of the Avdele Conglomerate.

The Naopurdan Group was deposited in a shallow environment, while the Nummulitic facies are deposited as shoals. The clastic beds include turbidities and shales with planktonic foraminifera In addition, they added the Naopurdan Formation which consists predominantly of flysch with volcanic units and Nummulitic limestone lenses deposited in a fore-arc region.

3. Studied Section

The Naopurdan Formation in the Dawzhan section reaches approximately 48 meters, its color is somehow darker and the limestones are very tough and fine-grained (Fig. 2). The whole section is highly deformed and fractured, this deformation as also supported by microscopic study (Fig. 3), and the section may contain some repeated intervals. a full lithological description of the Dawzhan section is described in Table (1). This study is the first attempt to study the mentioned section by means of paleontology and biostratigraphy

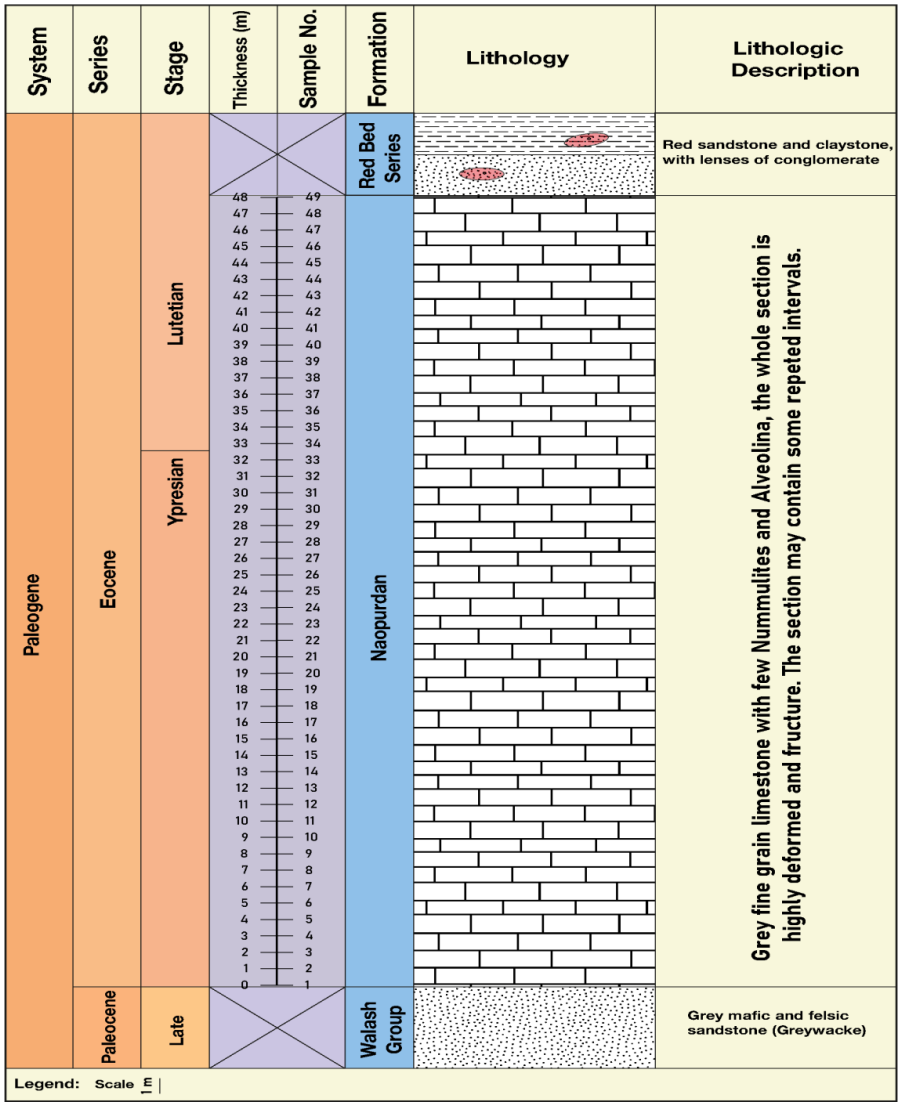


Figure 2: Lithostratigraphic Column of Late Paleocene- Early Eocene from Dawzhan Section, Issewa Sub-District, Sulaimani City.

Sample No.	Hand Specimen Descriptions
1-2	Grey limestone, highly fractured contain styllolites, no fossils and recrystallized.
3	Milky limestone, highly fractured contain styllolites, no fossils and recrystallized.
4-8	Dark grey, brecciated highly fractured, slightly recrystallized
9	Milky recrystallized limestone, fractured, no fossils
10	Dark grey, brecciated highly fractured, slightly recrystallized
15 and 23	Grey recrystallized limestone, vuggy and fractured.
11-14, 16- 22, 24-28	Light grey to grey recrystallized limestone, fractured no fossils observed.
29-31	Milky limestone, vuggy and brecciated, contain ghost of Alveolina and slightly recrystallized.
32	Grey limestone, highly fractured, contain ghost of Alveolina, slightly recrystallized
33	Grey limestone fractured, contain Nummulites, Alveolina, bioclast and lithoclast.
34	Light grey fine-grain limestone with small Nummulites.
35-36	Grey limestone contain Alveolina, bioclast and lithoclast.
37	Grey limestone contains Alveolina, bioclast, and lithoclast, slightly recrystallized.
38-43	Grey limestone contain Nummulites, Alveolina, bioclast and lithoclast.
44	Fine grain limestone fractured and slightly recrystallized, contain ghoste of Alveolina
45-46	Grey limestone contain Alveolina, bioclast and lithoclast.
47-48	Milky limestone is highly fractured with small Alveolina.
49	Fine grain limestone fractured and slightly recrystallized, no fossil can be observed

Table 1: Hand Specimen Descriptions for Samples of the Naopurdan Limestone Unit from the Dawzhan Section from Bottom to Top

4. Geological Setting

The studied area is located within the Zagros Suture Zone, specifically in the Penjwen-Walash subzone (Fig. 1), and tectonically, it is very complex in terms of structure, stratigraphy, and metamorphism [5]. They added that it represents the deformed oceanic domain of the middle part of the Neo-Tethys, which is made up of un-metamorphosed Paleogene fore-arc and volcanic arc rocks that formed during the final closure of the Neo-Tethys.

The outcrops in the study area elongate from the Iranian border near Penjwen town as a belt toward the NW which consists of sedimentary and metamorphic rocks. The metamorphism is concentrated in the central part of the Mawat and Bulfat area. These two complexes are surrounded by the Red Bed series and the Walash Naopurdan group. The main structural features of the zone are thrust sheets sometimes dislocated by reverse faults and consist of the top Qandil (structurally highest at the top), the middle Walash, and the structurally lowest Naopurdan [5,6]. clarified that the Naopurdan Series has a relatively wider distribution of outcrops in the Chwarta and Mawat areas compared to the neighboring areas due to indirect evidence of the subsidence of that area. The Naopurdan group cropped-out areas are subjected to different studies in the literature, which are summarized here.

divided Northeastern Iraq into three units: a) an anticline of Triassic limestone and shale, b) a folded mass of radiolarian chert and shale, c) a nappe of igneous and metamorphic rocks [7]. subdivided the thrust zone from northeast to southwest into [3,7]:-

1) The Thrust Zone (the igneous and metamorphic nappe of Heron and Lees), which consists of three tectonically bounded units, from bottom to top are the Naopurdan series, Walash series, and Qandil series.
2) The intermediate zone comprises the Cretaceous Qulqula series (units (a) and (b) of Heron and Lees) and the Red Beds series.
3) The Folded Zone.

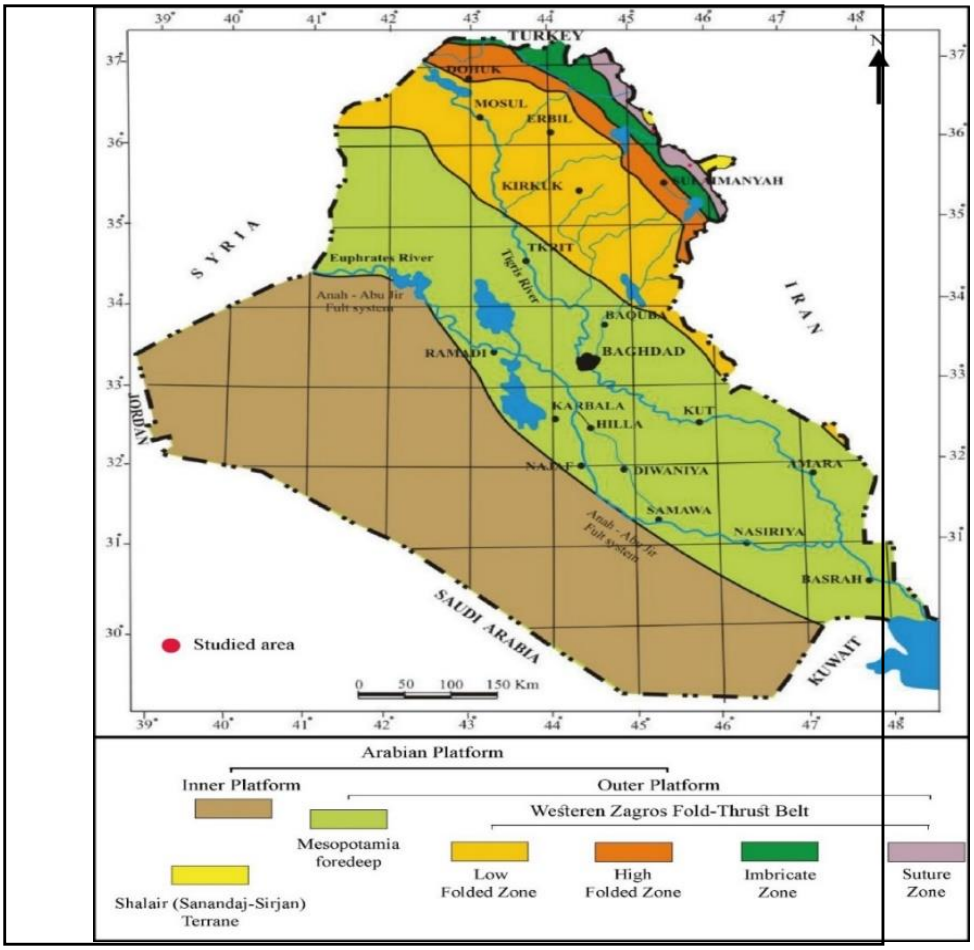


Figure 3: Location Map of the Studied Section

Bolton's intermediate zone was separated into two divisions by The Qulqula uplift and the "intermountain troughs" (The Red Beds). established the following classifications according to previous studies with some field research:

1) The Thrust Zone
a-The External Zagros Suture Zone (Qulqula subzone and Walash-Naopurdan subzone)
b-The Internal Zagros Suture Zone (equivalent to the Qandil series of Bolton)
2-The Imbricated Zone (including the Red Beds and the most northeastern part of the Fold Zone).
The outcrops of the Naopurdan Formation extend into Iran where they are mapped as thrust sheets of an unnamed unit of shale and limestone with volcanic rocks of Eocene. In SE Turkey, the group can be correlated with parts of the 2000 m Urse Formation of the Hakkari Complex. It may also correlate with the Cungus Formation (middle Eocene). Similarly, the Durnnkayn Formation may be equivalent to parts of the Naupordan Group explained that all exposed rocks in the Bulfat area consist of either fresh volcaniclastic sediments (sandstone, conglomerate, greywackes, and shale) or their regional metamorphosed equivalent rocks. According to field observation area around both studied sections appeared to be in robust agreement with the previously mentioned literature.

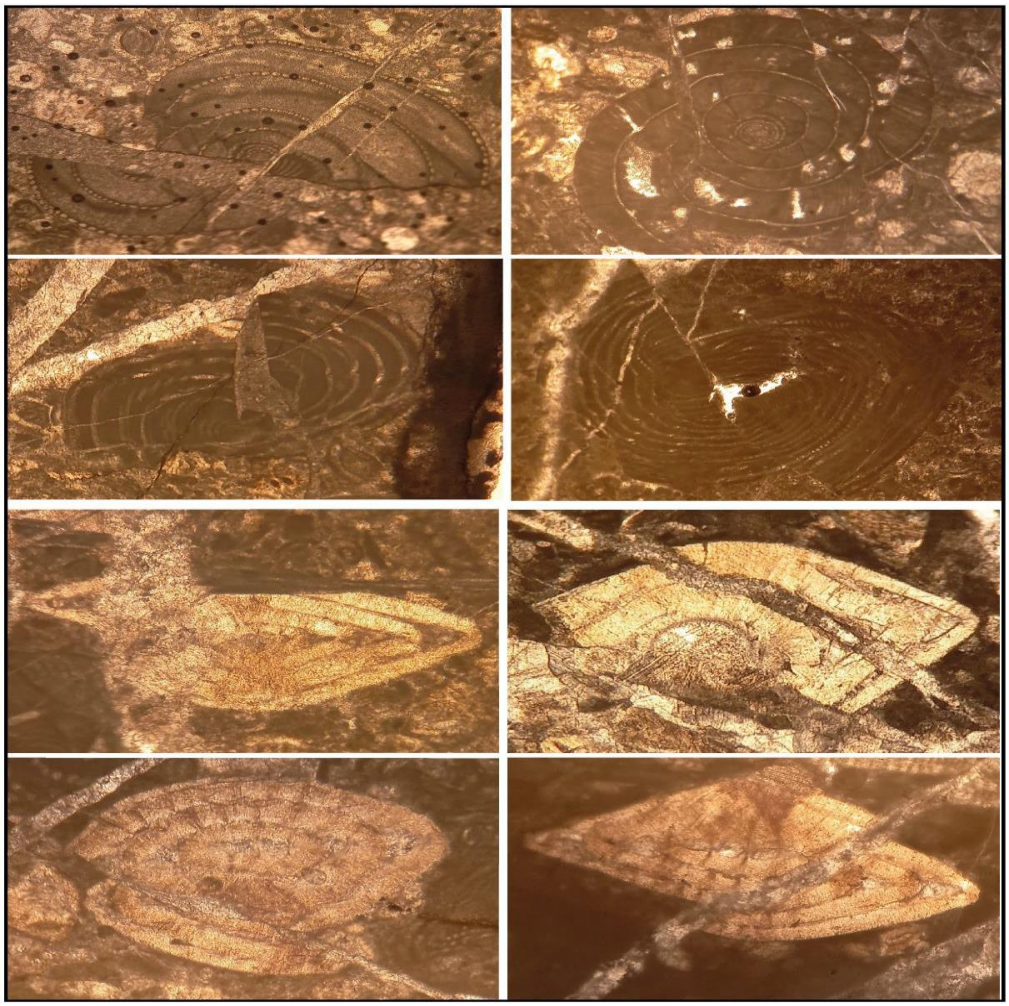


Figure 4: Broken Species and Displacement Due to High Tectonic Activity within the Studied Section

5. Materials and Methods

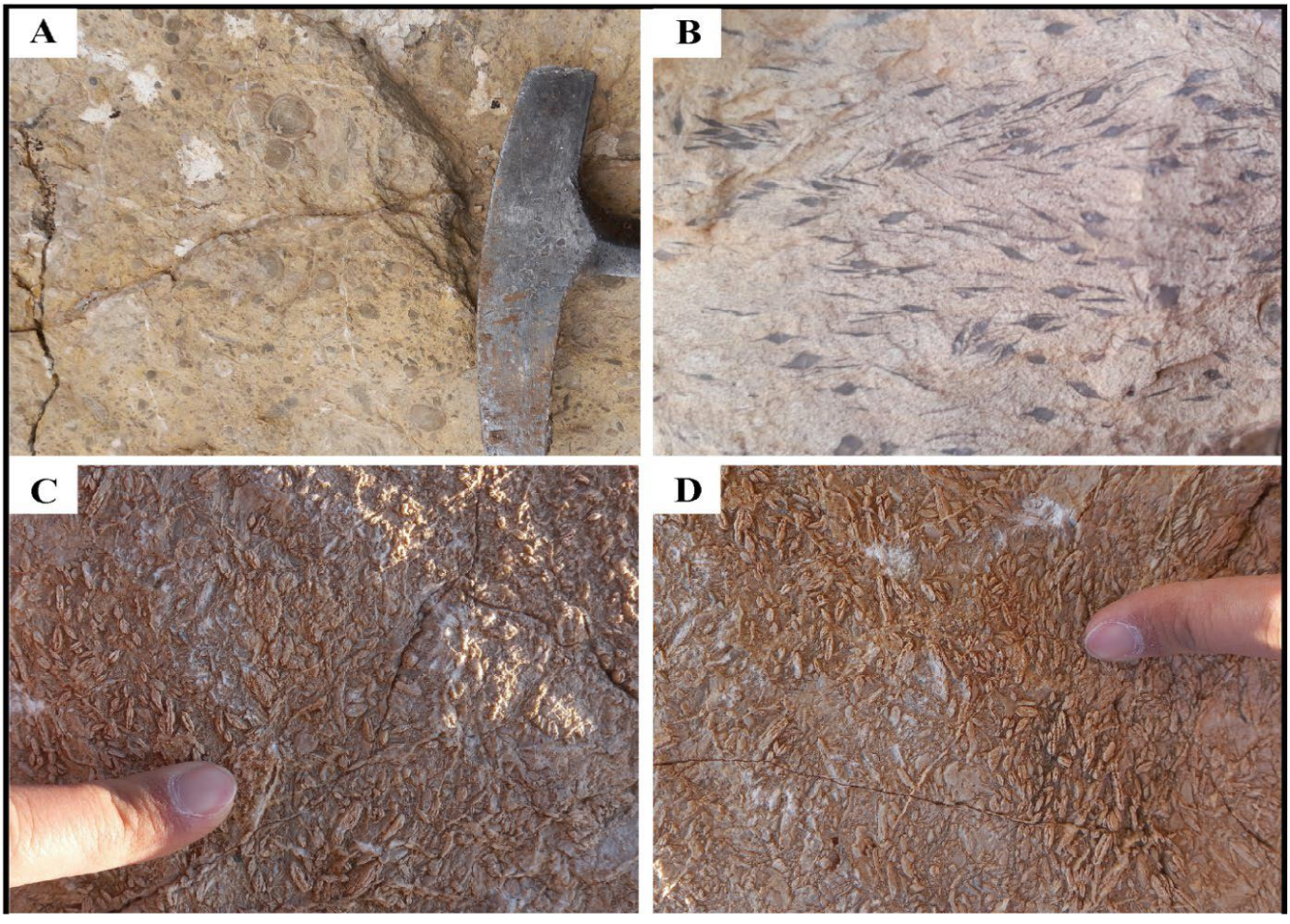
Surveying the area and collecting data are the first steps for this study. Additionally, fieldwork and sampling are good sources for obtaining data. Dawzhan section was selected for this study, (Figs. 5 and 6). Several field trips were conducted at different times to obtain more information and accurate data about the studied area. Totally 49 samples were picked up, and each sample was inspected with a 10X hand lens. 38 samples were taken at regular intervals of one meter, and from each sample, two thin sections were prepared in the perpendicular direction. The thin sections were studied under a binocular microscope to identify their foraminifera contents, and suitable pictures were taken for each index fossil using different magnifications. All thin sections were prepared in the lab. of the Department of Geology, College of Science, University of Sulaimani. The biozonation of the foraminifera is based on [8,9].

The aims of this study are as follows:

1-To identify the foraminiferal assemblages that occur in the studied Naopurdan limestone unit.

2-to establish the biostratigraphic zones and correlate them with their equivalent biozones in and outside Iraq in order to determine the age of the study section.

Figure 5: Field Photograph Showing the Exposed of Naopurdan Formation of the Studied Area



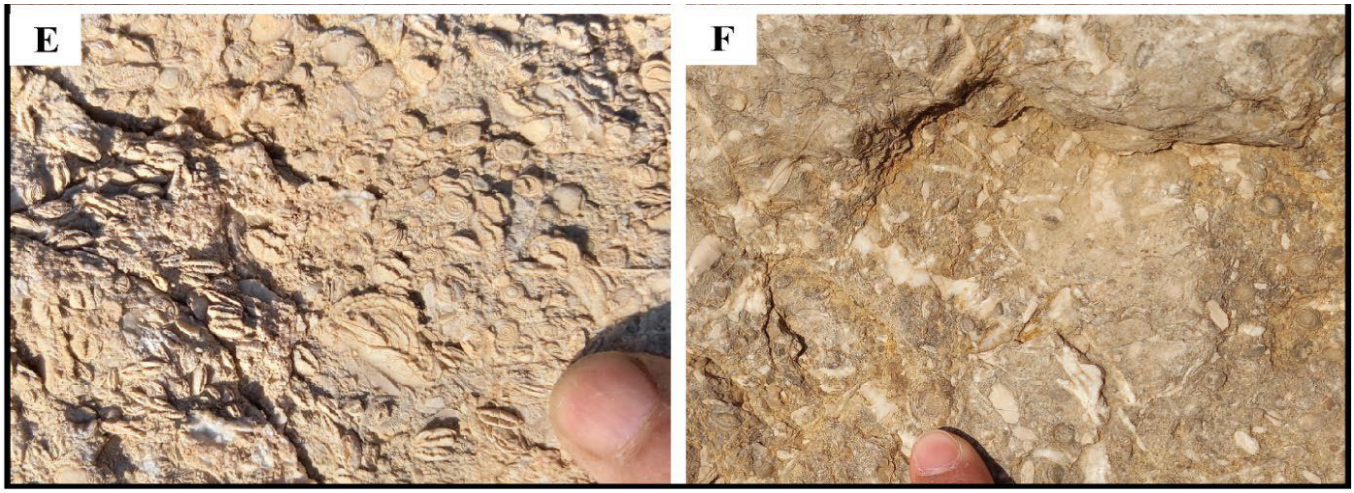


Figure 6: Field Photograph Showing the Microfossils from the Naopurdan limestone Unit, (A, C, D and E): Genera of *Nummulites, Assilina and Alveolina,* (B) *Discocyclina*, (F) *Nummulites*, and Algae

6. Previous Work

Since the early 1940s, research on the thrust sheet of northeastern Iraq has continued to obtain better insight into the area, and the research work of numerous authors has focused on the Naopurdan Formation (Previously Naopurdan Group). Bolton determined that the age of the group was proven by fossils as Paleocene-Oligocene or possibly Miocene. The limestone unit of the Naopurdan Shaly Group was originally dated using a biostratigraphic study by who estimated its age to be lower-middle Eocene. Al-Mehaidi, studied the Tertiary nappes in the Mawat range and stated that this nappe is underlain by Red Bed Series and Cretaceous rocks. Early Eocene strata from the Sinjar area, NW Iraq have been studied by [10 ,11]. According to Jassim and Goff , the Naopurdan Group was deposited in the Paleogene. Surdashy, determined the depositional environment of the limestone unit in the Naopurdan group from outcrops at the Chwarta and Mawat localities, depending on the microfacies and paleo communities, he recognized that this limestone unit was deposited during regression by the effect of the uplifting orogenic facies on the subduction zone of the Zagros in three major environments: a) the lower part deposited in the deep shelf margin, b) the middle part deposited in the open slope, and c) the upper part deposited in the shallow platform [12]. Furthermore, he also proved the relationship between tectonism and sedimentation at the time of postdeposition. Ghafor and Karim studied the Eocene rocks from Northeastern Iraq [13]. The Early to Late Danian rocks in the Shaqlawa area, NE Iraq, have been described by using spores and pollen [14]. Ghafor and Baziany, studied larger foraminifera from the former Qulqula Conglomerate Formation, Kurdistan Region, northeastern Iraq, and gave the age of the recorded fossils from upper Paleocene to middle Eocene which more likely belongs to the Walash-Naopurdan source area that was deposited during the upper Paleocene to middle Eocene. Three groups of larger foraminifera from the Red Bed Series, have been described by Ghafor and Qadir which more likely belong to the Walash–Naopurdan group [15]. Planktic and benthic foraminifera are used to study the early Eocene rocks in North and Northeastern Iraq Sharbazheri 16,17]. Ali shows that the composition of the Walash and Naopurdan clastic deposits varied systematically from Eocene to Oligocene time in response to changes in the rock types exposed to erosion in the back-arc and island arc environments prior to the closure and obduction of the Neotethys basin [18]. Al Fattah, studied benthic and planktic foraminifera from Early Eocene rocks in Sinjar, Shaqlawa, and Dohuk areas [19-22]. during his study on the Nummulitic limestone of the Naopurdan group from the Chwarta area, recognized four depositional microfacies (Packstone, Floatstone, Boundstone, and Wackestone) and established nine levels of microfauna distribution. In addition, the new paleoenvironment of the group was determined from the subtidal to the outer ramp, also confirming the age of the late Paleocene to the middle Eocene [23]. studied the Zagros Metamorphic Core Complex from Bulfat Mountain, Qala Diza Area, Kurdistan Region, Northeast Iraq. They mentioned the absence of igneous rocks and what previously called igneous rocks are metamorphosed greywacke of Walash-Naopurdan. Al Nuaimy, separated the Eocene sediments from Northeastern Iraq, based on the planktic and benthic foraminifera [24]. Walash and Naopurdan Groups are autochthonous sedimentary stratigraphic units that are metamorphosed regionally inside the two complexes [25]. considered the Walash, Kolosh, and Naopurdan groups (formations) as one sedimentary succession that was deposited in one basin during the same age and changed the name of the Walash group and Naopurdan group to the Walash Formation and Naopurdan Formation, respectively. Ahmad, studied the new contribution to the biostratigraphy of a foraminiferal condensed section within the Naopurdan Group, confirming the Lutetian age of the succession and demonstrating that the lithology of this limestone/condensed section is equivalent to that of the Avanah Formation [26]. Ghafor & Muhammad, studied the microfossils and biostratigraphy of marine Eocene deposits in the Naopurdan Group, Chwarta area, and assigned the age of the group as (early to middle Eocene) [27]. Finally studied the Eocene rocks from the Sinjar, Dokan, and Dhock areas.

7. Results and Discussion

7.1 Biostratigraphy

The study of 49 samples taken from the Dawzhan section, led to the identification of 104 species from 51 genera of Larger Benthic Foraminifera (LBF) and other microfossils such as

Echinoid fragments, bryozoans, red algae, green algae, bivalve fragments, coral, gastropods, and pelecypods (Fig. 7, plates 1, 2). Based on the larger benthic foraminifera, which appeared in relatively high variety and very abundant, four biostratigraphic zones were identified, from the lower part of the Dawzhan section, there is no evidence of fossils present, which may be due to recrystallization because the section is located in the high tectonic activity zone, recognized biozones are described below, starting from older to younger:

1-Alveolina oblonga-Nummulites djokdjokartae Interval Zone.
Definition: Biostratigraphic interval of this zone characterized by the interval of the nominate taxa (Alveolina oblonga d'Orbigny, 1826 and *Nummulites djokdjokartae* Martin, 1881)
Boundaries: The lower boundary of this zone is marked by the First Appearance Datum (FAD) of *Alveolina oblonga*, whereas its upper boundary is marked by the First Appearance Datum (FAD) of Nummulites *djokdjokartae*.
Remarks: The thickness of this zone is equal to 5m from samples 29 to 33 (Figure 4.2). The most diagnostic species include *Nummulites atacicus* Leymerie, 1846, *Nummulites globulus* Leymerie 1846, *Nummulites* sp., *Assilina granulosa* d'Archaic, 1850, *Assilina* sp., *Operculina* sp., *Lepidocyclina* sp., *Cuvillierina sirelii* Inan, 1988, *Rotalia trochidiformis* Lamarck, 1804, *Rotalia* sp., *Lockhartia conditi* Nuttall, 1926, *Lockhartia hunti* Ovey, 1947, *Lockhartia* sp., *Cibicides nammalensis* Haque, 1956, Alveolina cosigena Drobne, 1977, *Alveolina elliptica* Sowerby, 1840, *Alveolina globula* Hottinger, 1960, Alveolina aff. Haymanaensis Sirel, 1976, *Alveolinailerdensi* sHottinger,1960, *Alveolina laxa* Hottinger,1960, *Alveolinaoblongad'*Orbigny,1826, *Alveolina solida* Hottinger,1960, *Alveolina* sp., *Quinqueloculina* sp., Miliolid sp., Gastropod, Pelecypod, Bryozoan,Calcareous algae
Correlation: This zone is equivalent to the *cucumiformis-ellipsoidalis-moussoulensis-corbarica-trempina-oblonga-dainellii-violae* Alveolinid biozone of Hottinger, of the Ypresian age and correlated to the SBZ 5-12 of Serra-Kiel and to the BFZK 1B - BFZK2- BFZK 3A- BFZK 3B of who considered it of the Ypresian age [28]. Additionally, correlated to *pernotus-burdigalensis burdigalensis- burdigalensis cantabricus-campesinus* Nummulitid biozones of Schaub. It is equivalent to the Nummulites globulus-Nummulites planulatus zone of (Table 2) [27].

Age: Early Eocene (Ypresian).
2-*Nummulites djokdjokartae* Total Range Zone
Definition: Biostratigraphic interval of this zone is characterized by the total appearance of
Nummulites djokdjokartae Martin, 1881. Boundaries: The lower boundary of this zone is marked by the First Appearance Datum (FAD) of *Nummulites djokdjokartae*, whereas its upper boundary is marked by the Last Appearance Datum (LAD) of *Nummulites djokdjokartae*
Remarks: The thickness of this zone is equal to 5m from samples 34 to 38. The most diagnostic species include *Nummulites atacicus* Leymerie, 1846, *Nummulites globulus* Leymerie 1846, *Nummulites* sp., *Assilina granulosa* d'Archaic, 1850, *Assilina* sp., Operculina complanata Defrance in Blainville, 1822, Operculina sp., Ranikothalia sp., Discocyclina dispansa Sowerby, 1840, Discocyclina sp., Cuvillierina vallensis Ruiz De Gaona, 1948, Rotalia sp., Lockhartia cf. conditi, Lockhartia sp., Alveolina cosigena Drobne, 1977, Alveolina decipiens Schwager, 1883, Alveolina elliptica Sowerby, 1840, Alveolina globula Hottinger, 1960, Alveolina globosa Leymerie 1846, Alveolina laxa Hottinger, 1960, Alveolina cf. munieri, Alveolina palermitana Hottinger, 1960, Alveolina solida Hottinger, 1960, Alveolina sp., Periloculina sp., Triloculina trigonula Lamarck, 1804, Quinqueloculina sp., Textularia sp., Miliolid sp., Orbitolites complanatus Lamarck, 1801, Trinocladus sp., Soritid, Corals, Gastropod, Pelecypod, Ostracod, Echinoid spines, Echinodermata, Calcareous algae and Lithophylum sp.
Correlation: This zone is apparently equivalent to the stipes-munieri-prorrecta Alveolinid biozone, which is described by Lutetian age, and correlated to the SBZ 13- 16 of Serra-Kiel et al. to the BFZK 4- BFZK 5- BFZK 6 of and to the to the gallensis-obesus-beneharnensis-crasus-atauricus Nummulitid biozones of Locally in Iraq, this zone is correlated with the Nummulites gizehensis zone of Al- Kubaysi, to the Hantkenina alabamensis-Acaranina bulbrooki zone of Karim and Al- Kubaysi , to the Acaranina bulbrooki-Catapsydraz dissmilis-Morozovella lehneri zone of Ghafor and finally to the Nummulites gizehensis-Nummulites mouculatus zone of Al-Qayim and Ghafor , who considered it of Lutetian age [29 ,30,31]. It is equivalent to the Nummulites mamillatus-Nummulites alshahrani-Nummulites fabianii-Nummulites exponens zone of (Table 2) [27].
Age: middle Eocene (Lutetian)
3- Nummulites fabiani Total Range Zone
Definition: Biostratigraphic interval of this zone is characterized by the total appearance of Nummulites fabiani
Boundaries: The lower boundary of this zone is marked by the First Appearance Datum (FAD) of Nummulites fabianii, whereas its upper boundary is marked by the Last Appearance Datum (LAD) of Nummulites fabiani Remarks: The thickness of this zone is equal to 5m from samples 39 to 43. The most diagnostic species include Nummulites atacicus Leymerie, 1846, Nummulites subatacicus Douvillé, 1919, Nummulites cf. atacicus, Nummulites globulus Leymerie 1846, Nummulites partschi de La Harpe, 1880, Nummulites sp., Assilina sp., Operculina sp., Rotalia sp., Lockhartia sp., Linderina chapmani Halkyard, 1918, Cibicides nammalensis Haque, 1956, Alveolina cosigena Drobne, 1977, Alveolina elliptica Sowerby, 1840, Alveolina globula Hottinger, 1960, Alveolina globosa Leymerie 1846, Alveolina oblonga d'Orbigny, 1826, Alveolina palermitana Hottinger, 1960, Alveolina subovata Wan, 1990, Alveolina solida Hottinger, 1960, Alveolina sp., Glomalveolina lepidula Schwager, 1883, Triloculina trigonula Lamarck, 1804, Quinqueloculina sp., Miliolid sp., Gastropod, and Red algae.

Correlation: This zone is apparently equivalent to the lower part of Alveolinid elongata zone described by Hottinger , of early Bartonian age, correlated to the SBZ 17 of Serra-Kiel et al. (1998), and correlated to the lower part of the Nummulitid perforatus zone of Schaub (1981). Locally in Iraq, this zone is correlated with the lower part of Miliolids-peneroplid zone of Al-Kubaysi (2014), to the Globigerina semiinvoluta- Hantkenina alabamensis of Ghafor and Al- Qayim , and finally, to the lower part of Assilina spira- Lokharatia hunti zone of Al- Qayim and Ghafor, who considered it of early Bartonian age [31,32]. It is equivalent to the lower part of Nummulites fabiani- Assilina

exponens zone of
(Table 2) [27].
Age: Middle Eocene (Bartonian).
4-Alveolina leupoldi-Alveolina elliptica Interval Zone
Definition: Biostratigraphic interval of this zone is characterized by the interval of the nominate taxa (Alveolina leupoldi Hottinger, 1960 and Alveolina elliptica Sowerby, 1840)
Boundaries: The lower boundary of this zone is marked by the Fast Appearance Datum (FAD) of Alveolina leupoldi, whereas its upper boundary is marked by the Last Appearance Datum (LAD) of Alveolina elliptica.

Remarks: The thickness of this zone is equal to 6m from samples 44 to 49. The most diagnostic species include Nummulites globulus Leymerie 1846, Nummulites sp., Assilina sp., Operculina complanata Defrance in Blainville, 1822, Operculina sp., Ranikothalia sp., Discocyclina archiaci Schlumberger, 1903, Discocyclina dispansa Sowerby, 1840, Discocyclina sp., Lepidocyclina sp., Rotalia sp., Lockhartia hunti Ovey, 1947, Lockhartia sp., Alveolina cosigena Drobne, 1977, Alveolina elliptica Sowerby, 1840, Alveolina globulina Hottinger, 1960, Alveolina globosa Leymerie 1846, Alveolina laxa Hottinger, 1960, Alveolina leupoldi Hottinger, 1960, Alveolina palermitana Hottinger, 1960, Alveolina subovata Wan, 1990, Alveolina solida Hottinger, 1960, Alveolina sp., Glomalveolina lepidula Schwager, 1883, Triloculina trigonula Lamarck, 1804, Quinqueloculina sp., Valvulina sp., Miliolid sp., Orbitolites complanata Lamarck, 1801, Schlumbergerina sp.,

Correlation: This zone is apparently equivalent to the upper part of Alveolinid elongata zone described by Hottinger (1960) of early Bartonian age, correlated to the SBZ 18 of Serra-Kiel, and correlated to the upper part of Nummulitid perforatus zone of Locally, in Iraq, this zone is correlated with the upper part of Miliolids-peneroplid assemblage zone of and finally to the upper part of Assilina spira- Lokharatia hunti zone of who considered it of early Bartonian age. It is equivalent to the upper part of Nummulites fabiani- Assilina exponens zone of (Table 2).
Age: Middle Eocene (Bartonian

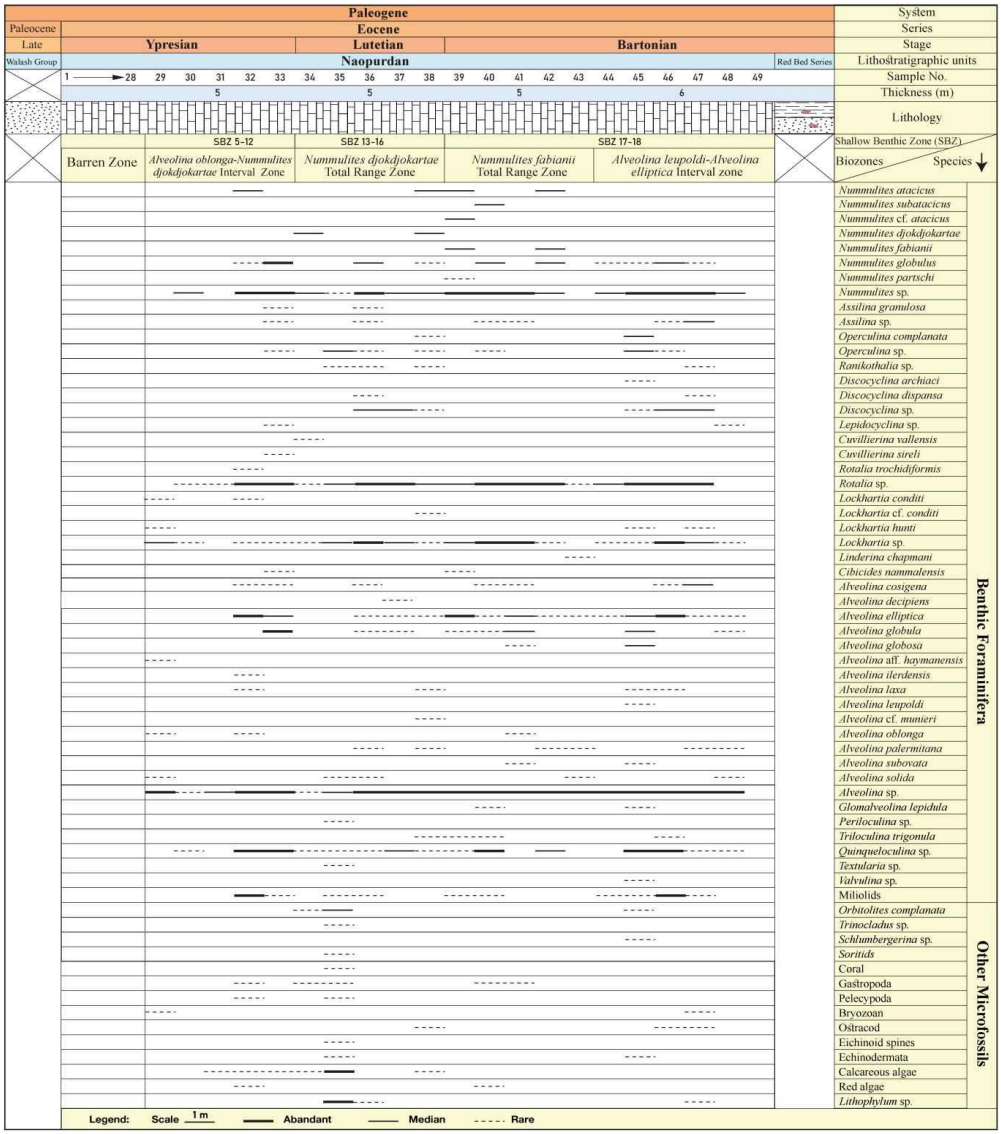


Figure 7: Biostratigraphic Range Chart of Benthic Foraminifera (BF), and Other Microfossils in the Dawzhan Section

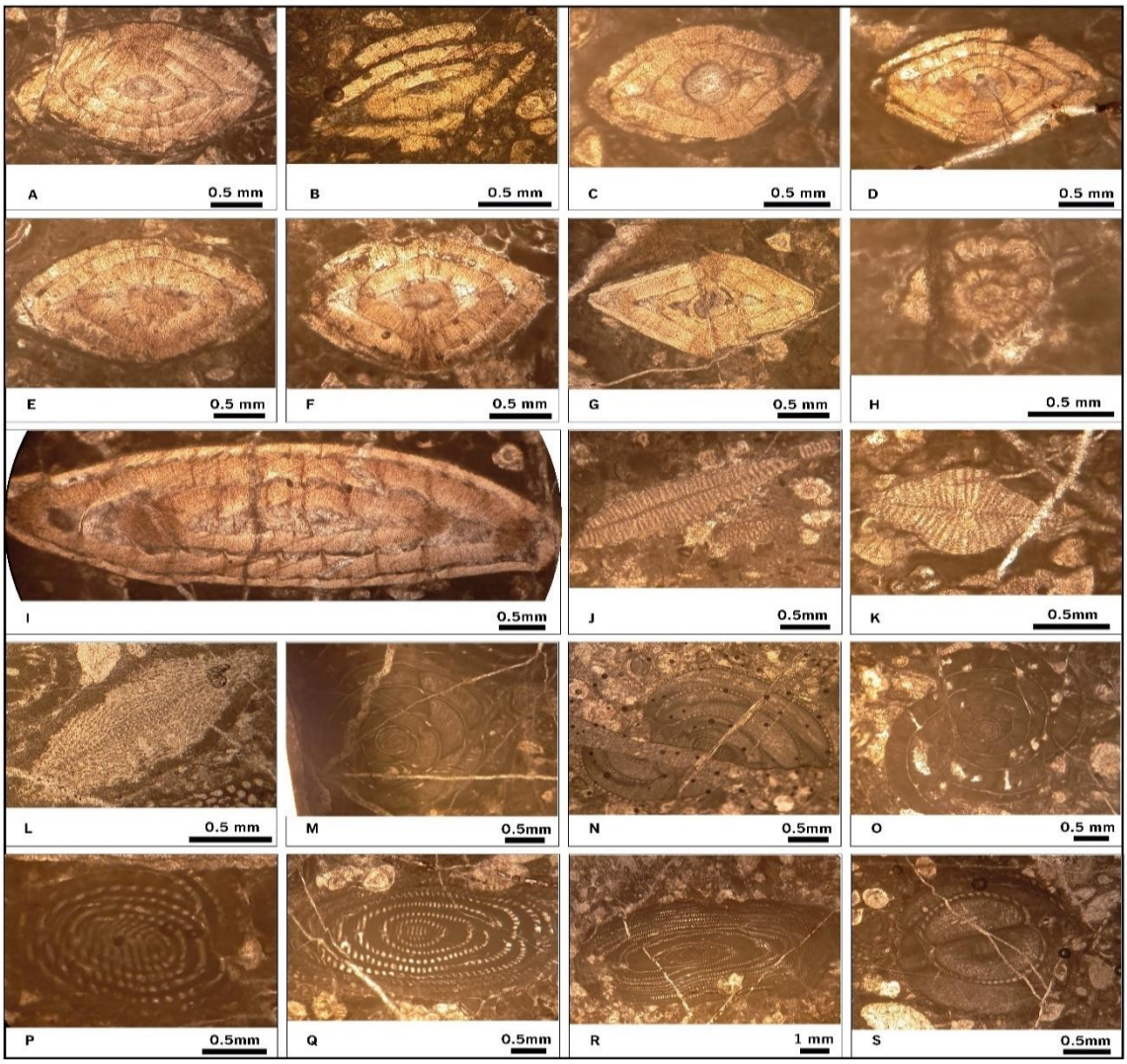


Plate 1: A- *Nummulites subatacicus* Douvillé, 1919, Axial Section, Sample No. 40; **B**-*Nummulites djokdjokartae* Martin, 1881, Axial Section, Sample No. 34; **C**- *Nummulites fabianii* Prever, 1905, Sub-Axial Section, Sample No. 42; **D**- *Nummulites fabianii* Prever, 1905, Sub-Axial Section, Sample No. 39; **E**- *Nummulites globulus* Leymerie, 1846, Sub-Axial Section, Sample No. 42; **F**- *Nummulites globulus Leymerie,* 1846, Sub-Axial Section, Sample No. 46; **G**- *Nummulites globulus* Leymerie, 1846, Sub-Axial Section, Sample No. 33; **H**- *Nummulites partschi* De La Harpe, 1880, Equatorial Section, Sample No. 39; **I**- *Assilina granulosa* d'Archiac, 1850, Axial Section, Sample No.36; **J**- *Discocyclina archiaci* Schlumberger, 1903, Oblique To Axial Section, Sample No. 45; **K**- *Discocyclina dispansa* Sowerby, 1840, Axial Section, Sample No. 36; **L**- *Lepidocyclina sp*., Axial Section, Sample No. 48; **M**- *Alveolina cosigena* Drobne, 1977, Axial Section, Sample No. 33; **N**- *Alveolina cosigena* Drobne, 1977, Axial Section, Sample No. 32; **O**- *Alveolina cosigena* Drobne, 1977, Axial Section, Sample No. 40; **P**- *Alveolina decipiens* Schwager 1883, Axial Section, Sample No. 37; **Q-R**- *Alveolina elliptica* Sowerby, 1840, Axial Section, Sample No. 46; **S**-Alveolina globose Leymerie, 1846, Axial Section, Sample No. 45

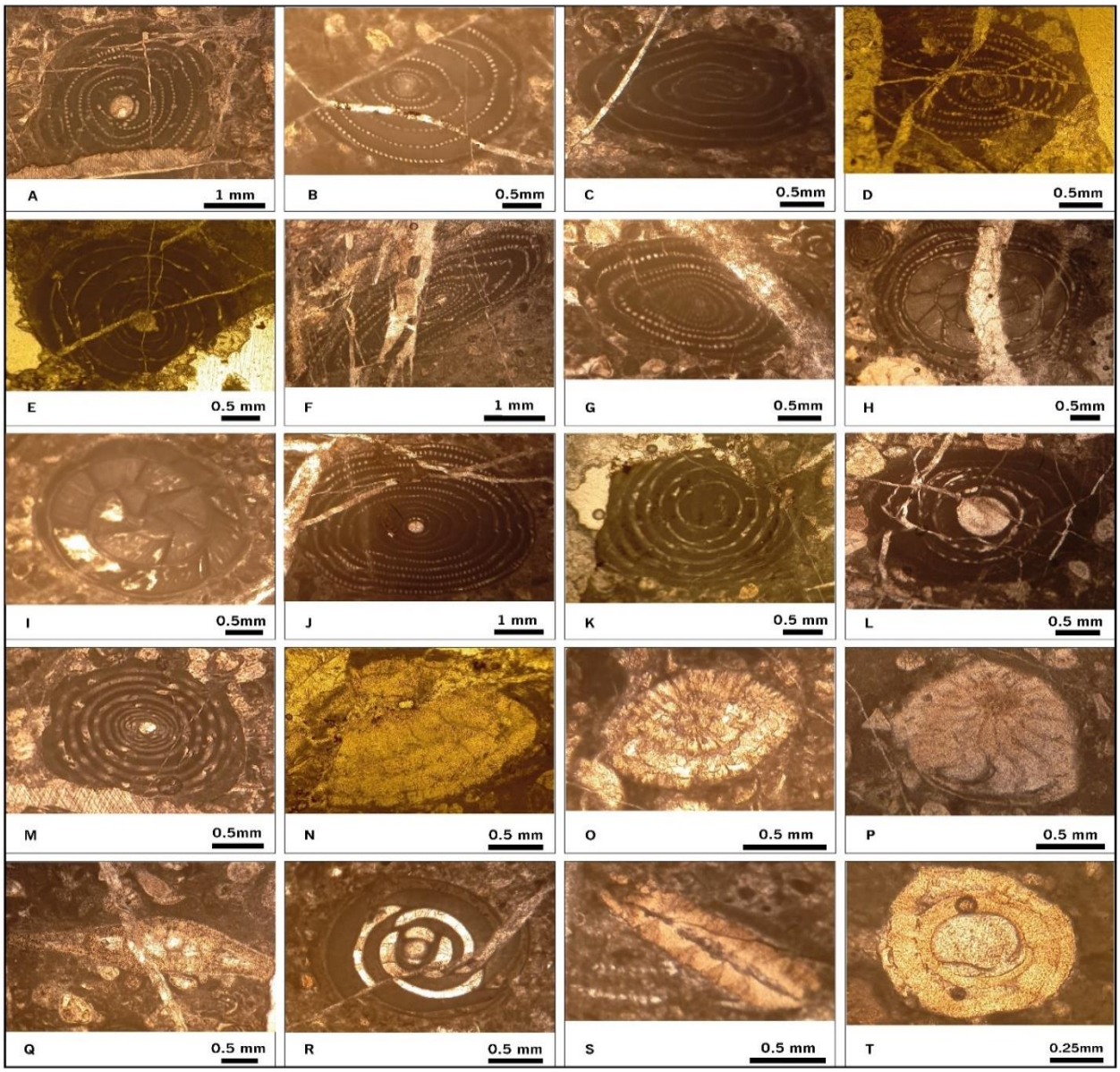


Plate 2: **A**- *Alveolina globula* Hottinger, 1960, Axial Section, Sample No. 33; **B**- *Alveolina globula* Hottinger, 1960, Axial Section, Sample No. 41; **C**-*lveolina* cf. munieri Axial Section, Sample No. 38; **D**- *Alveolina oblonga* d'Orbigny, 1826, Axial Section, Sample No. 29; **E**- *Alveolina aff*. haymanaensis Sirel, 1976, Axial Section, Sample No. 29; **F**- *Alveolina ilerdensis* Hottinger 1960, Axial Section, Sample No. 32; **G**- *Alveolina laxa* Hottinger, 1960, Axial Section, Sample No. 46; **H**- *Alveolina leupoldi* Hottinger 1960, Axial Section, Sample No. 45; **I**- *Alveolina palermitana* Hottinger 1960, Axial Section, Sample No. 38; **J**- *Alveolina subovata* Wan, 1990, Axial Section, Sample No. 45; **K**- *Alveolina solida* Hottinger, 1960, Axial Section, Sample No. 29; **L**- *Alveolina solida* Hottinger, 1960, Axial Section, Sample No. 36; **M**- *Glomalveolina lepidula* Schwager, 1883, Axial Section, Sample No. 40; **N**- *Lockhartia conditi* Nuttall, 1926, Oblique Section, Sample No. 29; **O**- *Lockhartia* cf. conditi Oblique Section, Sample No. 38; **P**- *Lockhartia hunti* Ovey, 1947, Oblique To Equatorial Section, Sample No. 47; **Q**- *Linderina chapmani* Halkyard, 1918, Axial Section, Sample No. 43; R- Periloculina sp., Equatorial Section, Sample No. 35; **S**- Trinocladus sp., Axial Section, Sample No. 35; **T**- *Calcareous algae*, Axial Section, Sample No.33

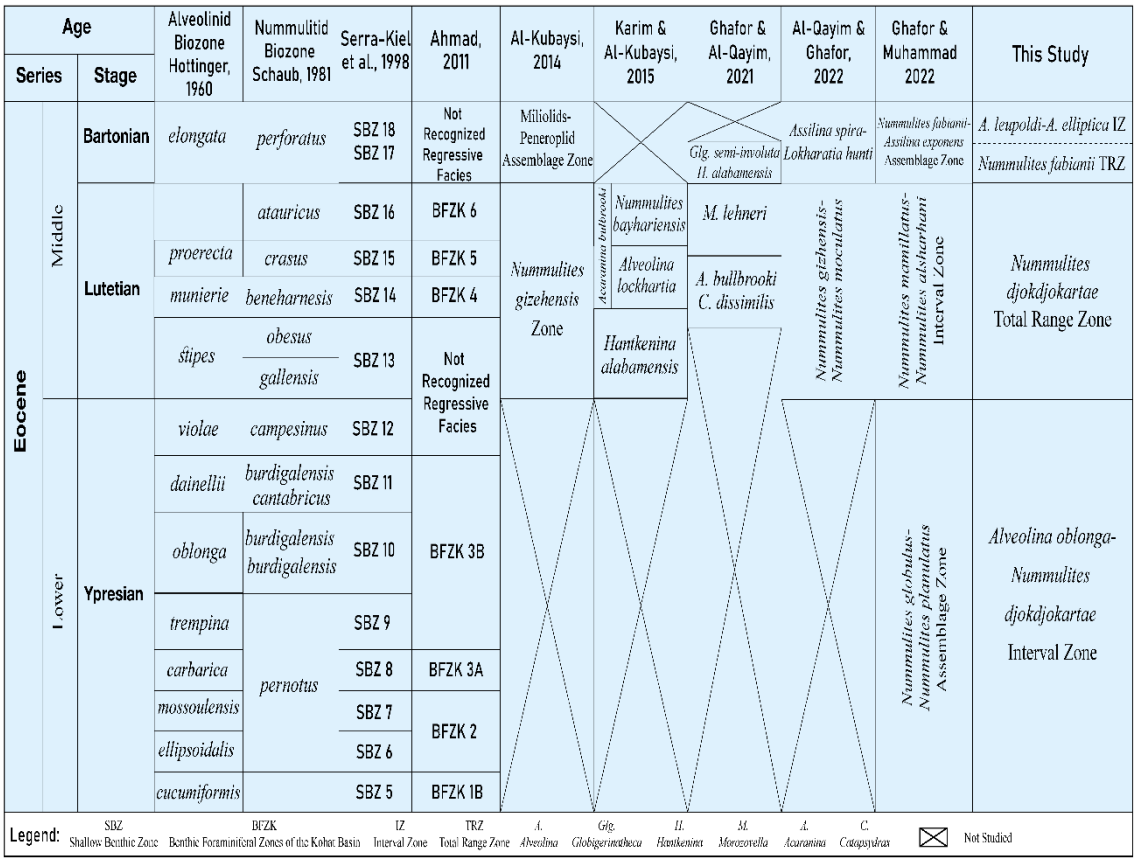


Table 2: Comparisons of Zonal Schemes of the Studied Section with Other Studies

8. Discussion

The Nummulitic limestone of the Naopurdan Formation is considered the lower part of the Walash 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. The paleogeography 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.

According to the previous studies, larger benthic foraminifera in the section implies the shallowing of the depositional environment. Upper Paleocene–Middle Eocene was determined for Walash-Naopurdan Group sediments [33]. Al-Qayim et al. 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 Kharajiany [34,35]. studied the Nummulitic Limestone of the group and determined the Late Paleocene - Early Eocene age. Ahmad et al., recorded the Eocene/Lutetian age of the group, and finally, recorded the Ypresian-Bartonian age of the Naopurdan group [36].

The interpretation of the present work which is studied for the first time in detail with the viewpoint of microfossils and biostratigraphy is interpreted that the studied area is rich in large benthic foraminifera with very few planktic foraminifera in addition to other microfossils, and the age of Naopurdan Group is shown to be close to early-Middle Eocene as follows:

1-*Alveolina oblonga-Nummulites djokdjokartae* Interval Zone.
Alveolina oblonga and *Nummulites djokdjokartae* recognized from the Ypresian age Racy, Shreif , Hadi, Okur and Kutluk associated with this benthic foraminifera, *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* [37-41].

2- *Nummulites djokdjokartae* Total Range Zone.
Nummulites djokdjokartae extended from Ypresian- Lutetian according to Olempska and Boukhary associated with this benthic foraminifer for the Lutetian age (*Nummulites alsharhani, Discocyclina varians, Discocyclina ranikotensis*) [42].

3- *Nummulites fabiani* Total Range Zone, and *Alveolina leupoldi-Alveolina elliptica* Interval Zone *Nummulites fabiani; Alveolina leupoldi-Alveolina elliptica* have been recognized from early Bartonian. [45,46].

9. Conclusions

This study revealed the following conclusions:
1-The Naopurdan Formation of the study area is rich benthic foraminifera belonging to the following genera: -
Nummulites; Alveolina; Assilina; Discocyclina; Lepidocyclina; Amphistegina; Heterostegina; Sphaerogypsina; Triloculina; Textularia; Quinqueloculina; Orbitolites; Lockhartia; Rotalia;

Asterocyclina; Operculina; Cuvillierina; Linderina; Cibicides; Pyrgo; Glomalveolina; Periloculina; Schlumbergerina; Sortids.

2-In addition to Larger Benthic Foraminifera (LBF) assemblages, some species of other microfossils were identified in the Naopurdan group such as coral, algae, pelecypods, gastropods, bryozoans, and fragment spines of stracds.

3- Four Larger benthic foraminiferal biozones are recognized that unified from old to young: -
Alveolina oblonga-Nummulites djokdjokartae Interval Zone; *Nummulites djokdjokartae* Total Range Zone; *Nummulites fabianii* Total Range Zone; *Alveolina leupoldi-Alveolina elliptica* Interval Zone. From this, it is concluded that the age of the section extends from Early to Middle Eocene (Ypressian to Early Bartonian).

4-The biostratigraphic zones established in this study were correlated with other early-middle Eocene biozones inside and outside Iraq [47-59].

Declarations

Conflict of interest. The author(s) declare that they have no competing interests.

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