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Biostratigraphy of Dammam Formation Succession in Boreholes N2 and S1 in Al-Najaf and Al-Samawa Area

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Abstract

The Dammam Formation in S and SW of Iraq is an Eocene carbonate succession consisting of limestone and dolostone. Two boreholes are selected in Al-Najaf and Al-Samawa area to investigate the biostratigraphy. The biostratigraphy of Dammam Formation consist of 22 species which belong to 13 genera of fossils foraminifera.

Two biozones were distinguished in Dammam Formation depending on benthonic foraminifera *Nummulite*s. These biozones are; *Nummulites gizehensis* range zone and *Alveolina* sp. – *Coskinolina* sp. assemblage zone. According to thESE biozones the age of Dammam Formation represent Middle Eocene , whereas absent of these biozone represent Early and Late Eocene.

Keywords: Biostratigraphy**,** foraminifera, biozones**,** Dammam Formation**.**

الطباقية الحياتية لتتابع تكوين الدمام في آبآر N2 & S1 في منطقة النجف والسماوة

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الخلاصة

يمثل تكوين الدمام في جنوب وجنوب غرب العراق تتابع الايوسين الكاربوني ويتكون من الحجر الكلسي والحجر الجيري. تمت دراسة الطباقية الحياتية للتكوين في بئرين في منطقتي النجف والسماوة. اظهرت الدراسة ان تكوين الدمام يتكون من 22 نوعاً تعود الى 13 جنس من متحجرات الفورامنيفرا. نطاقان حياتيان يتميز بهما تكوين الدمام اعتمادا على الفورامنيفرا القاعية (نيوميلايت) وهذان النطاقان الحياتيان هما نطاق المدى *Nummulite gizehensis* ونطاق التجمعي *Alveolina* sp. – *Coskinolina* sp. . بموجب هذين النطاقين الحياتيين قدر عمر تكوين الدمام على انه يمثل الايوسين الاوسط ، بينما غياب هذين النطاقين الحياتيين يمثل الايوسين المبكر والتأخر.

▪ Introduction:

The Dammam Formation is exposed in the most parts of the studied area. It is composed mainly of *Nummulite*s, recrystallized and cavernous limestone. This aquifer represents the main upper aquifer within the most parts of the area. The Dammam carbonate is one of the most important aquifers in southwest Iraq. The Dammam Formation was first described by Bramkamp in 1941 from the Dammam dome in E Saudi Arabia [1]. It was divided into five informal members in the supplementary type section in well Zubair-3 of the Mesopotamian Zone [2, 3] mapped the area regionally and they divided the Dammam Formation into three members as follows:

- Lower Member, which has been subdivided into three units; Wagsa, Sharaf and Shbicha - Lower Huweimi Units.
- Middle Member, which has been subdivided into four units; Upper Huweimi, Shawiya, Ghabd and Radhuma – Barbak Units.

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– Upper Member, which includes Ghanimi unit.

According to [4] Dammam Formation in Iraq is equivalent to the Dammam Formation in neighbored countries such as Saudia Arabia, Kuwait, Jordan (Ma,an Formation), Iran (Juhram Formation).

- **Aims:**

The main aims of the present study include the following:

1. Biostratigraphic analysis of Dammam Formation based on the occurrence of Nummulites.
2. Estimation the age of Dammam Formation.

- **Location:**

The studied area is located in the Southern part of Desert area, within Al-Najaf and Al-Samawa Governorates, Figure-1. We study two boreholes with the following coordinate system Table-1. The distance between two boreholes (N2 and S1) extend about (72) Km.

Table 1- Show coordinates of boreholes

Borehole No.	Latitude	Longitude
N 2	31˚31´53.4″	44˚24´21.4″
S1	31˚08´12.9″	45˚08´09.5″

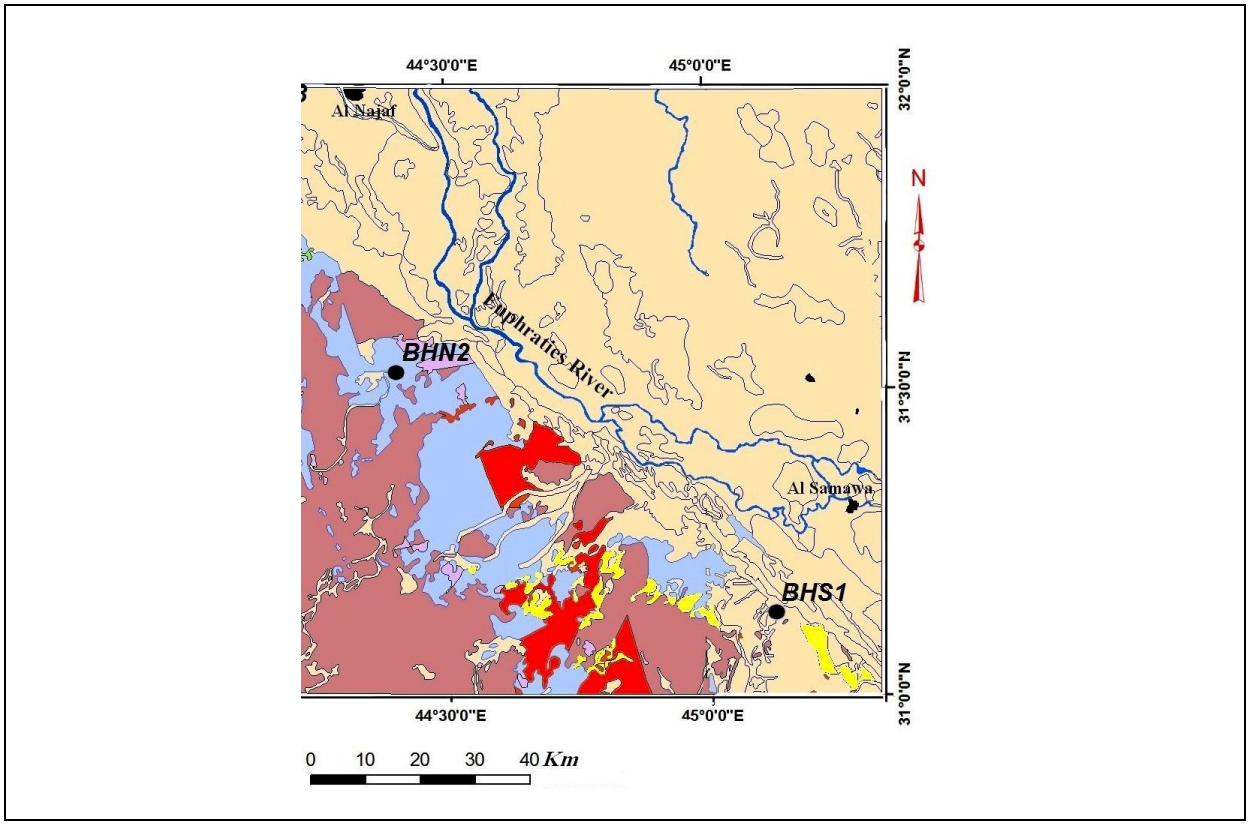

Figure 1- location map of the study area

- **Previous Work:**

- Al-Hashimi, (1973) studied the stratigraphy and paleontology of Eocene succession in Western Desert and in Samawa area, He recorded the Dammam Formation in the former area and Rus & Dammam Formations in the subsurface of Samawa area.
- Amer, (1980) Studied the biostratigraphy and micropaleontology of Dammam Formation (Lower - Middle Eocene), from West Najaf-Nukhaib area. Recorded characterized Middle Eocene in study area of large fauna of *Nummulites* sp.
- Al-Mutter, (1983) Studied the biostratigraphy of Dammam Formation (Lower - Middle Eocene) from South Najaf area. Recorded characterized of four biozone of Dammam Formation equivalent of wagsa, upper huwiemi, shawiya and chabad units.
- Al-Mubark and Amin, (1983) mapped regionally the Western and the Southern Deserts area. They divided Euphrates Formation into three units, Upper, Middle and Lower, and the Dammam Formation into three members, Lower, Middle, and Upper.

- Al-Mutter, (1985) Studied the biostratigraphy of the formation (Middle – Upper Eocene) in K.H.5, Salhubiya.
- Al-jibouri, (2003) studied the sequence stratigraphic of the Paleocene-Eocene Succession in Western & Southern Iraq. Also, studied different facies result in different environment of Dammam Formation.

- **Biostratigraphy of Dammam Formation Succession:**

The biostratigraphy of the Dammam Formation is studied depending on benthonic foraminifera and other associated fossils. Some of these fossils have a short vertical distribution, while others have long range of distribution.

- **Biostratigraphy of Borehole AL-Najaf (N2):**

The following benthonic foraminifera are identified from the sediments of Dammam Formation as showing in Figure-2 and- 3 are:

Nummulites gizehensis Foreskal Figure-4, , *Nummulites bayhariensis* Checchia-Rispoli, *Nummulites* sp. Figure-5, *Nummulites millicopeta* Boubee, *Nummulites discorbinus* Schlotheim ,*Rotalia* sp., *Coskinolina* sp., algae , *Bigenerina* sp. Figure-6, Brozyoa and Shell fragments.

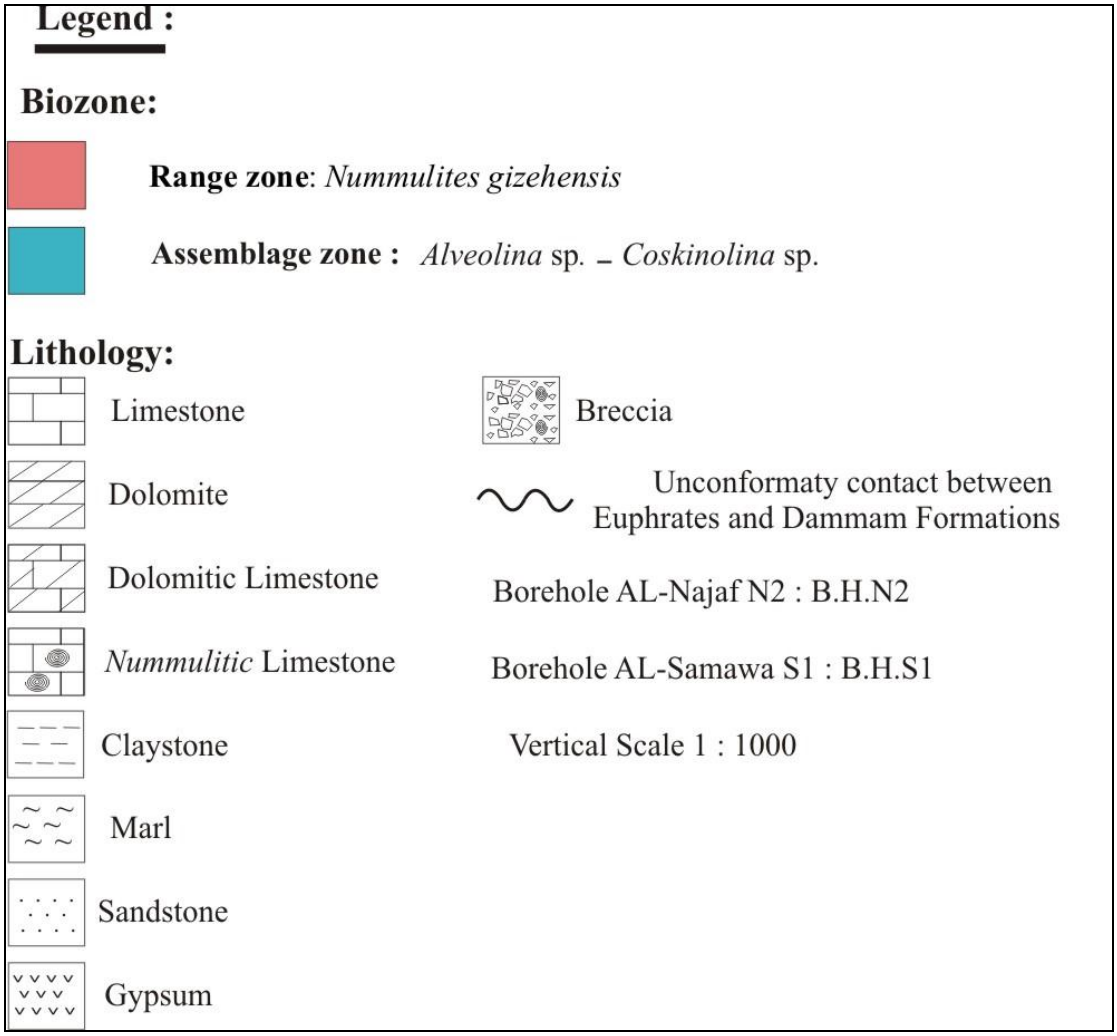

Figure 2- legends used in the current study

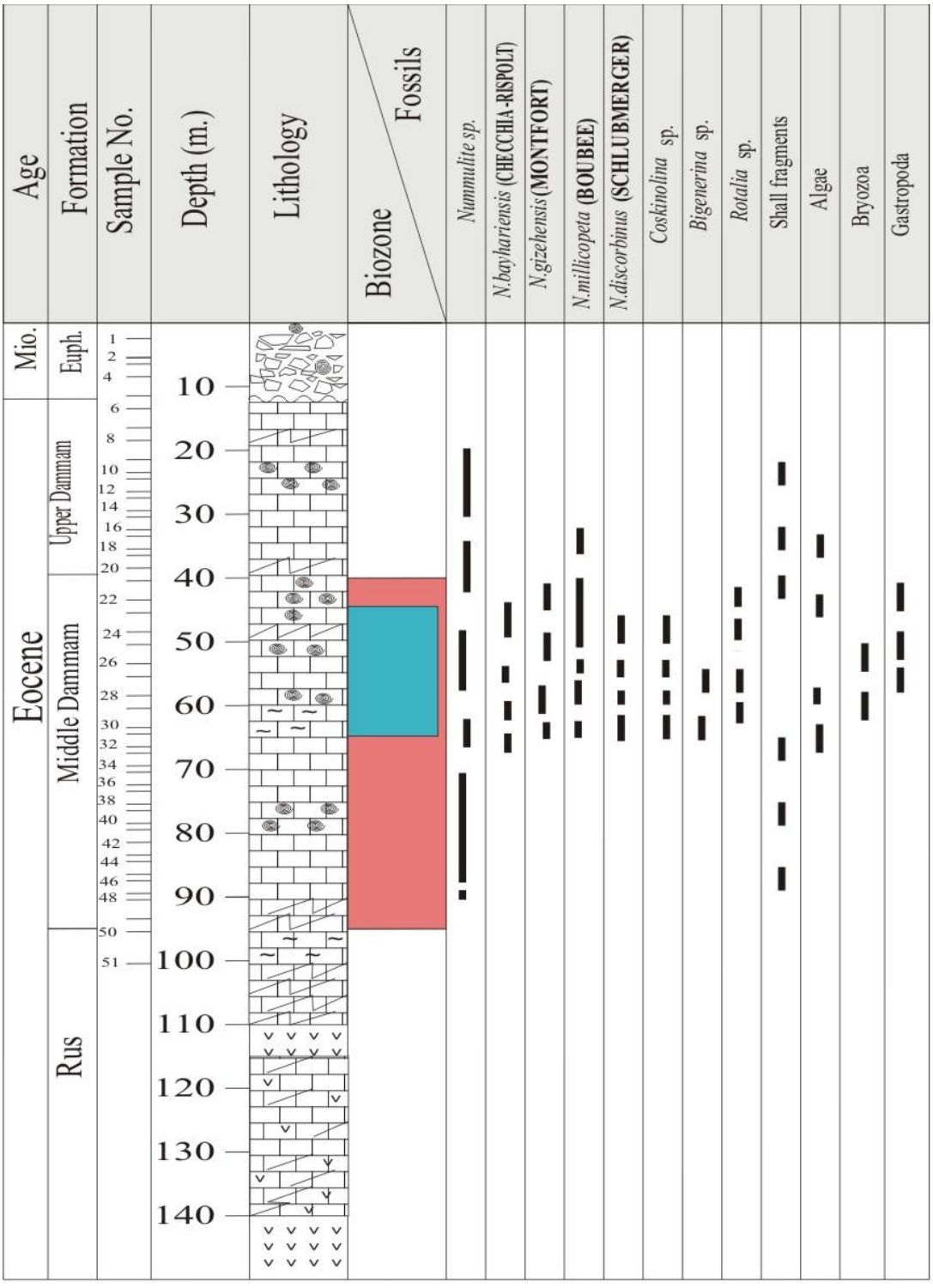

Figure3- Biostratigraphy of borehole N2

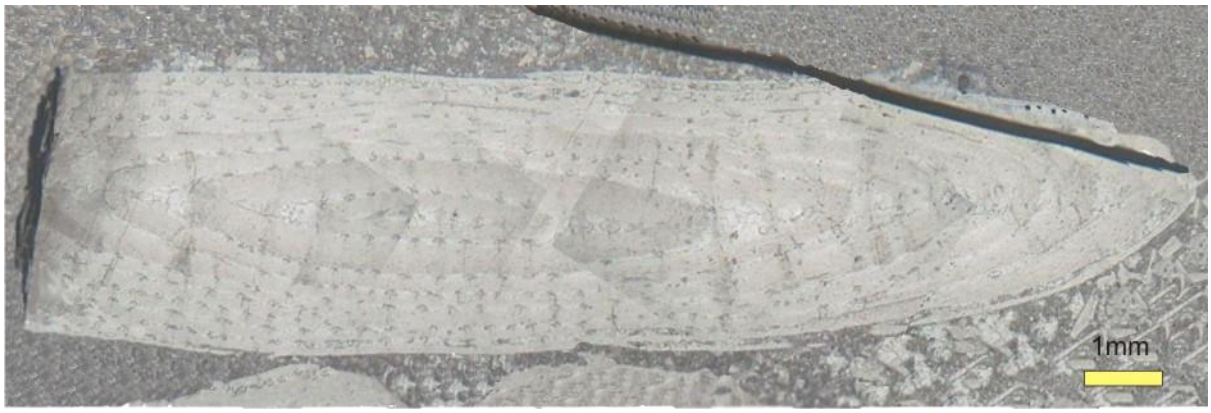

Figure 4- *Nummulites gizehensis*

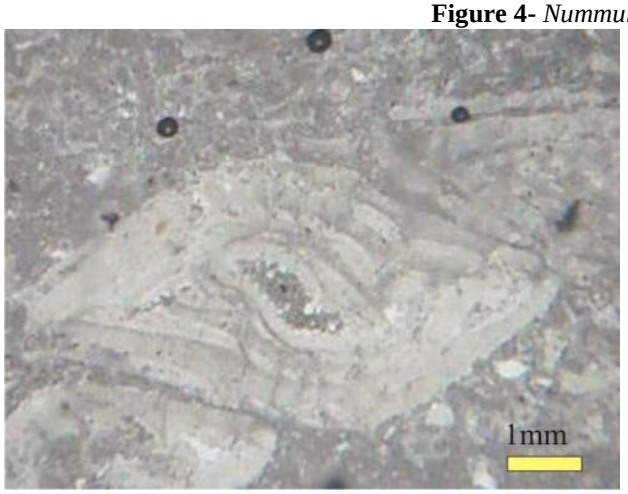

Figure 5- *Nummulites* sp.

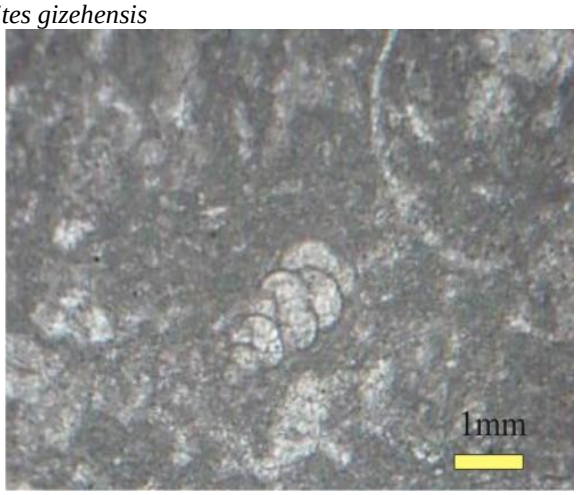

Figure 6- *Bigenerina* sp.

Biostratigraphy of Borehole AL-Samawa (S1)

The following benthonic foraminifera are identified from the sediments of Dammam Formation are Figure-2 and -7:

Nummulites gizehensis Foreskal Figure-8, *Nummulites gizehensis zeitteli* De la harpe , *Nummulites bayhariensis* Checchia-Rispoli , *Nummulites elevata* AL-Hashimi and Amer Figure-9, *Nummulites planulatus* Lamarck, *Nummulites murchisoni* Rutimeyer , *Nummulites* sp. ,*Nummulites discorbinus* Schlotheim , *Nummulites millicopeta* BOUBEE , *Lockhartia* sp., *Spiroloclina* sp. Figure-10, *Linderina chapmani* Figure-11, *Alveolina* sp. , *Alveolina muneri* Hottinger Figure-12, *Lituoneila* sp., *Peneroples* sp., *Rotalia* sp., *Bigenerina* sp., *Coskinolina* sp. , Miliolids, Algae, brozyoa Figure-13, Echinoid Figure-14, shell fragments , Pelecypoda, Planktonic Foraminifera**.**

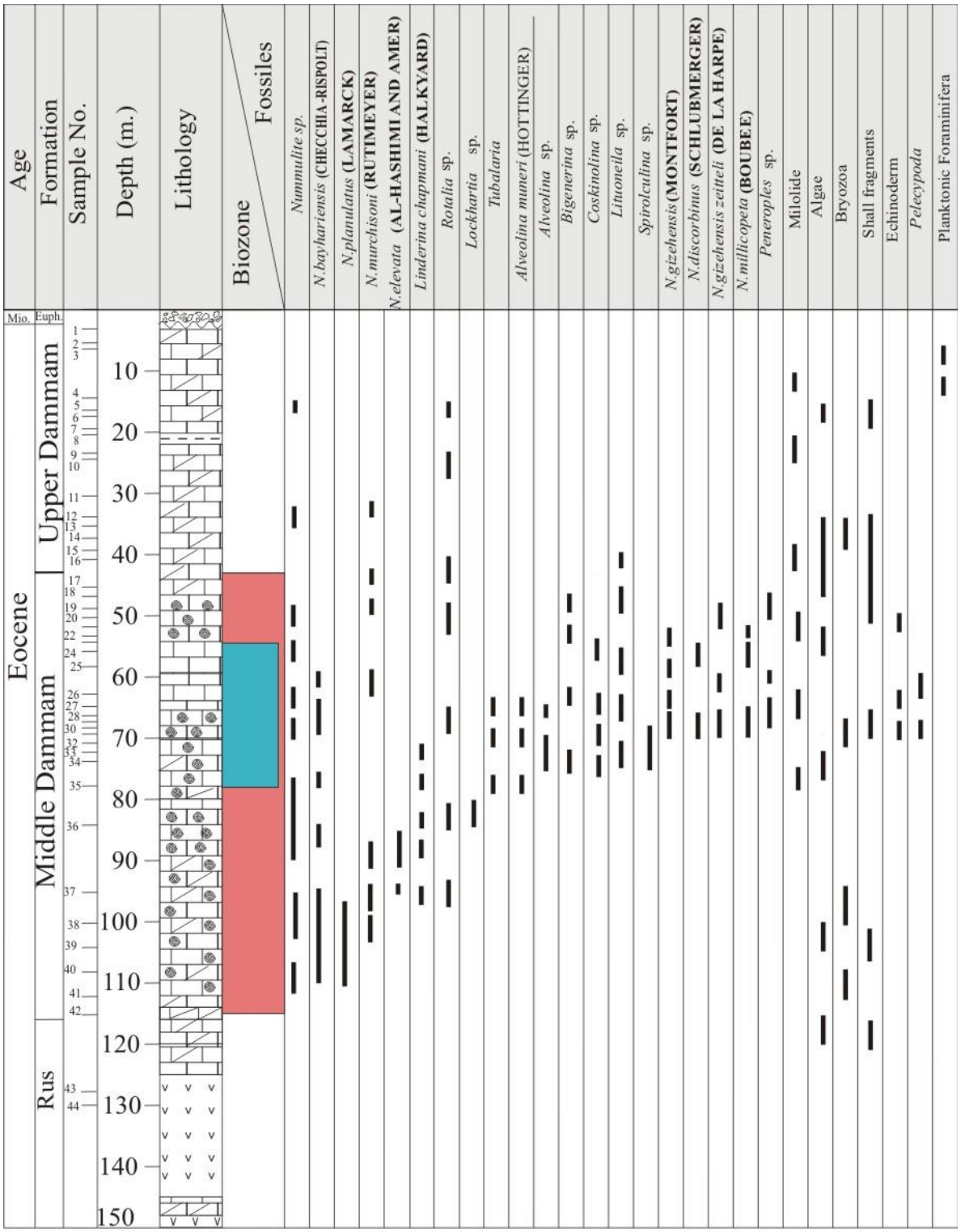

Figure 7- Biostratigraphy of borehole S1

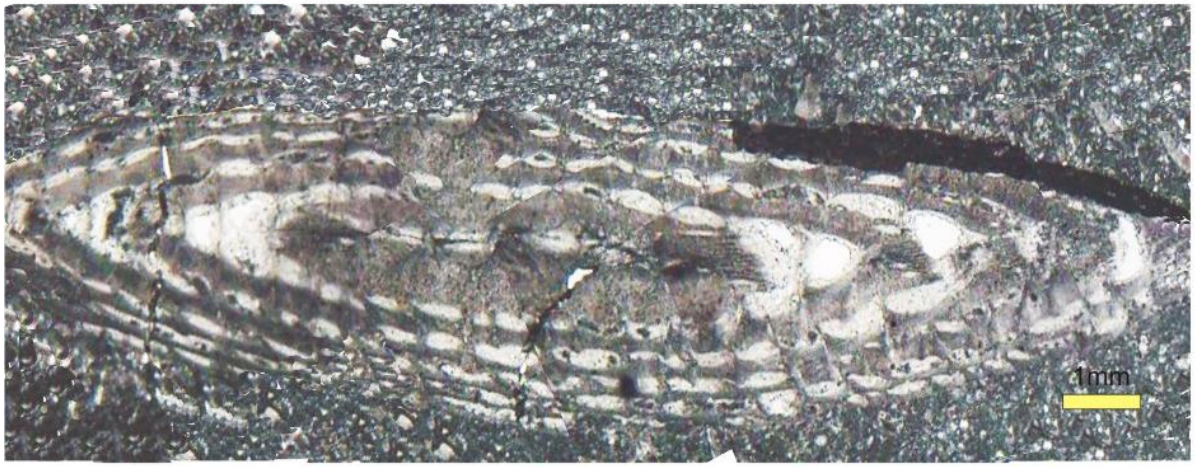

Figure 8- *Nummulites gizehensis*

Figure 9- *Nummulites elevata*

Figure 10- *Spiroloclina* sp

Figure 11- *Linderina chapmani*

Figure 12- *Alveolina muneri*

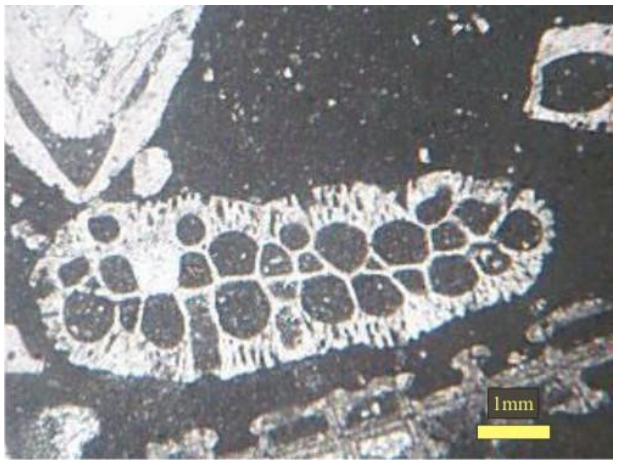

Figure 13- brozyoa

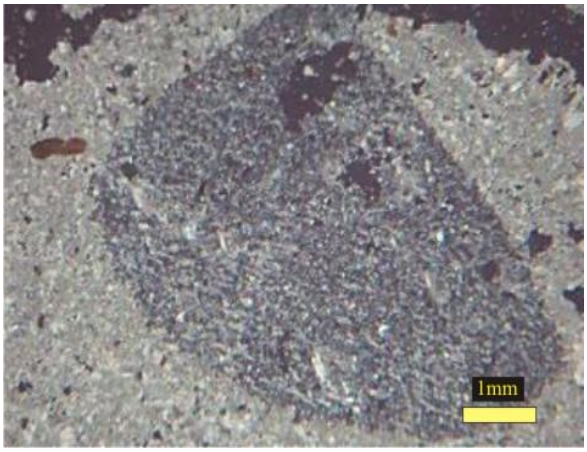

Figure 14- Echinoid

- **Biozone the Dammam Formation:**

Through the detailed biostratigraphic study of the Dammam Formation depending on benthonic Foraminifera two Biozones are identified in this study ,the description of the Biozones are manifested in Figures-3 and -7.

- ***Nummulites gizehensis* Range zone**:

This zone was determined with accordance of the first appearance of this species as the lower limit and the disappearance of it as the upper limit.

It is recognized by widely distribution, distinct and large size more than (2 mm). It indicates Middle Eocene. The thickness of this zone determined in this study as follow:
(55m) in borehole AL-Najaf (N2), (70m) in borehole AL-Najaf (S1).

The fossils associated with this zone are: *Nummulites gizehensis* Foreskal, *N. discorbinus* Schlothien, *N. perforatus* Montfort, *Nummulites bayhariensis* Checchia-Rispoli), *Nummulites elevata* AL-Hashimi and Amer), *Nummulites murchisoni* Rutimeyer, *Nummulites millicopeta* Boubee, *Nummulites planulatus* Lamarck , *Nummulites* sp., *Linderina* sp., *Lockhartia alveolata* Silvestri, *Coskinolina balsilliei* Daves, *Linderina brugesi* Schlumberger, *Alveolina elliptica* Sowerby, *Alveolina lepidula* Schwager, *Dictyoconoides cooki* Carter , *Coskinolina* sp., *Orbitolites* sp., miliolids, gastropods, pelecypods, ostracods, algae and echinoid spines.

Age of *Nummulite gizehensis* Rang zone was determined depending on its occurrence among Eocene deposited located worldwide, some of these occurrence were recorded by number of reserchers as:
Nummulites gizehensis FORESKAL represented by middel Dammam Formation (middel Eocene) according to [1, 5-11]. According to [12] many assemblages of fossils above mentioned are existed with this zone. The *Nummulites gizehensis* Zone is existed in many countries, such as Iran as mentioned by [13,14]; Syria by [15]; Egypt by [16,17]; Packstane by [18].

- ***Alveolina* sp. – *Coskinolina* sp. Assemblage zone**

This zone was determined with accordance of the first appearance of this species as lower limit and the disappearance of it as the upper limit.

It is recognized by widely distribution and distinct. The thickness of this zone determined in this study as follow: (20m) in borehole AL-Najaf (N2), (23m) in borehole AL-Najaf (S1).
The fossils associated with this zone are:

Nummulites gizehensis Foreskal, *N. discorbinus* Schlothien, *N. bayhariensis* Cheshea-Rispoli, *Nummulites* sp.,*Linderina brugesi* Schlumberger, *Coskinolina* sp., *Alveolina* sp., *Dictyoconoides cooki* Carter, *Lockhartia* sp., *Linderina* sp., miliolids, gastropods, pelecypods, ostracods, algae and echinoid spines. This Assemblage zone indicates Middle Dammam Formation, which represents Middle Eocene age.

Age of Alveolina sp. – *Coskinolina* sp. Assemblage zone was determined depending on its occurrence among Eocene deposit. It is located worldwide. However, some of these occurrences were recorded by number of researchers e.g. [7,8,19-21].

- **Dammam Formation Biostratigraphy discussion:**

The Middle Dammam represent new cycle of transgression sedimentation with marked by the first appearance of excellent index *Nummulite* fossils, which represents by large size about more than (2-10mm) as mentioned by [7-9,11,22].

In the present study, the middle Dammam could be characterized by presence of large Nummulite with other macrofossils of Gastropod and Pelecypod. The Biostratigraphy discussion of middle Dammam Formation composed of two zones such as:

A. *Nummulites gizehensis* Range zone is characterized by large size of *Nummulite gizehensis* species about more than (2-10mm), in addition to availability other associated faunas. It is represent the Middle Dammam Formation marked by the first appearance of excellect index *Nummulite gizehensis* range zone. It appears within the study area in Middle Dammam at depth interval (40-95 m) in borehole (N2), (40-114 m) in borehole (S1).

B. *Alveolina* sp. – *Coskinolina* sp. Assemblage zone and other associated faunas, which are represented Middle Dammam within the study area at depth interval (45-65m) in borehole (N2), (55-78m) in borehole (S1).

According to [11,20] Upper Dammam (Upper Eocene) consists of these faunas above with characterized dominant of miliolid and peneroplis. Upper Dammam (Upper Eocene) sequence is extended less than the Middle Dammam (Middle Eocene) sequence. [23] Recorded these fossils within Upper Dammam (Upper Eocene) with age of Late Eocene (Priabonian). [21] recorded the abundant appearances of miliolids and Peneroplis fauna with above fossils is marked Upper Eocene (Upper member of Dammam Formation).

In the study area, Upper Dammam Formation which represent Upper Eocene toward the south could be Characterized small size of *Nummulite* sp.,in addition to availability other associated faunas like: Echinoderm, *Rotalia* sp., shall fragment, Algea, Bryozoa, Pelecypoda, Gastrapoda and Miliolid. However, these fauna can be recognized in boreholes (N2) and (S1) in the sediment of Upper Dammam (Upper Eocene) at depth from (12m - 32m) and (3m - 45m) respectively.

- **Conclusions**

This study involves comprehensive microfacies, biostratigraphic, and sequence stratigraphic analyses of Dammam Formation in 3 boreholes (N2, N3, N15) in Najaf area and a single borehole (S1) in Samawa area, SW of Iraq. The main conclusions of the study can be listed as follows:

1. Petrographic examination of thin sections shows that the main components of Dammam Formation are skeletal grains, particularly Nummulite foraminifera and other large benthonic foraminifera such as Alveolina….. Other important skeletal components include echinoderm, molluscs, and pelecypods. The subordinates non- skeletal grains are peloids and intraclast.

2. Diversity of microfacies has been recognized and grouped into five facies associations reflecting different depositional environments. The nummulitic-rich microfacies such as Nummulite rudstone is the most distinctive indicator of Nummulite bank environment, which is characterized by shallow, high energy depositional conditions. The back-bank facies association represents a transitional environment towards semi-restricted environment, and represented by nummulitic wackestone-packstone and numulitic floatstone-rudstone microfacies with the association of semi-restricted fauna such as miliolids and alveolinids. In boreholes, N3 and N15, the open marine facies association includes various bioclastic-rich microfacies such as bioclastic wackestone-packstone, foraminiferal-bioclastic wackestone that were deposited in proximal setting to Nummulite Bank. The semi- restricted facies association occurred remarkably in Boreholes N2 and S1 as thick succession of benthonic foraminiferal wackestone and ….. that deposited in a low- energy, protected inner ramp setting. In addition, shoal facies association is found in boreholes, N3 and N15 as interbedding units with semi-restricted succession, and they consists of ….. indicating shallower, higher energy environment. The peritidal facies association occurs only in borehole S1 where it consists of unfossiliferous lime mudstone and microcrystalline dolomite.

3. The carbonates of the Dammam Formation have been altered by a variety of diagenetic processes as inferred from petrographic observation of thin sections. The processes involved micritization, which obliterated some of the original fabric of many skeletal grains and ooids, and the formation of micrite envelopes. Dissolution of bioclasts and the matrix created

vuggy and moldic pores, which is partially or completely filled by granular and minor blocky calcite cements, in addition to secondary dolomite cement. Other types of cement include fine crystalline rim and syntaxial calcite. Recrystallization of micrite to microspar and pseudospar is dominant in lime mud rich facies. Inversion affected the skeletal grain with the preservation of their original structures. Early dolomitization is represented by fine crystalline dolomite crystals that replace micritic matrix, whereas late dolomitization occurs as medium-coarse, interlocking dolomite crystals. Compaction and silicification represent late diagenetic processes.

This study involves comprehensive biostratigraphy of Dammam Formation in two boreholes Najaf N2 and Samawa S1 in SW of Iraq. The main conclusions of the study can be listed as follows:

1. The biostratigraphy of Dammam Formation consist of 22 species belong to 13 genera of foraminifera fossils.
2. Two biozones were distinguished in Dammam Formation depending on benthonic foraminifera *Nummulite*s these biozone are:
   - **a.** *Nummulites gizehensis* range zone.
   - **b.** *Alveolina* sp. – *Coskinolina* sp. assemblage zone.
3. The age of Dammam Formation estimated as Early Eocene to Late Eocene, according to these biozones of foraminifera which represent Middle Eocene , whereas absent of these biozone represent Early and Late Eocene.

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