NEW OCCURANCE OF RATGAH FORMATION (EOCENE) IN SOME SUBSURFACE SECTIONS IN NASIRYA, SOUTHERN DESERT, IRAQ

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ABSTRACT

The Ratgah Formation (Eocene) is found extending towards the Southern Desert of Iraq. This added an important knowledge on the formation's distribution, and basin configuration, which is known to bedominent in western Iraq.

The results of studying the subsurface sections in South Nasirya area, Southern Desert, were an important improvement in the documentation of the presence of the Ratgah Formation. The age designation and facies analysis were determined, by means of planktonic and larger foraminifera.

Two planktonic foraminiferal zones of Late Lutetian – Early Bartonian (Late Middle – Early Late Eocene) stage is found in this part of Ratgh Formation, they are:

1- *Hantkenina alabamensis* Zone of Early Bartonian (Early Late Eocene).
2- *Acarinina bullbrooki* Zone of Late Lutetian (Late Middle Eocene).

The *Acarnina bullbrooki* Zone is divided into two larger foramininferal subzones, they are:

a- *Alveolina – Lockhartia* Subzone of Late Lutetian.
b- *Nummulites bayhariensis* Subzone of Late Lutetian.

ظهور جديد لتكوين الرتكة في بعض المقاطع تحت السطحية في الناصرية، الصحراء الجنوبية، العراق

ساهرة عبد الكريم و كفاح نوري الكبيسي

المستخلص

عثر على امتداد لتكوين الرتكة باتجاه الصحراء الجنوبية في العراق، ويمثل هذا الامتداد إضافة مهمة لانتشار التكوين وحوضه الرسوبي الذي سجل وجوده من قبل Karim and Al-Bassam (1997) لأول مرة في الصحراء الغربية في العراق. إن نتائج دراسة المقاطع تحت السطحية في منطقة جنوب الناصرية (خمسة آبار، BH4، BH6، BH7، BH8، BH9 والتي حفرت ضمن مشروع المسح الجيولوجي التفصيلي لمنطقة جنوب الناصرية) مثلت دليل مهم في توثيق تواجد تكوين الرتكة في الصحراء الجنوبية لأول مرة. وتم تحديد العمر والتحليل السحني للتكوين نتيجة لتواجد مستحاثات الفورامنيفير الطافية والفورامنيفيرا الكبيرة معا.

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تم تميز نطاقيين حياتيين للفورامنيفيرا الطافية هما

1- *Hantkenina alabamensis* Zone of Early Bartonian (Early Late Eocene).
2- *Acarinina bullbrooki* Zone of Late Lutetian (Late Middle Eocene).

وضمن النطاق الحياتي الثاني تم تميز نطاقيين حياتيين ثانويين للفورامنيفيرا الكبيرة هما

a- *Alveolina – Lockhartia* Subzone of Late Lutetian.
b- *Nummulites bayhariensis* Subzone of Late Lutetian.

INTRODUCTION

During the drilling project for the purpose of detail geological survey at Nasirya area Southern Desert of Iraq, Paleogene sediments were recovered from boreholes nos. (4, 6, 7, 8, and 9); they were composed mainly of carbonate sequence of Eocene Epoch; these carbonate are phosphatic in some horizons and hard silicified carbonate or chert in others; some of these samples are rich with foraminifera, many samples suffer dolomitization; they grade from fossiliferous clayey limestone to dolomite. The presence of planktonic and larger foraminifera provid evidence for age determination, correlation, and depositional environment of the sequence.

During the recent study of the boreholes in Nasirya drilled during the years 2012 – 2013 by the survey department, an important encounter of phosphatic and silicified horizons is found with a mixture of planktonic and larger foraminifera that resemble part of the Ratgah formation. It is felt that this new finding should publish to add a new scientific knowledge concerning the areal distribution of this formation. More than (200) samples from the subsurface sections were thin section and studied. The area of study is located at (45° 30' 00" – 46° 30' 00") E and (30° 45' 00" – 30° 30' 00") N, (Fig.1).

The aim of the present work is to study the age, facies and depositional environment of the newly discovered phosphatic horizons believed to be Ratgah Formation. This discovery will add to our knowledge of the distribution and basin configuration of the Ratgah Formation.

PREVIOUS WORK

Previous work on the outcrops and subsurface sections in the Southern Desert of Iraq was first carried out by Owen and Nasr (1958) to show the distribution of the Dammam Formation. The type locality of Dammam Formation was described from the Saudi Arabia by Bromkamp (1941) in Bellen *et al.*, (1959). A supplementary type section was chosen by Owen and Nasr (1958) from PBC well Zubair No.3 and described it as a grey porous dolomitize limestone with some chalky horizons; and near the base, a grey green waxy body is encountered. It is given (an Early Middle – Late Eocene) age.

Al-Hashimi (1972) stated that the whole sequence of outcrops in the Southern and Western Desert of Iraq belong to the Dammam Formation and divided it into 4 nummulitic zones and 3 planktonic zones, and gave it an Early Eocene – Late Eocene age. This is followed by Al-Jumaily (1974) and Hagopian (1979) who generally agreed with Al-Hashimi (1972) in their study of the Dammam Formation in the Western Desert, but they, later, divided the sequence into five mapable units.

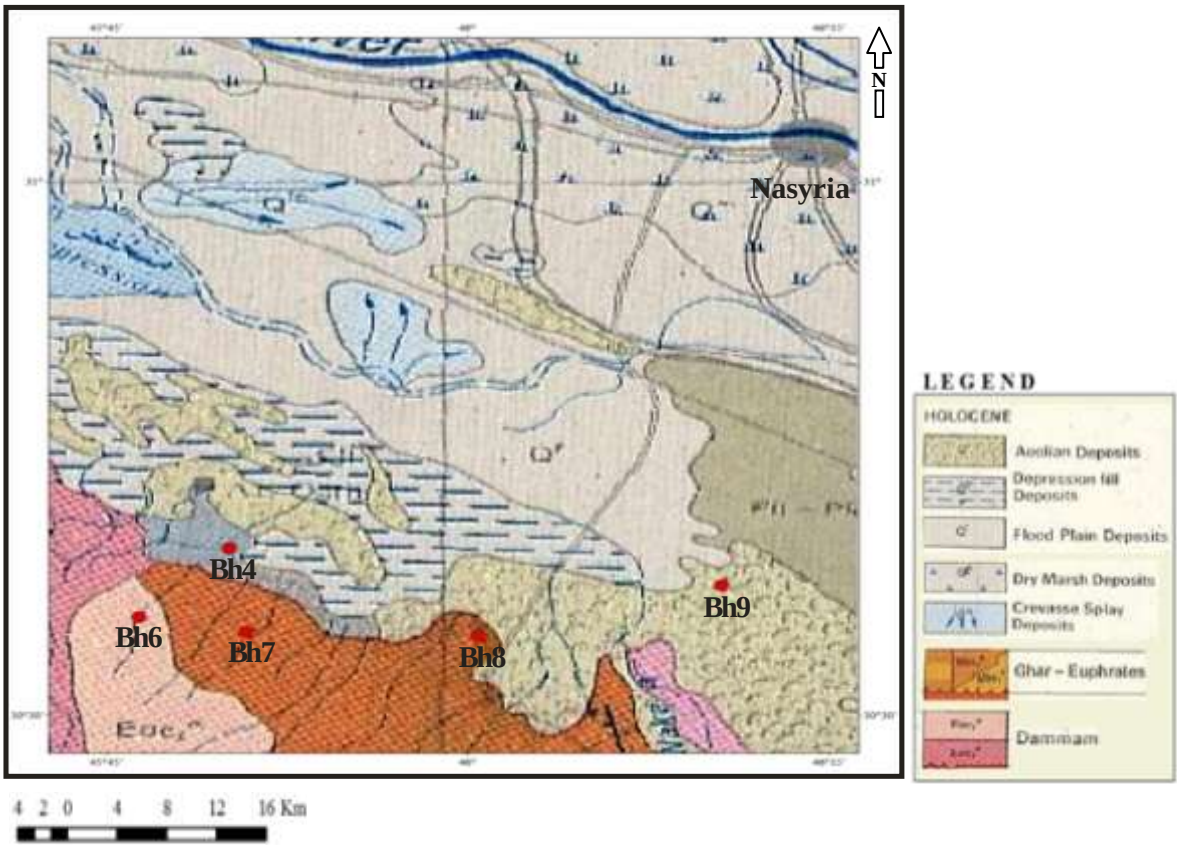

Fig.1: The location of the studied borehole

In the process of compilation of the regional geology of Iraq (stratigraphy and paleogeography) by Jassim *et al.* (1984) and Jassim and Karim (1984), the phosphate cherty sequence, rich with planktonic phosphate horizons in the Western Desert of Iraq was recognized and given the name of the phosphatic facies of Jaddala Formation.

Later, Karim and Al-Bassam (1997) introduced the name of Ratgah Formation as a new rock unit representing the phosphatic cherty limestone that is rich with *Nummulites* and planktonic forams, with clear boundaries and wide distribution. It extends in the Western Desert of Iraq from the Jordanian borders to Saudi Arabia. They also divided the new formation into three members:

1- Swab Member (Early Eocene)
2- Damluk Member (Middle Eocene)
3- Mugur Member (Late Eocene)

This was very important; finding that changed the whole picture of the stratigraphic map of Iraq.

Al-Jibouri (2003) studied the biostratigraphy, depositional environment, the sequence development and basin evolution for Paleocene – Eocene succession of Western and southern Iraq as represented by Umm Er Rudhuma, Akashat, Dammam, Ratga, Rus and Jaddala formations.

STRATIGRAPHY

Since Owen and Nasr's description of the rock unit in BPC (1958), in well Zubair No.3 as a supplementary type section of the Dammam Formation (high Early Eocene, Middle Eocene and Late Eocene), all the following workers have agreed with this description: Al-Hashimi (1972), Jassim *et al*. (1984), Jassim and Karim (1984), Al-Hashimi and Amer (1985) and Al-Jibouri (2003). Some of these, however, made some changes which include the age extensions of the formation to the Late Eocene. They also stated that the lower and the middle members of Dammam Formation consist of nummulitic carbonate rocks (shoals) of Early – Middle Eocene, while the upper member of Dammam Formation consists of carbonate rock rich with miliolids (lagoon).

The present study of five boreholes in Nasirya province, produced new results concerning the stratigraphy of the rock unit of the Paleogene Period recovered from these subsurface sections. The lithology and biofacies of the units found to be similar to the newly named formation from the Western Desert of Iraq described by Karim and Al-Bassam (1997) with its nummulitic, planktonic and phosphatic characters similar to Damluk Member of the Middle Eocene Epoch (Lutetian Stage) rich with planktonic foraminifera such as *Acarinina bullbrooki* (BOLLI), *Globorotalia broedermanni* CUSHMAN AND BERMUDEZ, and larger foraminifera like *Nummulites globulus* LEYMERIE, *Nummulites bayhariensis* CHECCHIA-RISPOLI, *Alveolina munieri* HOTTINGER and *Lockhartia alveolata* SILVESTRI.

The upper part represents the Mugur Member with abundant planktonic such as *Hantkenina alabamensis* CUSHMAN, *Truncorotaloides rohri* BRÖNNIMANN AND BERMUDEZ, *Globorotalia centralis* CUSHMAN AND BERMUDEZ and small *Nummulites* sp., Large *Spiroloculina* sp. and sponge spicules with some chert and phosphate representing the Late Eocene Epoch (Early Bartonian Stage).

This finding proved that Ratgah Formation has a wide geographical distribution extending to parts of the Southern Desert of Iraq.

The Lower boundaries of the formation was not reached by drilling; which did not reach the lower member of the formation (Swab Member); the upper boundary “if it is present” is always uncomfortable with the Ghar/ Euphrates Formations of Early Miocene age and is marked by clastic sediments.

BIOSTRATIGRAPHY

Based on the Standard Planktonic Zonation established by Blow (1979), Bolli *et al*. (1985), Berregren *et al.* (1995), Jenkins (1995), McGowran *et al.* (1997), Li, *et al.* (2003), Rincon *et al.* (2007) and Zakreveskaya and Beniamovsky, (2011) have documented the following zones:

1- *Acarinina (Globorotalia) bullbrooki* Zone of Late Middle Eocene (Late Lutetian)
2- *Hantkenina alabamans* Zone of Early Late Eocene (Early Bartonian)

All larger foraminiferal zones are based on Al-Hashimi (1972) and Al-Hashimi and Amer (1985):

1- *Nummulites globulus-Nummulite bayherensis* Zone of Lutetian (Middle Eocene)
2- *Nummulites gizehensis* Zone of Lutetian (Middle Eocene)
3- *Alveolina munieri-Lockhatia alveolata* subzone of Middle Eocene.

▪ **Borehole No.4**

Borehole No.4 (Fig.2) is located at 45° 50' 07" E, 30° 39' 23" N, (Sheet NH-38-07-31).

The total thickness of the borehole is 150 m, from depth interval 0.0 – 1.0 m represents the Quaternary sediments and from depth interval 1.0 – 18.0 m represents sandy dolomite of Ghar Formation. From depth interval 18.0 – 26.0 m represent period of coarse grain dolomite with trace of small *Nummulites* sp. represent the upper member of Dammam formation.

At depth interval of 26.0 – 27.5 m rich with planktonic fauna, they are *Hantkenina alabamensis* CUSHMAN (Fig.3), *Chiloguembelina cubensis* (PALMER) (Fig.4), *Globorotalia cerrazulensis* (COLE) (Fig.5) and *Glt*. spp. together with benthonic fauna like traces of small *Nummulites* spp. representing the Early Bartonian Stage of Early Late Eocene Epoch.

Depth interval 27.5 – 39.0 m most probably belongs to the Dammam Formation (Upper Member), forms mainly dolomite with traces of small *Nummulites* spp., *Lockhrtaia* sp., *Lituonella* sp. (Fig.6), *Textularia* sp. and shell fragments. Depth interval 39.0 m – 52.0 m represent fossiliferous

dolomite and fossiliferous clayey dolomitic limestone, rich with mixture of planktonic and benthonic foraminifera namely *Truncorotaloides rohri* BRÖNNIMANN and BERMUDEZ (Fig.7), index of Early Upper Eocene (Early Bartonian), together with *Globorotalia broedermanni* CUSHMAN and BERMUDEZ (Fig.8), *Glt.* aspensis (COLOM), *Chiloguembelina* sp., *Globigerapsis* sp. together with traces of forams (*Nummulites* sp. and *Lockhrtaia* sp.), *Uvigerinella* sp., *Triloculina* sp., *Pyrgo* sp. (Fig.9), and miliolids. These horizones is characterized by chert occurrences and silicified sediments.

Depth interval 52.0 – 70.0 m was represent by clayey dolomite with *Assilina spira* DE ROISSY (Fig.10), traces of forams (*Nummulites* sp., *Lockhartia* sp. and others), echinoids spines and shell fragments of Middle part of Dammam Formation. Depth interval 70.0 – 76.0 m represented by dolomite with *Lockhartia alveolata* SILVESTRI and dolomitize planktonic of the middle member of Ratgah Formation (Damluk) of Upper Lutetian age. Depth interval 76.0 – 150.0 m represented by nummulitic clayey dolomite with *Nummulites gizehensis* FÖRSKAL (Fig.11), *Nummulites bayhariensis* CHECCHIA-RISPOL (Fig.12), *Lockhartia alveolata* SILVESTRI (Fig.13) *and Bigenerina* sp. (Fig.14) of Middle Dammam Formation.

It is very important to note that towards the position of Borehole 4 an interfingering of upper Dammam Formation with the upper member (Mugur) of Ratgah Formation had been encountered.

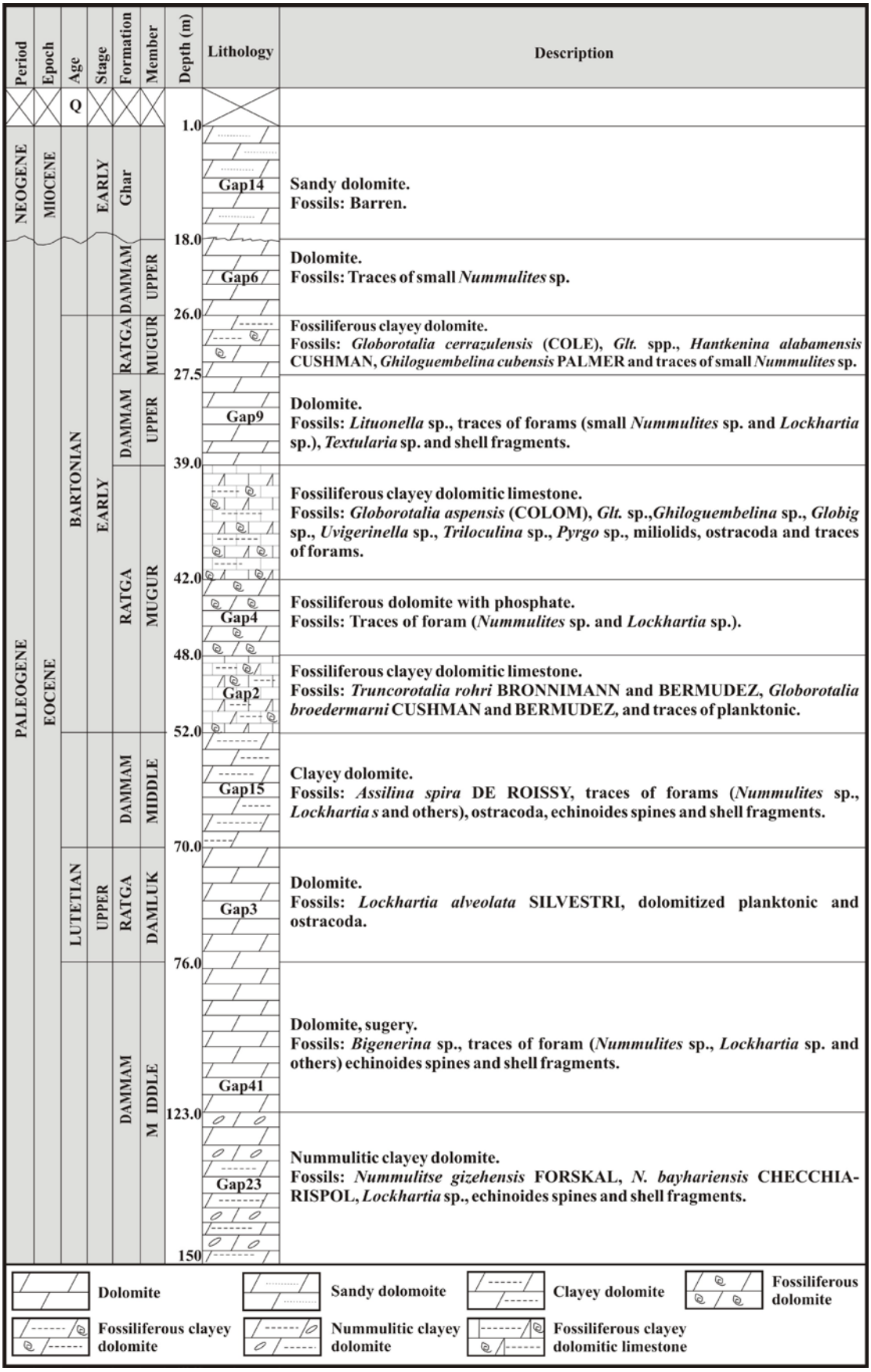

Fig.2: Stratigraphic column of BH4 (Scale: 1m = 1cm)

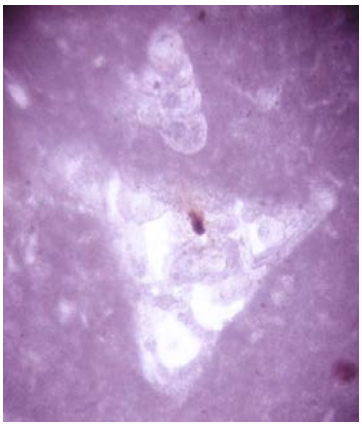

Fig.3: *Hantkenina alabamensis* CUSHMAN, *Chiloguembelina cubensis* PALMER, X20

Fig.4: *Chiloguembelina cubensis* PALMER, X20

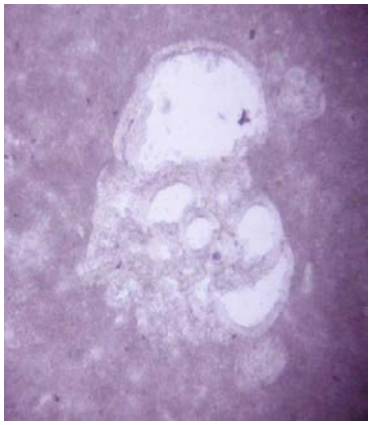

Fig.5: *Globorotalia cerrazulensis* (COLE), X20

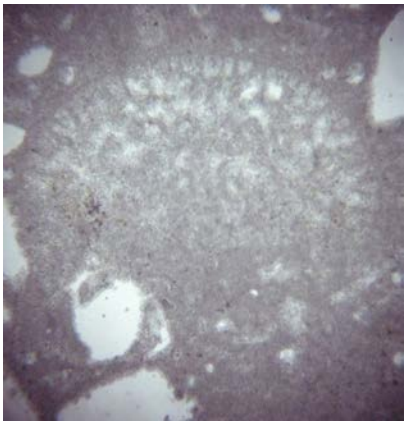

Fig.6: *Lituonella* sp., X10

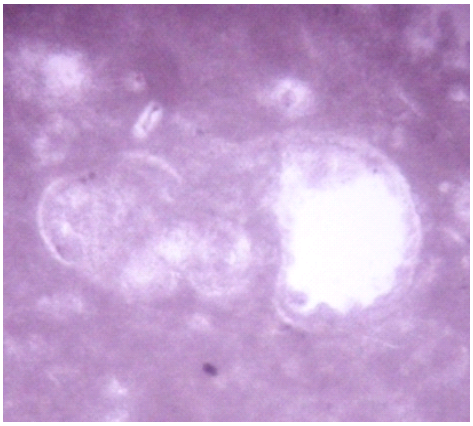

Fig.7: *Truncorotaloides rohri* BRONNIMANN and BERMUDEZ, X20

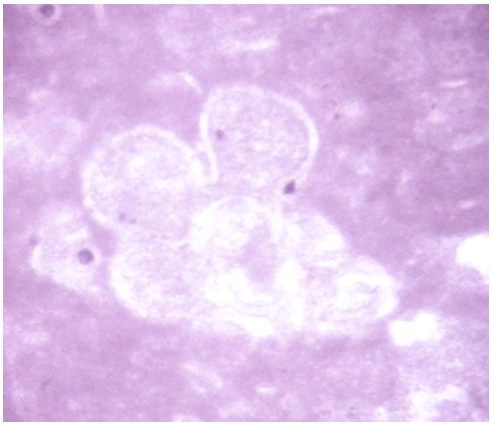

Fig.8: *Globorotalia broedermanni* CUSHMAN and BERMUDEZ, X20

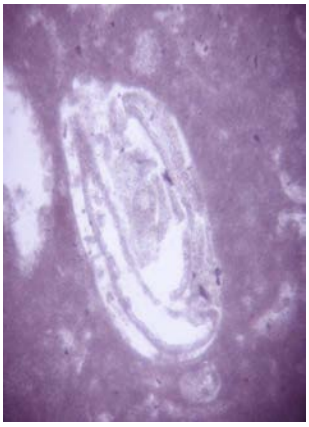

Fig.9: *Pyrgo* sp., X10

Fig.10: *Assilina spira* DE ROISSY, X10

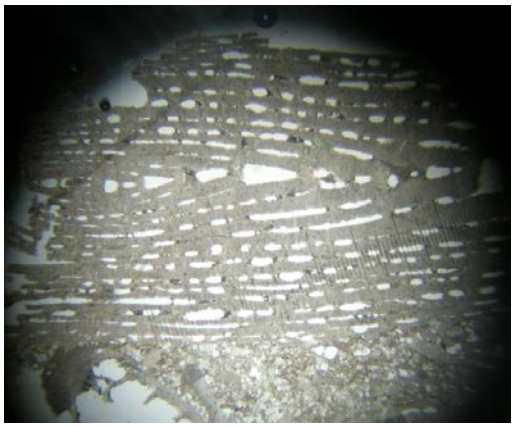

Fig.11: *Nummulites gizehensis* FÖRSKAL, X2.5

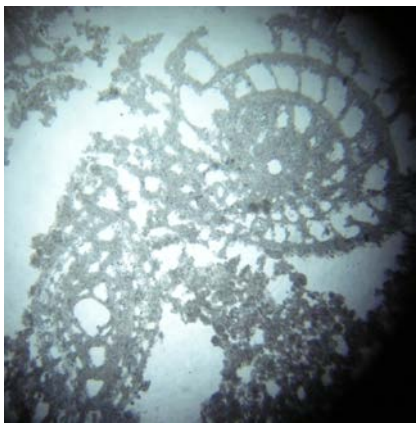

Fig.12: *Nummulites bayhariensis* CHECCHIA-RISPOL, X2.5

Fig.13: *Lockhartaia alveolata* SILVESTRI, X10

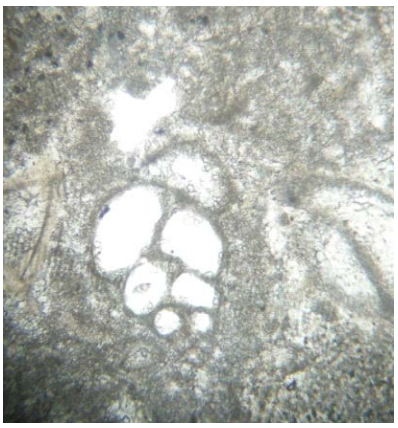

Fig.14: *Bigenerina* sp., X10

▪ **Borehole No.6**

Borehole No.6 (Fig.15) located at 45° 46' 21" E, 30° 35' 31" N, (Sheet NH-38-07-43).

The total thickness in the borehole is 120 m. Depth interval 0.0 – 0.7 m represents the Quaternary sediments, depth interval 0.7 – 5.9 m represents sandy dolomitic limestone of Zahra Formation. The Ratgah Formation (Mugur Member) start at depth 5.9 – 11.0 m represented by dolomite rich with *Hantkenina alabamensis* CUSHMAN, *Hantkenina* sp., *Globorotalia* spp., *Pyrgo* sp., miliolids and shell fragments, the presence of *Hantkenina alabamensis* CUSHMAN indicate the Early Upper Eocene Epoch (Bartonian Stage).

Depth of 11.0 – 82.0 m represents clayey dolomite and dolomite, abundant planktonic foraminifera is present i.e.: *Globorotalia broedermanni* CUSHMAN and BERMUDEZ (Fig.16), *Chiloguembelina cubensis* (PALMER) (Fig.17), *Goloborotalia* spp., benthonic forams were also present such as *Alveolina* sp. (Fig.18), traces of *Nummulites* spp., *Pyrgo* sp., *Quinqueloculina* sp., miliolids, biserial forams and shell fragments, these planktonic and larger foraminifera indicate the Middle Eocene (Lutetian) of the Damluk Member of Ratgah Formation. Depth interval 82.0 – 120.0 m represents by dolomite rich with traces of *Nummulites* spp., miliolids, echinoids spines, and shell fragments, of Middle Dammam Formation.

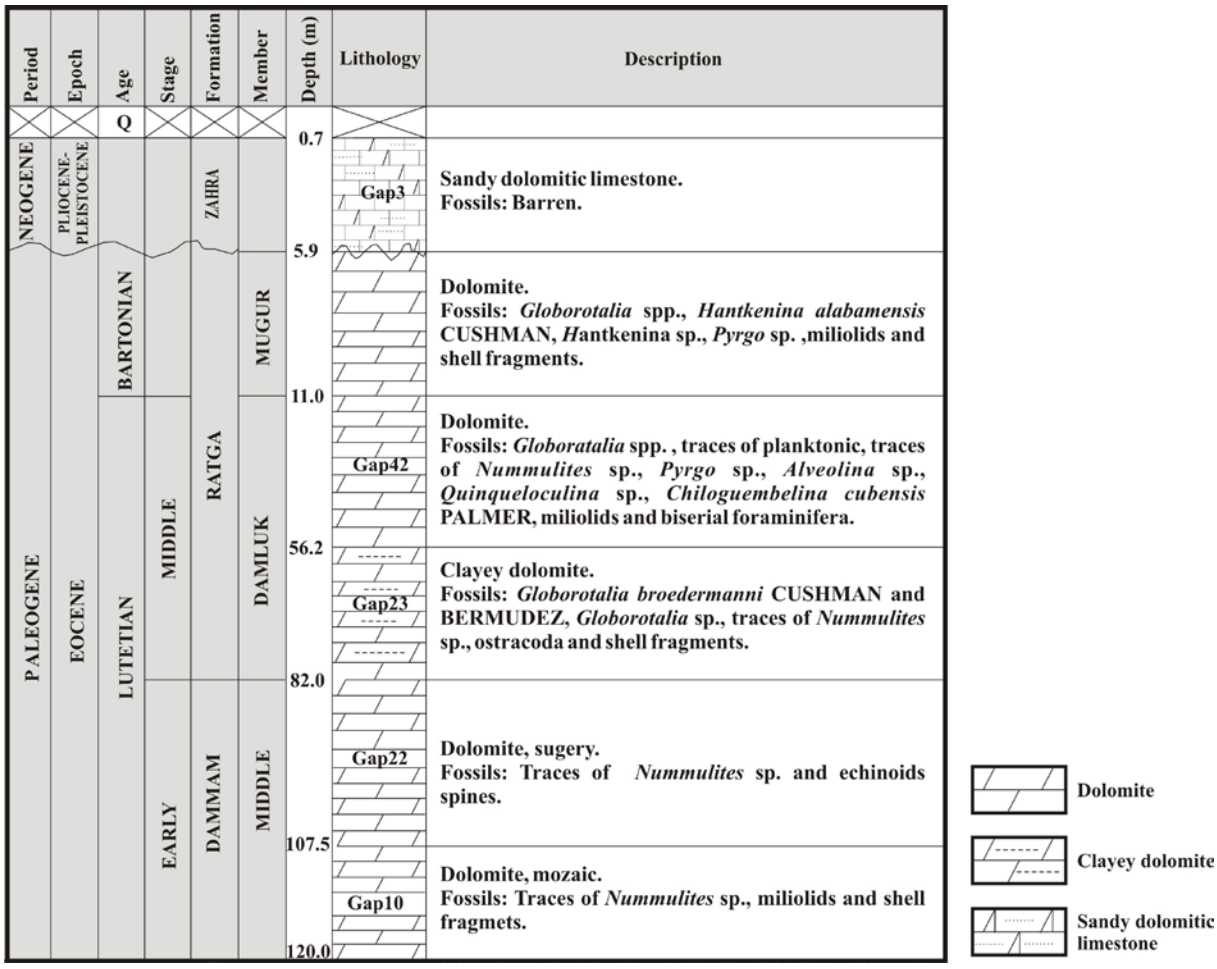

Fig.15: Stratigraphic column of BH6 (Scale: 1m = 1cm)

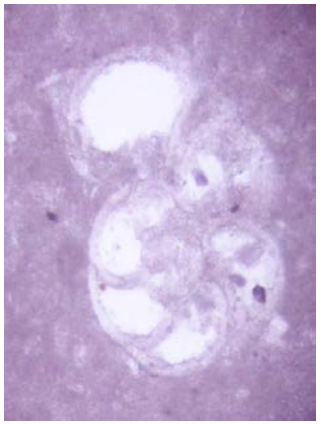

Fig.16: *Globorotalia broedermanni* CUSHMAN and BERMUDEZ, X20

Fig.17: *Chiloguembelina cubensis* (PALMER), X20

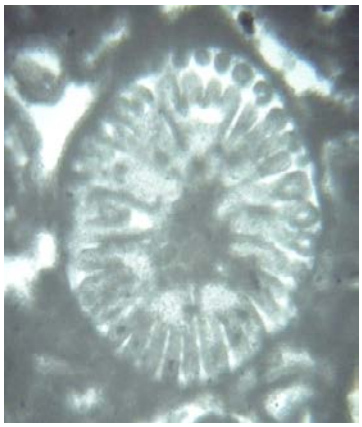

Fig.18: *Alveolina* sp., X10

▪ **Borehole No.7**

Borehole No.7, (Fig.19) lies at 45° 50' 49" E, 30° 34' 41" N, (Sheet NH-38-07-44).

The total thickness in the borehole is 150 m, depth interval from 0.0 – 1.0 m represents residual soil. Depth interval 1.0 – 9.8 m represents dolomite with *Peneroplis farsensis* HENSON, *Peneroplis* sp., *Triloculina* sp. and miliolids of Ghar Formation of Early Miocene.

Depth interval 9.8 – 146 m represents fossiliferous clayey calcareous dolomite, clayey dolomite and dolomite. At depth interval 11.5 m a few planktonic foraminifera are present mixed with *Nummulites* sp. and *Lockhartaia* sp., at depth interval 12.3 – 146.0 m, the presence of abundant *Acarinina bullbrooki* (BOLLI) (Fig.20), *Globorotalia broedermanni* CUSHMAN and BERMUDEZ (Fig.21), *Chiloguembelina cubensis* (PALMER), *Globorotalia* sp. with *Nummulites globulus* LEYMERIE, *Alveolina munieri* HOTTINGER, *Lockhartia alveolata* SILVESTRI, *Assilina spira* DE ROISSY (Fig.22), *Assilina* sp., *Beginerina* sp. (Fig.23), *Spiroloculina* sp. (Fig.24), *Bolivinoides* sp. and *Pyrgo* sp., all these faunas are indicative of Late Middle Eocene (Late Lutetian). Depth interval 146.0 – 150.0 m represents dolomite with traces of forams (*Nummulites* sp., *Lockhartaia* sp. and others), miliolids and shell fragments of Dammam Formation (Middle Member).

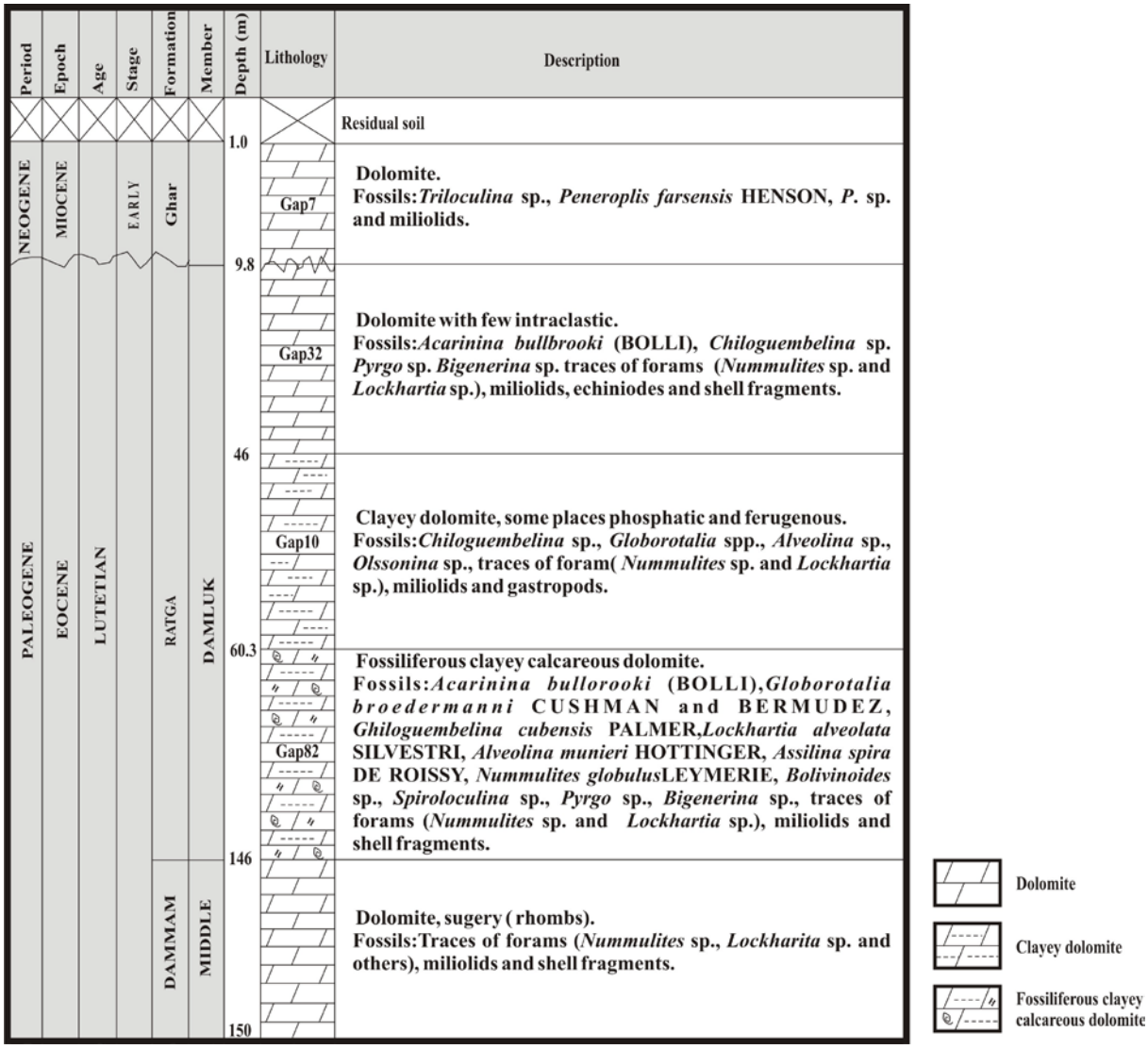

Fig.19: Stratigraphic column of BH7 (Scale: 1m = 1cm)

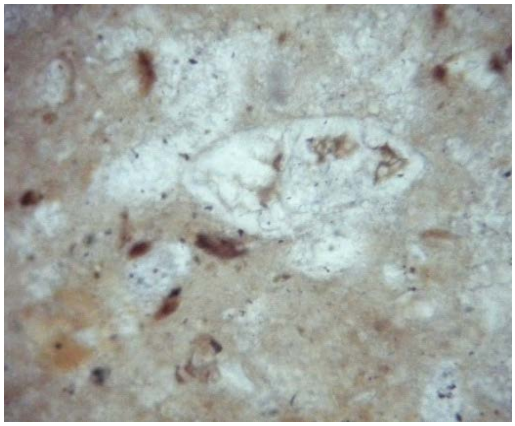

Fig.20: *Acarinina bullbrooki* (BOLLI), X20

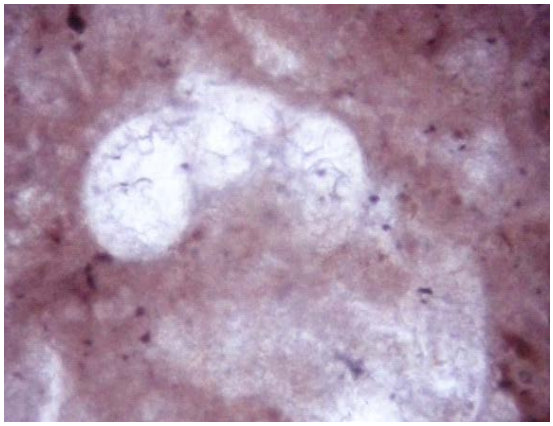

Fig.21: *Globorotalia broedermanni* CUSHMAN and BERMUDEZ, X20

Fig.22: *Assilina spira* DE ROISSY, X10

Fig.23: *Beginerina* sp., X10

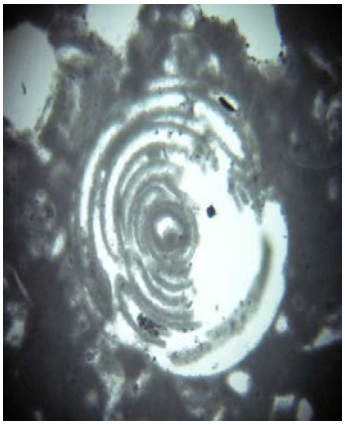

Fig.24: *Spiroloculina* sp., X10

- **Borehole No.8**

Borehole No.8, (Fig.25) lies at 46° 00' 27" E, 30° 34' 28" N, (Sheet NH-38-07-45).

The total thickness in the borehole is 100 m. The borehole starts with residual soil (interval depth 0.0 – 0.7 m). At depth interval of 0.7 – 33.2 m Early Miocene sediment is encountered representing Ghar/ Euphrates formations, sandy dolomitic limestone rich with Charaphyte, miliolids, gastropod, ostracods and shell fragments, the depth 33.2 m represent the unconformable contact between the Early Miocene and the early late Eocene of Mugur Member.

Between depths interval of 33.2 – 99.0 rich planktonic foraminifera is present: *Hantkenina alabamensis* CUSHMAN, *Truncorotaloides rohri* BRÖNNIMANN and BERMUDEZ, *Globorotalia aspensis* (COLOM), *Chiloguembelina* sp., *Globorotalia* spp., small molds of *Nummulites* spp., miliolids, rotallids and shell fragments. These planktonic foraminifera together with small *Nummulites s*p., *Coskinolina* sp, (Fig.26) *Praerhapydionina* sp. (Fig.27), *Spiroloculina* sp., ostracods and shell fragments, indicate the Early Upper Eocene (Early Bartonian), it is worthy to mention that this member contain phosphate and chert. Drilling stopped at this level.

▪ **Borehole No.9**

Borehole No.9, (Fig.28) lies at 46° 10' 32" E, 30° 37' 18" N, (Sheet NH-38-07-46).

The total thickness of in the borehole is 150 m. The boreholes start with Quaternary sediments (interval depth 0.0 – 1.2 m). At depth interval of 1.2 – 12.0 m a sandy dolomitic limestone includes rotallids, miliolids and shell fragments of Nfayil Formation of Middle Miocene age. At depth interval of 12.9 – 83.0 m a dolomitic limestone with pellet and oolite, silty clayey dolomite and sandy clayey dolomite rich with *Ammonia beccarrii* (LINNE), *Textularia* sp., *Pyrgo* sp., *Peneroplis* sp., *Elphidium* sp., *Rotalia* sp., miliolids, rotallids, gastropods, echinoids spines, and shell fragments belong to the Euphrates/ Ghar formations of Early Miocene age.

Depth interval 83.0 – 132.6 m is rich with traces of forams (small *Nummulites* sp., *Lockhartia* sp. and others) (Fig.29), *Olssonina* sp., mixed with shell fragments and miliolids all in a fossiliferous clayey dolomite representing the Upper Member of Dammam Formation, most probably the Early Bartonian stage of basal Upper Eocene.

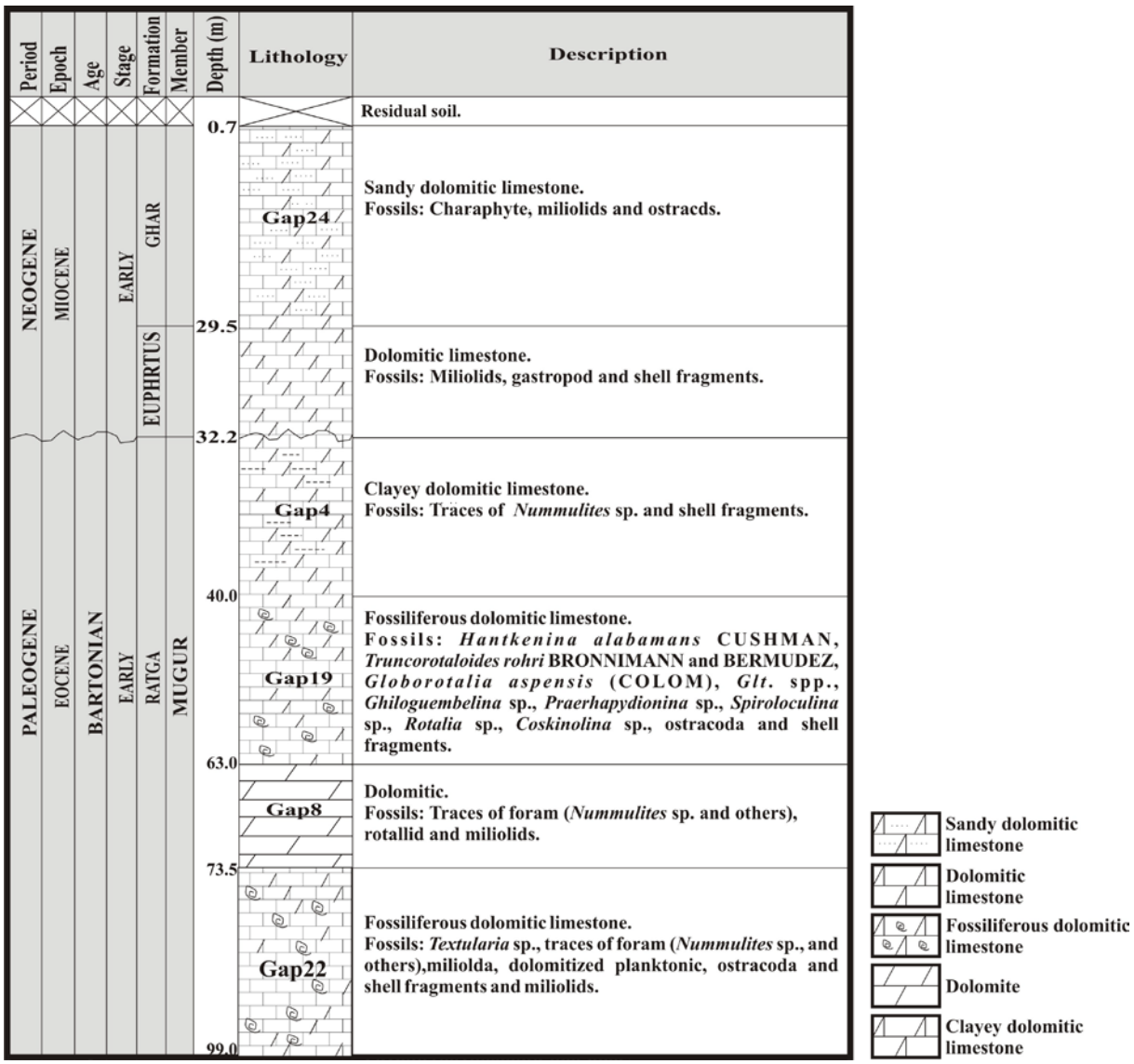

Fig.25: Stratigraphic column of BH8 (Scale: 1m = 1cm)

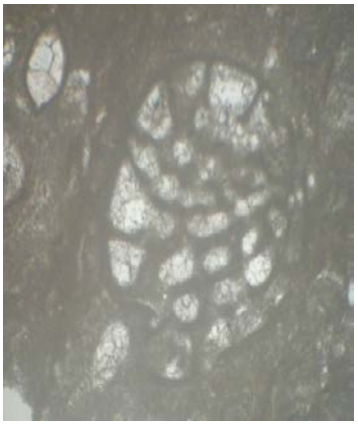

Fig.26: *Coskinolina* sp., X5

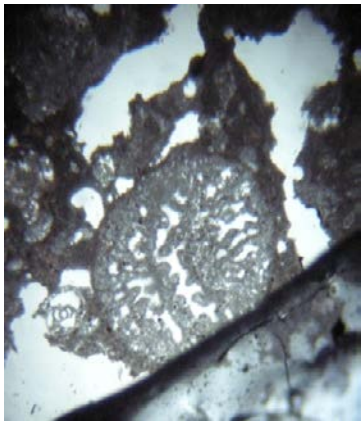

Fig.27: *Praerhpydionina* sp., X4

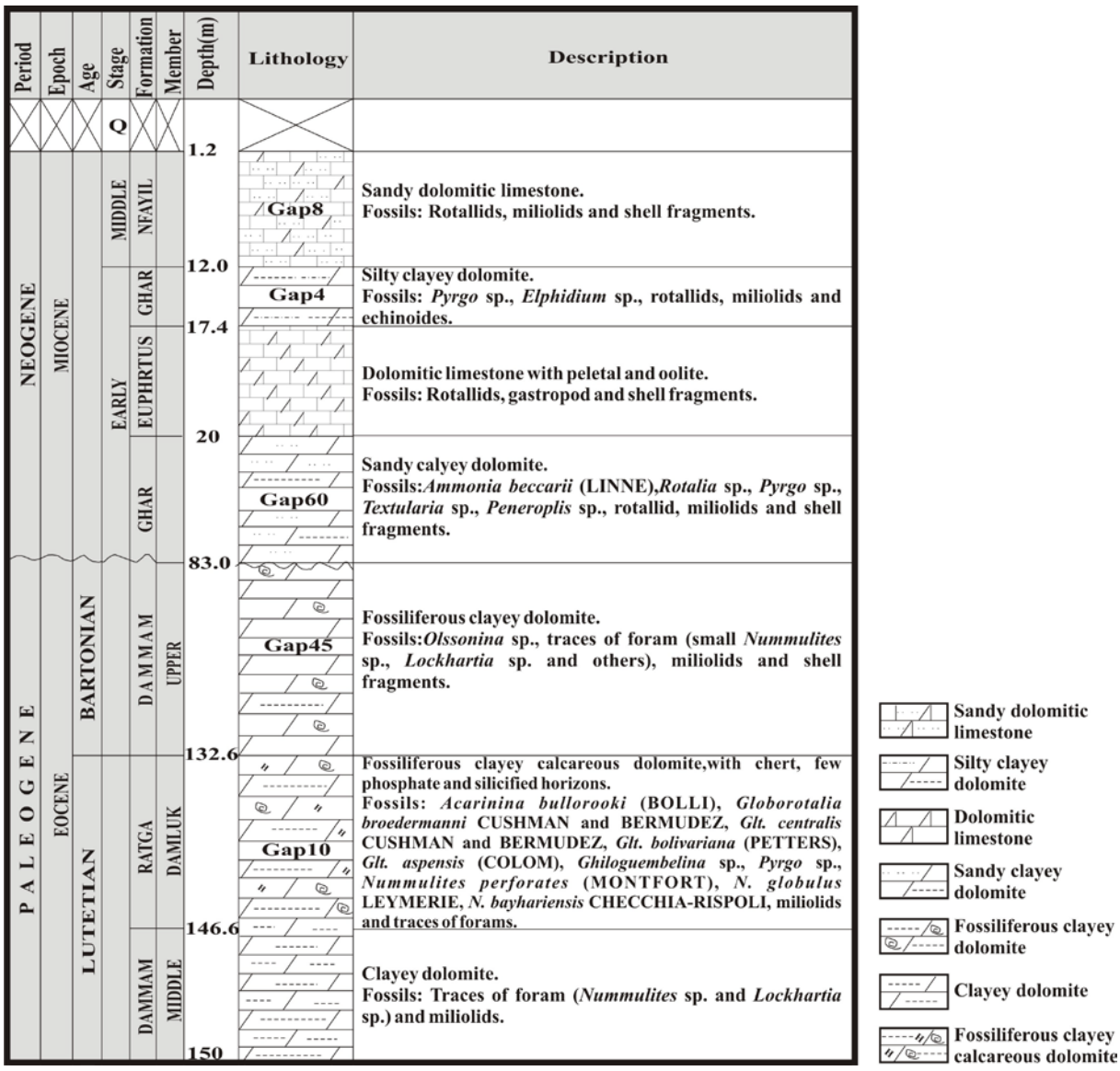

Fig.28: Stratigraphic column of BH9 (Scale: 1m = 1cm)

Depth interval of 132.6 – 146.6 m represents the Damluk member of Ratgah Formation of Middle Eocene; the sediments are fossiliferous clayey calcareous dolomite with common occurrences of phosphate, chert and silicified horizons with a mixture of planktonic/ benthonic foraminifera. depth interval of 132.9 – 134.20 m rich *Globorotalia* spp., *Pyrgo* sp. and shell fragments, depth of 134.1 – 138.2 m is rich with *Globorotalia* sp., *Lockhartaia alveolata* SILVESTRI and traces of *Nummulites* spp., depth interval 140.5 – 142.9 m is rich with planktonic foraminifera *Globorotalias*, and *Nummulites gizehensis* FÖRSKAL, depth of 143.2 – 146.1 m is rich with the index species of *Acarinina bullbrooki* (BOLLI), *Globorotalia centralis* CUSHMAN and BERMUDEZ, *Globorotalia aspensis* (COLOM), *Globorotalia bolivariana* (PETTERS), *Chiloguembelina cubensis* PALMER, *Globorotalia broedermanni* CUSHMAN and BERMUDEZ and larger benthonic foraminifera like *Nummulites perforate* (MONTFORT) (Fig.30), *N. globulus* LEYMERIE (Fig.31), and *N. bayharienesis* CHECCHIA-RISPOL, all are indicative of Late Lutetian (Late Middle Eocene). Depth interval of 146.1 – 150.0 m represents clayey dolomite with traces of forams (small *Nummulites* sp., *Lockhartia* sp.) and miliolids of Dammam Formation (Middle Member).

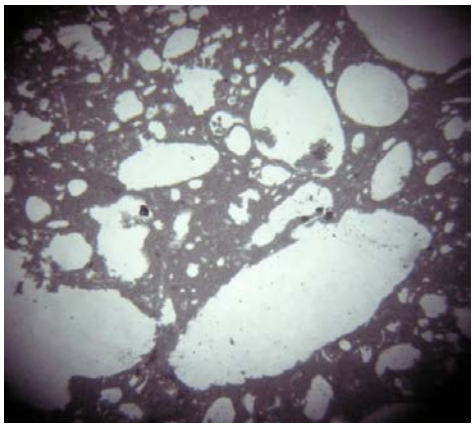

Fig.29: Traces of forams (small *Nummulites* sp., *Lockhartia* sp. and others), X 2.5

Fig.30: *Nummulites perforates* (MONTFORT), X5

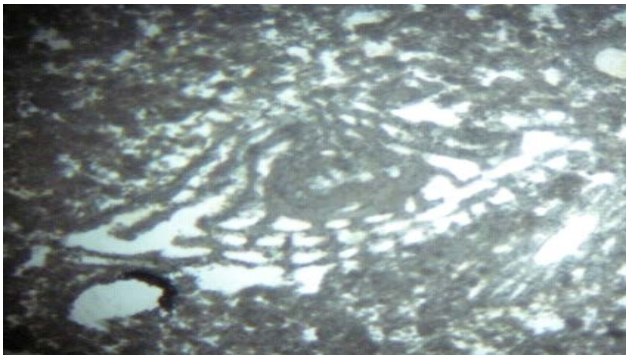

Fig.31: *Nummulites globulus* LEYMERIE, X5

COCLUSIONS

Based on the samples from five boreholes drilled in Nasirya provence, we studied the planktonic and larger foraminifera and correlated them with the studies of Al-Hashimi (1972) and Al-Hashimi and Amer (1985).

As for the planktonic foraminifera we compared them with the work of Blow (1979), *Beregren et al.* (1995), Jenkins (1995), Li, *et al.* (2003), Rincon *et al.* (2007) and Zakreveskaya and Beniamovsky (2011). The following are found:

- The Early Miocene – Early Upper Eocene boundary is marked by an unconformity, depth 18.0 m in borehole 4, shows an angular sandy horizon. The same is found at depth 9.8 m in borehole 7, at depth 32.2 m in borehole 8, at depth 83.0 m in borehole 9, it starts with Mugur Member of Ratgah Formation.
- There is similarity in lithology and fossils contents between the Ratgah Formation and the samples from these five boreholes both have chert horizons and phosphate and both have the mixing character of planktonic/ benthonic foraminifera. The studied samples are different from the Dammam Formation which is rich with nummulitic shoals and the upper part is lagoonal miliolids dolomite or dolomitic limestone, while in this study the mixing nature of planktonic and benthonic fauna was found in a clayey phosphatic cherty with some part silicified horizon or dolomitic.
- The depositional position of Dammam Formation, based on fauna, ranges from shoal facies to inner shelf facies while this study shows the mixing of planktonic with larger foraminifera which indicate deposition on a shelf edge/ upper slope area which is similar to the depositional condition of Ratgah Formation in the Western Desert.

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