BIOSTRATIGRAPHY OF THE MISHRIF FORMATION FROM WELL AMARAH-1 SOUTHEASTERN IRAQ

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ABSTRACT

The fossils of the Mishrif Formation for well Amarah-1 in southeastern Iraq was studied, where 312 thin sections have been used for litho-and biostratigraphic studies. Two biozones have been distinguished within the studied succession**;** these are from older to younger:

1- ***Praealveolina cretacea*** partial range zone
2- ***Praealveolina tenuis*** range zone

According to these zones, the age of formation was Late Cretaceous (Cenomanian – Early Turonian). Microfacies analysis showed six environmental indicative facies associations within the Mishrif carbonate platform; these are: deep open marine, shallow open marine, shoal barriers environment, rudisted barriers, back barrier and restricted marine environments.

الطباقية الحياتية لتكوين المشرف لبئر عمارة-1، جنوب شرق العراق

رشا طالب الدليمي و سعد سامي الشيخلي

المستخلص

تمت دراسة المتحجرات لتكوين المشرف لبئر عمارة-1 في محافظة ميسان، من خلال فحص 312 شريحة مجهرية حيث جرى التعرف من خلالها على المحتوى الحياتي الموجود في هذا التكوين، وتم تحديد نطاقين حياتيين من الأقدم الى الأحدث:

1- النطاق الأسفل: نطاق المدى الجزئي للنوع ***Praealveolina cretacea***
2- النطاق الأعلى: نطاق المدى للنوع ***Praealveolina tenuis***

واستنادا لذلك تم تحديد عمر التكوين بالطباشيري الأسفل (سينوماني – توروني مبكر) ومن ثم دراسة السحنات الدقيقة وأثبت أن التكوين ترسب في ست بيئات بحرية رسوبية مختلفة وهي: البيئة البحرية العميقة المفتوحة، البيئة البحرية الضحلة المفتوحة، بيئة الحواجز المتضحلة، بيئة الحاجز الرودستي، بيئة خلف الحيد والبيئة البحرية المحصورة.

INTRODUCTION

Mishrif Formation is one of the most important formations in Iraq, both economically and geologically, which was deposited during the Cretaceous period within the secondary sedimentary cycle (Cenomanian – Early Turonian) and is regarded as the principal carbonate reservoirs in central and southern Iraq.

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The Cenomanian Mahilban, Maotsi and Fahad formations of central Iraq are the lateral chronostratigraphical equivalent of the Mishrif, and equivalents of both Mishrif and Rumaila formations in southern Iraq. These units together represent single Mid-Cretaceous carbonate succession in the Mesopotamian Basin. The Mishrif Formation, part of Wasia group is a carbonate succession wide spread out through the Arabian Gulf (Al-Sherhan and Narine, 1988). The Mishrif Formation in central Iraq reflects the continuous deposition of shallow shelf carbonates periodic rises in sea level, which have led to episodes of deeper sedimentation down.

- **Aim of Study**

1- Studying the fossils of previously prepared thin section of well Amarah-1 (312 core samples)
2- Delineating the possible biostratigraphic zones.

- **Location**

Amarah-1 well is located within the Maysan Governorate at southeastern Iraq, south the city of Amarah, (Fig.1), with coordinates: 695 300 E, 3519 250 N, top (3228) and bottom (2870). According to the tectonic zones of Iraq, the study area is located in the Unstable Shelf (Al-Kadhimi *et al*., 1996).

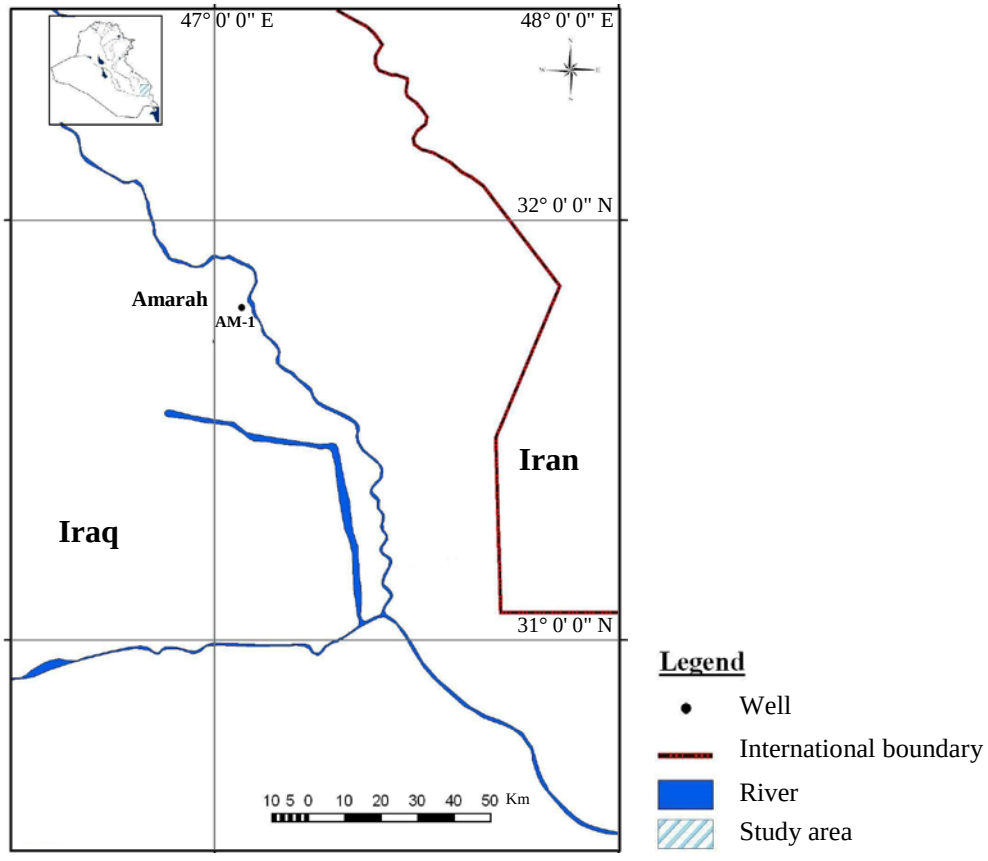


Fig.1: Location map of study area shows well Amarah-1

- **Previous studies**

The description of Mishrif Formation for the first time was given by (Rabanit, 1952) in well Zubair-3 from the upper part of what was previously called Khatiyah Formation, which was divided later on into three separated formations, i.e., Ahmadi, Rumaila and Mishrif formations. This formation was studied by Smout (1956). James and Wynd (1965) studied Sarvak Formation in Iran and they considered the upper part as representative of the typical Mishrif facies in Iran (Table 1).

Owen and Naser (1958) described the lithological cross-section of this formation in well Zubair-3; they considered it as a typical section.

Chatton and Hart (1961) studied the stratigraphic section of the Cenomanian – Turonian deposits and believed that Kifl Formation is, in terms of time, equivalent to Mishrif Formation in its upper part and it represents late facies that deposited in basins towards the end of marine regression. Al-Naqib (1967) studied Mishrif Formation and suggested that most of its rocks are limestone and contain small shale in some places and remnants of fossils and peloids.

- EIf – Iraq Company (1970) studied Mishrif Formation in Buzergan oil field southeast of Iraq, Its biostratigraphy, depositional environments and reservoir specifications. They also studied the formation in Fuqua oil field, analyzing its biostratigraphy and facies analysis.
- Gaddo (1971) divided the depositional environment of Mishrif Formation into rudist marine reef environment, which interferes with lagoon littoral – lake environment, algal facies with facies of basinal and sub-basinal environment.
- Al-Khersan (1975) believed that Mishrif Formation was deposited within five marine environments; they are intertidal, littoral, banks margins, banks and open sea environments.
- Al-Siddiki (1978) studied Mishrif Formation in southeastern part of Iraq and he indicated that the formation is composed of limonitic limestone, brown limestone and mud limestone.
- Agip Company (1980) studied facies and environment of Mishrif Formation in Halfaya field and drew a sedimentological and environmental model for this formation in the studied area.
- Reulet (1982) studied Mishrif Formation in south of Iraq, its facies, depositional environment and reservoir specifications.
- Belarabi (1982) studied depositional environments and facies distribution of the formation in south of Iraq.
- Sherwani (1983) divided Mishrif Formation into five depositional environments.
- Al-Nuaimy (1990) studied genres and types of large foraminifera, which include Alveolinde and their different kinds in Mishrif Formation.
- Al-Therb (1996) studied the biostratigraphy and facies of the formation with age Early Cenomanian – Turonian in south of Iraq which includes Mishrif Formation.
- Al-Jumaily (2001) studied Mishrif Formation in selected oil fields in south of Iraq, its facies and depositional environment and introduced a table indicating the horizontal and vertical relation for Albian – Turonian formations.
- Mahdi (2004) studied the sequence stratigraphy of Mishrif Formation in selected wells in the south of Iraq.
- Al-Khaldi (2004) studied the reservoir specification and determined the effective porosity of the formation in Halfaya field southeast of Iraq.
- Al-Ubaidy (2004) studied facies development, diagenesis processes and sedimentological cycles of Mishrif Formation.

- Al-Kilaby (2009) studied Mishrif Formation in Abu Ghirab and Fuqua field, its porosity and reservoir characters.
- Al-Rubiay (2009) studied the Sequence Stratigraphy in the wells of west Qurna and north Rumaila oil field, south of Iraq.

Table 1: Comparison with other biostratigraphic studies

<table>
<tr><th>AGE</th><th>STAGE</th><th>South Iraq (Abdul-Kareem and Yousif, 1990)</th><th>Saudi Arabia (Philip et al., 1995)</th><th>Southeast Iraq (Al-Therb, 1996)</th><th>South Iraq (Sharbazehry, 1999)</th><th>Southeast Iraq (Al-Badri, 2005)</th><th>Southeast Iraq (Al-Dulaimy, 2010)</th></tr>
<tr><td rowspan="6">MIDDLE CRETACEOUS</td><td rowspan="2">TURONIAN</td><td></td><td rowspan="3"></td><td rowspan="2"></td><td></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Qataria dukhani
Dicyclina schlumbergri</td><td>Heterhelix globulosa,

Rotalibora appennica</td></tr>
<tr><td>Praglobotruncana delrionesis</td><td>Cisalveolina lehneri</td><td>Praealveolina tenuis</td><td>Praealveolina tenuis</td></tr>
<tr><td rowspan="4">CENOMANIAN</td><td>Rotalina sp.</td><td rowspan="2">Praealveolina cretacea</td><td rowspan="2">Praealveolina cretacea</td><td rowspan="2">Praealveolina cretacea</td><td>Praealveolina cretacea</td><td>Praealveolina tenuis</td></tr>
<tr><td>Praealveolina cretacea,
Ovalveolina ovum</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Cisalveolina fallax</td><td rowspan="2"></td></tr>
<tr><td>Oligostegina sp.

Washintensis
Hedbergella</td><td></td><td>Nezzazata simplex</td></tr>
</table>

BIOSTRATIGRAPHY

Three hundred and twelve samples thin section were studied by a polarized microscope. Many fossils have been recognized through this study, especially planktonic and benthonic foraminifera. On the basis of biological content Mishrif Formation could be divided into a number of bio-zones depending on index fossils present.

- **Index Fossils of Mishrif Formation**

A number of index fossils present within Mishrif Formation have been recognized in order to establish the age of the formation. The most important fossils are planktonic foraminifera, which include *Hedbergella* spp. and *Oligostegina* sp., *Globigerina* sp. and *Hetrohelix* sp.; they play an important aspect in defining the transitional zones between Mishrif and Rumaila formations.

Many benthonic foraminifera are recognized within the formation and suggest the biozones below (Fig.2):

1- *Praealveolina cretacea* partial rang zone

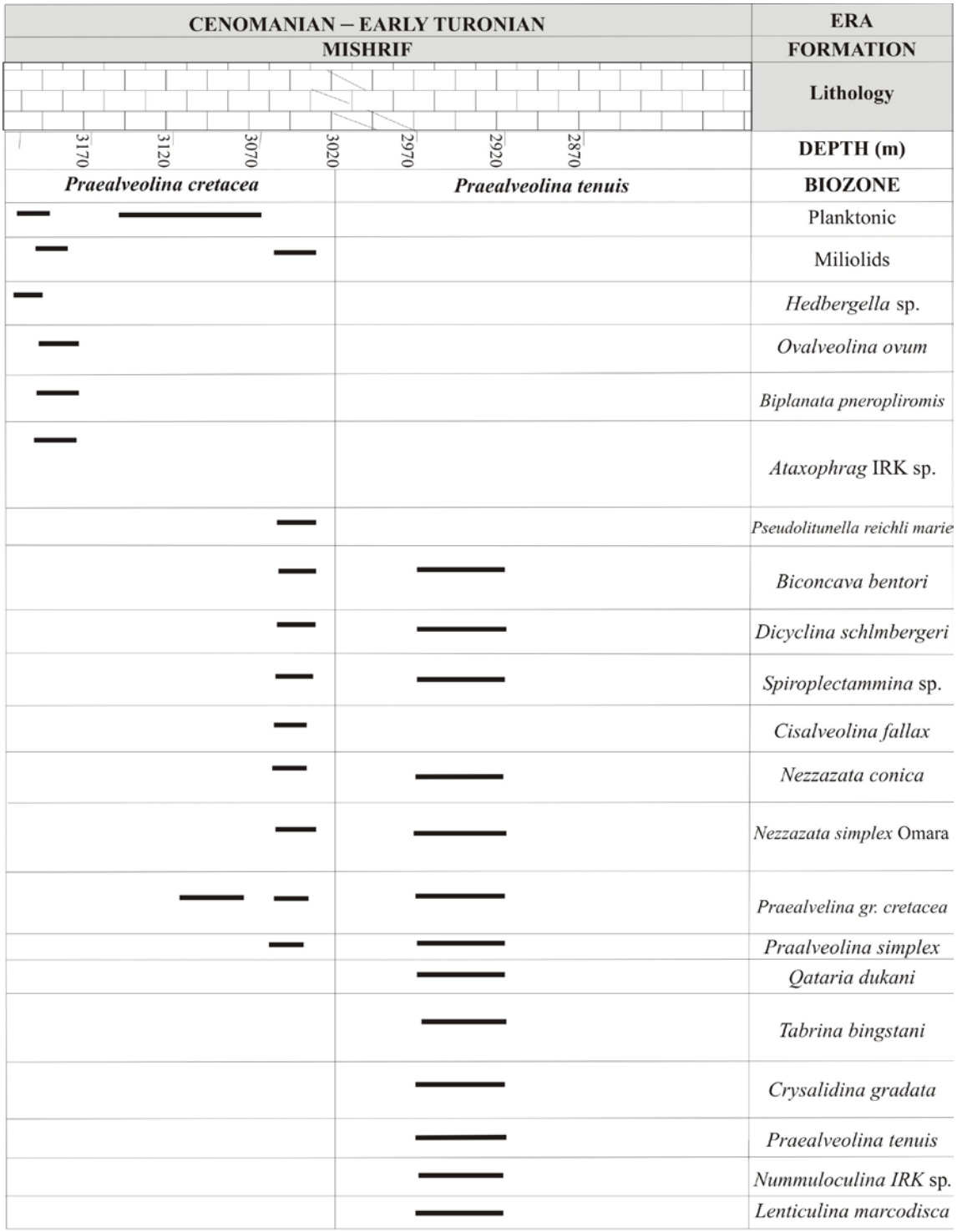
This nearly extends from the bottom to middle of the formation, accosssiated with the following species (depth 3220 – 3020 m):
Praealveolina cretacea D' archiac, *Biconcava bentori* Hamaoui, *Cisalveolina fallax* Reichel, *Dicyclina schlumbergeri* Munier-chalmas, *Nezzazata simplex* Omara, *Miliolids*, *Nezzazata conica* Smout, *Ovalveolina ovum* D' orbingy, *Praealveolina cretacea, Praealveolina simplex, Pseudolitunella* reicheli, *Spiroplectammina* sp., *Biplanata peneropiromis*, *Ataxophrag* IRK sp., *Cisalveolina fallax* Reichel, *Praealveolina simplex* Riechl, Planktons.

2- *Praealveolina tenuis* rang zone

This represents the upper part of the Mishrif Formation. The following species are found within the zone (depth 2970 – 2920 m):
Chrysalidina gradate D'orbingy, *Dicyclina schlumbergeri* Munier-chalmas, *Biconcava bentori* Hamaoui, *Cisalveolina fallax* Reichel, *Lenticulina macrodisca*, Miliolids, *Nezzazata conica* Smout, *N. simplex* Omara, *Praealveolina tenuis*, *Praealveolina simplex*, *Tabrina bingstani*, *Lenticulina macrodisca*, *Nummuloculina marcrodisca*, *Qataria dukani* Hensone, *Biconcava bentori* Hamaoui, *Spiroplectammina* sp., skeletal of echinoderm, calcareous algae, ostracoda, sponge spicules, corals and rudist (Figs.3, 4, 5 and 6).

According to Al-Naqib (1967), Gaddo (1971) and Brun (1971), the age of the formation was Early – Late Cenomanian depending on *Nezzazata simplex*. Al-Naggar and Al-Rifaiy, (1973) suggested age of the formation as Late Cenomanian depending on *Preaelveolina tenuis*, and *Ovalveolina ovum*. Al-Nuaimy (1990) suggests the age as Cenomanian – Turonian indicated by *Biconcava bentori*.

In the present study, the age was detremianed as Cenomanian – Early Turonian depending on index fossils of the formation, *Nezzazata simplex* Omara, *Praealveolina tenuis*, *Biconcava bentori* and *Cisalveolina fallax*.



scale 2 mm: 10 m

Fig.2: Vertical distribution of foraminifera and biozones of Mishrif Formation in well Amarah-1

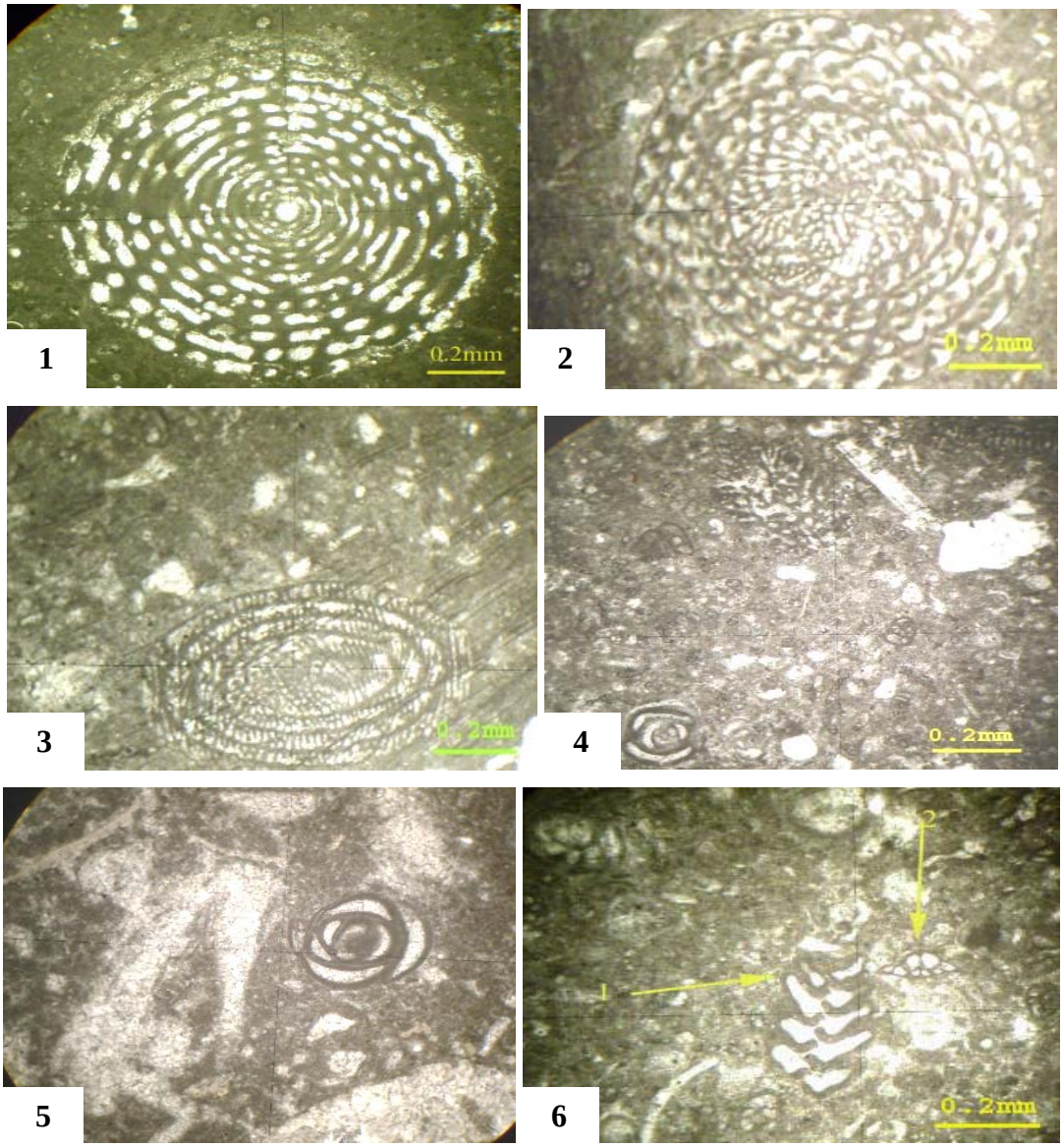


Fig.3: Index Fossils

1- *Cisalveolina frassi* in foraminiferal lime wackestone (AM-1, 2870 m, X10)
2- *Praealveolina tenuis* in foraminifera lime
3- *Praealveolina tenuis* in foraminifera lime wackestone (AM-1, 2926 m, X10)
4- *Tabrina bingstani*, calcareous algae, miliolid, calcisphere in foraminiferal lime wackestone (AM-1, 2926.8 m, X10)
5- Miliolids with bioclastic packstone (AM-1, 2576 m, X50)
6- (1) *Pseudorhapdionina dubia*, (2) *Nezzazata simplex*, sponge spicules and calcisphere in bioclastic foraminifera wackestone (AM-1, 2868m, X10)

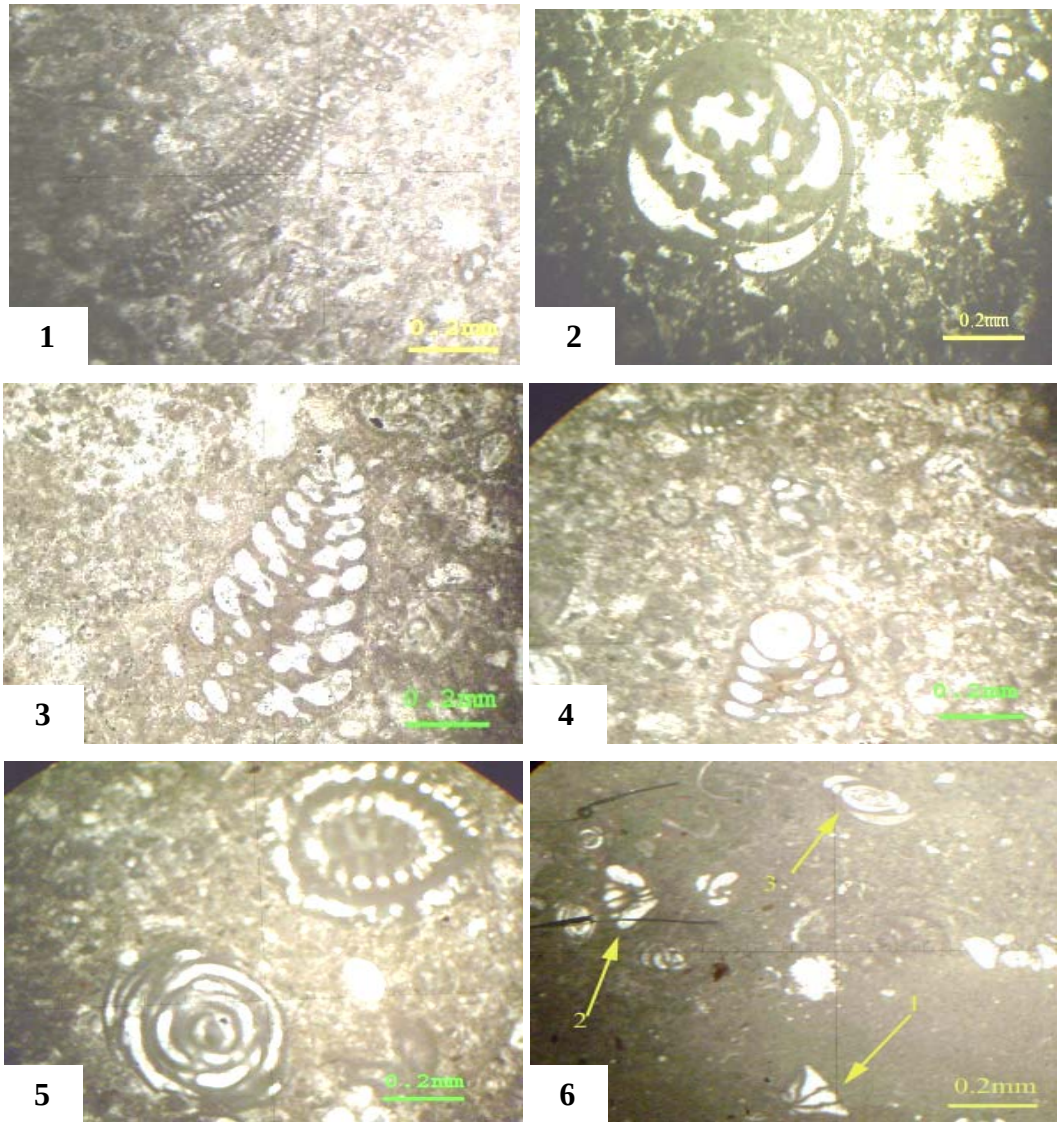


Fig.4: Index Fossils

1- *Dicycilina schlmbergeri*, *Nezzazata simplex* in foraminifera lime wackestone (2929, X10)
2- Miliolids, calcisphere, planktonic and *Chrysalidina gradata* in foraminifera lime wackstone with micrite (AM-1, 2929 m, X10)
3- *Chrysalidina gradata* and calcareous algae in foraminifera lime wackestone (AM-1, 2930 m, X40)
4- *Chrysalidina gradata*, *Nezzazata simplex* and calcareous algae in foraminiferal bioclastic packstone (AM-1, 2930 m, X10).
5- *Praealveolina tenuis*, *Nummoloculina* sp. and calcareous algae in foraminiferal lime wackestone
6- (1, 2) *Nezzazata simplex*, (3) Miliolids with fragment and micrite in foraminifera lime wackestone (AM-1, 2950 m, X10)

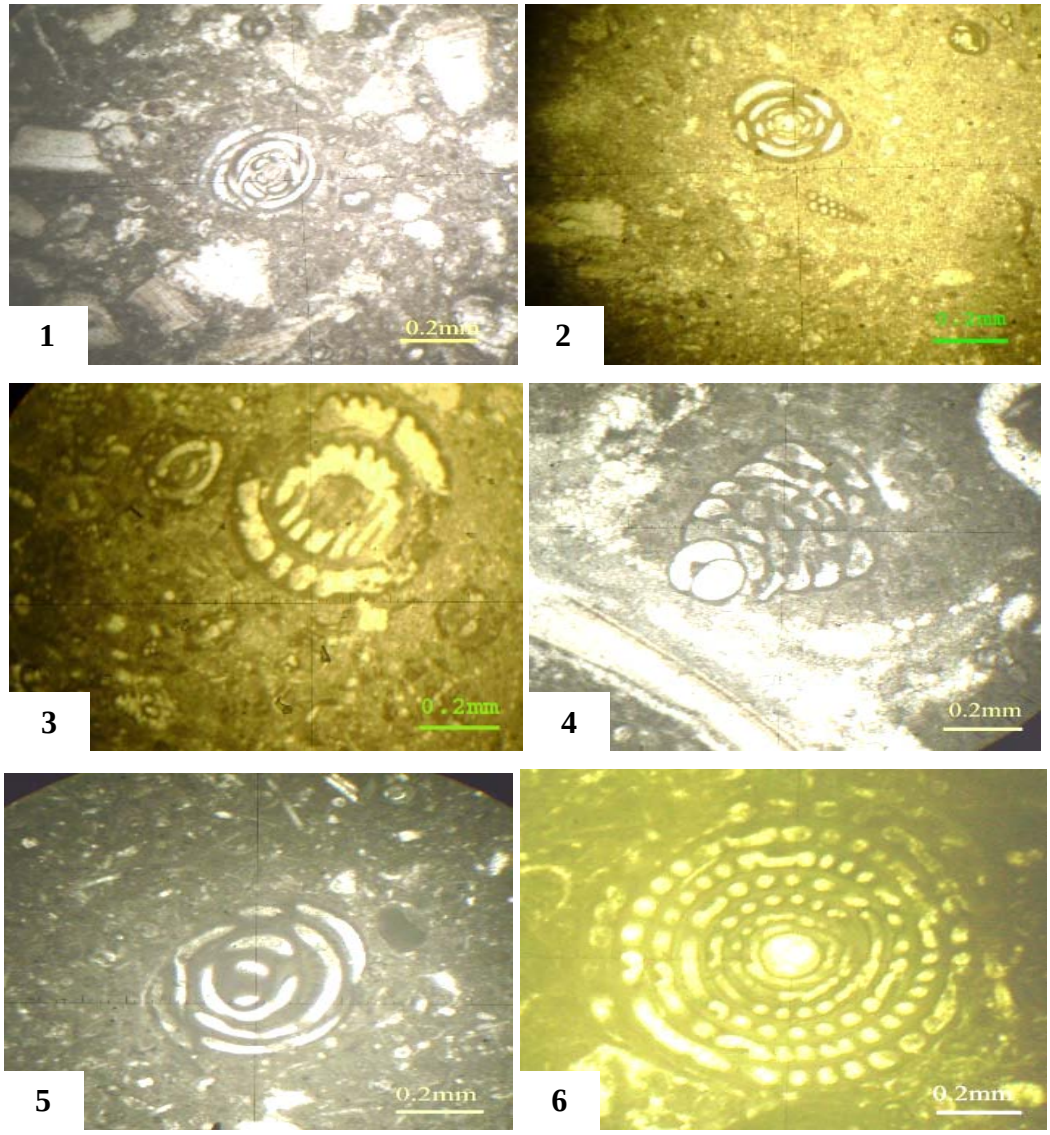


Fig.5: Index Fossils

1- Miliolid with debris of rudist and ostracoda in rudisted packstone (AM-1, 2935m, x10)
2- Miliolids, *Spiroplectammina* IRK sp. and rudist in bioclastic foraminifera wackestone (AM-1, 2953 m, X10)
3- *Praealveolina tenuis*, miliolid and calcareous algae in bioclastic foraminifera wackestone (AM-1, 2953 m, X40)
4- *Chrysalidina gradata* with neomorphism in foraminifera lime wackestone (AM-1, 2926.4 m, X4
5- Calcisphere, sponge spicules and *Nummoloculina IRK* sp. in foraminifera bioclastic wackestone (AM-1, 2966 m, X10)
6- *Cisalveolina lehneri*, sponge spicules with pelloids in bioclastic foraminifera packstone (AM-1, 2965 m, X40)

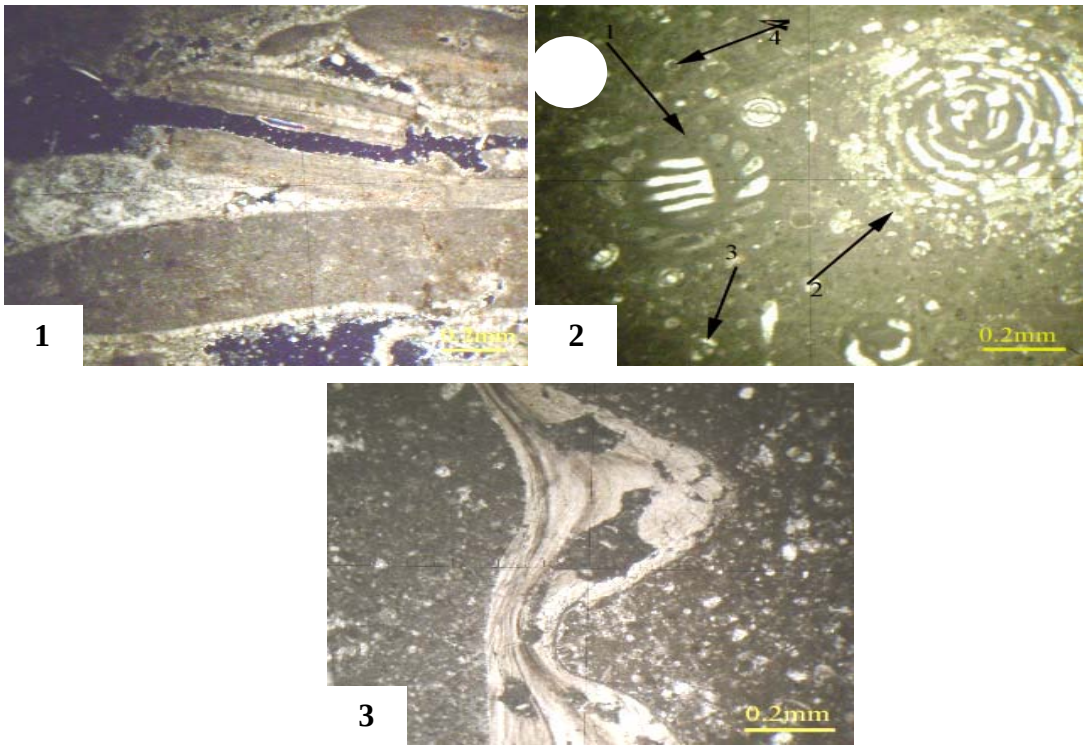


Fig.6: Index Fossils

1- Debris of rudist in rudisted grainstone with big intraclastic (AM-1, 2890 m, X40)
2- (1) *Ovalveolina crassa* with (4) calcisphere, (3) *Nezzazata simplex* in foraminifera wackestone (AM-1, 2266 m, X10)
3- Rudist debris show boring in the rudist, bioclastic lime wackestone (AM-1, 2329 m, X10)

MICROFACIES AND DEPOSITIONAL ENVIRONMENT

Many facies association were distinguished in the Mishrif Formation. Each represents a destine depositional environments (Fig.7):

1- Deep open marine facies:
a- Pelagic lime mudstone
b- Pelagic lime mudstone – wackestone

2- Shallow open marine facies:
a- Foraminiferal lime wackestone
b- bioclastic lime wackestone – packstone
c- Rudistid lime packstone

3- Shoal barriers facies:
a- Pelloidal and rudisted lime grainstone
b- Pelloidal and rudisted lime packstone
c- Rudisted and pelloidal lime packstone – Grainstone

4- Rudisted biostrome barriers facies:
a- Rudisted lime boundstone
b- Rudisted lime boundstone with rudisted lime Grainstone

5- Back barrier facies:
a- Bioclastic and foraminiferal lime packstone
b- Foraminiferal and bioclastic and pelloidal lime (wackestone with packstone)

6- Restricted Marine facies:
a- Interbedded Foraminiferal and Bioclastic lime (wackestone with packstone)
b- Foraminiferal and bioclastic lime wackestone

According to Wilson (1975), SMF types are characterized by SMF3, SMF7, SMF10, and SMF16.

DEPOSITIONAL ENVIRONMENT OF THE MISHRIF FORMATION

The carbonate of the Mishrif Formation is deposited within six marine environments, starting from the outer shelf, which includes deep open marine, shallow open marine, shoal barriers, rudisted biostrome ending to inner shelf environment, which includes back barrier environment and restricted marine environment.

CONCLUSIONS

According to the biozones the age of the Mishrif Formation, considered as Cenomanian – Early Turonian.

- Six microfacies were recognized, depending on the fossils content and lithological characters they are:
  1- Pelagic lime mudstone, Pelagic lime mudstone – wackestone.
  2- Pelagic lime wackestone, bioclastic rudistid lime wackestone – packstone and rudistid lime packstone.
  3- Pelloidal and rudistid lime grainstone, pelloidal and rudistid lime packstone and rudistid and pelloidal lime packstone – grainstone.
  4- Rudistid lime boundstone, rudistid lime boundstone and rudistid lime grainstone
  5- Bioclastic and foraminiferal lime packstone, foraminiferal and bioclastic and pelloidal lime wackestone – packstone,
  6- Foraminiferal and bioclastic lime wackestone – packstone and foraminiferal and bioclastic lime wackestone
- Depending on the biostratigraphic and the microfacies analyses, the Mishrif Formation was deposited in six marine environments: deep open marine, shallow open marine, shoal barriers, rudisted biostrome ending to inner shelf environment, which includes back barrier environment and restricted marine environment.

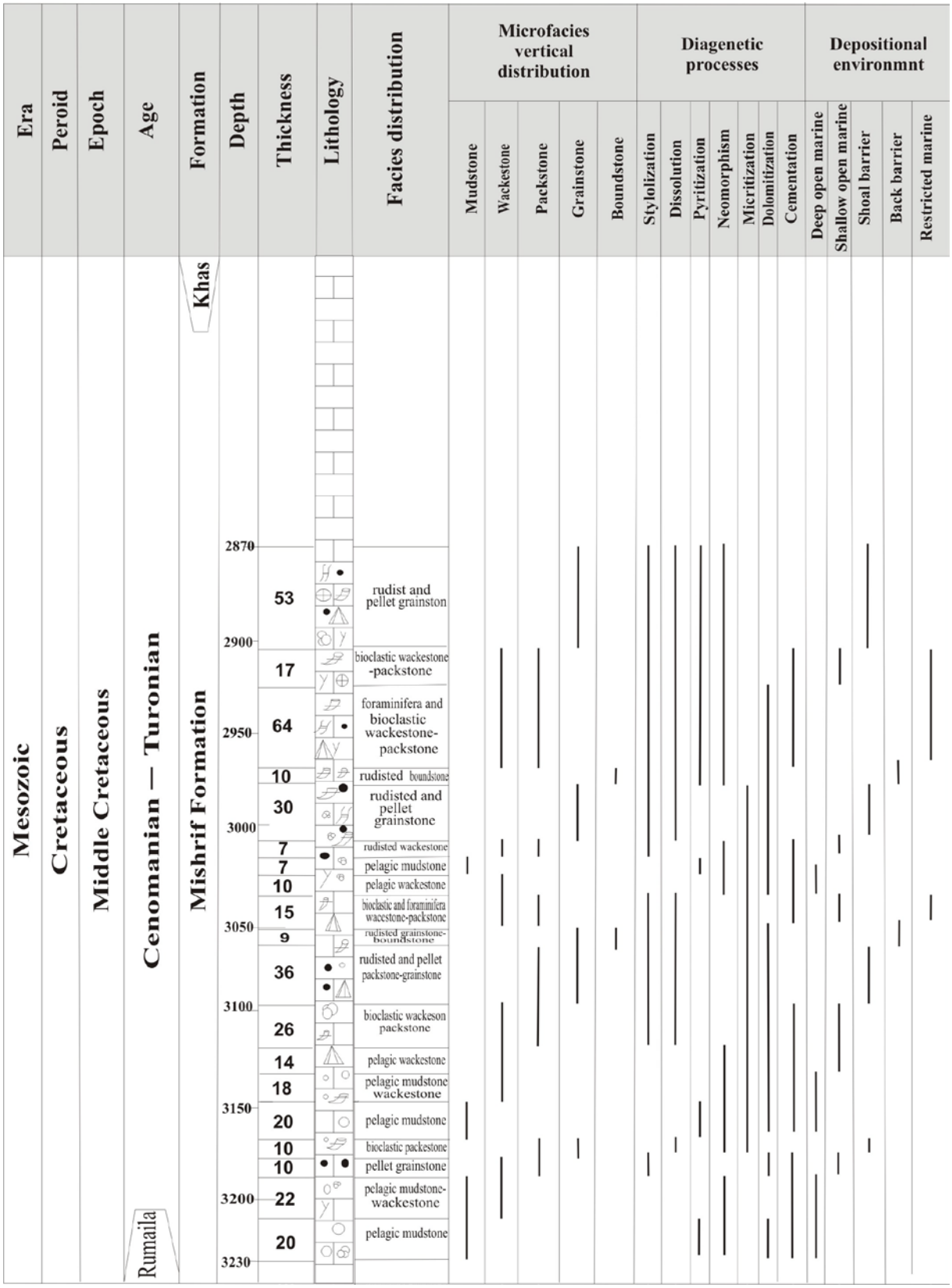


Fig.7: Vertical distribution of facies and diagenetic processes and depositional environment in well Amarah-1

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