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Original Article

Sedimentology & Microfacies Study of the Nfayil formation in Southern Samawa, -IRAQ

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ABSTRACT

The petrographic study is based on 88 samples obtained from 18 surface sections. The aim of this study is to shed more light on the facies, and the environment deposition for Nfayil formation, which is results depositional environments are interpreted as categorized by Flugel (2004). Show restricted carination on marine platform, deposited in very shallow hypersalline lagoon, was deposited in shallow marine environment with normal salinity. The age of Nfayil Formation, depending on the fossils content (Peneroplisfarsensis, Ammonia beccarii, Elphidiumsp., Textulariasp., Miliolids, rotalids). The assemblage fauna above the typical is Middle Miocene which is equivalent to Fat`ha Formation.

KEYWORDS: Petrography, Nfayil Formations, Samawa, Facies, Depositional Environment.

INTRODUCTION

The study area concern is a part of the Southern Desert of Iraq, which is still, in most of its parts, not well explored or mapped in detail to allow a fair understanding of its geology and stratigraphy. Generally, the Southern Desert is a part of the Arabian Platform, covered by Tertiary marine carbonate sedimentary rocks (lacking Oligocene rock units) and younger continental clastic and carbonate sediments(Jassim. and Al-Jiburi,2009).

The Nfayil Formation is recently announced and added to the stratigraphic column of Iraq by Sissakian et al. (1997). It is equivalent to the Fat'ha Formation of Middle Miocene age (Sissakian, 1999), and same as Fat'ha rocks and consists of alternation of green marl and limestone, except the absence of the gypsiferous beds in the Nfayil Formation. Previously in the study area, Nfayil Formation was included within the Euphrates Formation, (Al Mubarak and Amin, 1983). The type section of Nfayil Formation is of composite type (Bellen et al ,1959). The Lower Member is in GaratNfayil south of Haditha, whereas, the Upper Member is exposed at 3 Km to the west of Al-Habbania Lake (Buday1973). In the study area, (Al-Mubarak and Amin, 1983) denoted that the lower and middle cycles of the Lower Member of Nfayil Formation were considered as two members of the Euphrates

Formation, representing the Middle and Upper Members. The exposed thickness of Lower Member of Nfayil in the tudy area is a bout (12.0 m).

Lower Member of the Nfayil Formation exposed in the study area in limited area forming Mesas and small spots overly Euphrates formation. Only the lower member of the Nfayil formation, which consists of cyclic deposits, is exposed in the study area (Figure 1). The Lower Member of Nfayil Formation could be includes three cycles (Figure 2)., they are described here :The first cycle consists of (1 – 4) m of olive green marl, soft, massive, slope forming, fragmented, with rusty materials and secondary gypsum. In some locations, the marl bed becomes conchoidal fractured, in other locations it becomes highly burrowed, the burrows are filled with carbonate materials of the overlying limestone bed. The marl bed is overlain by (1 – 2) m of limestone, varicolored like yellowish white, pinkish yellow, pink or red in some locations, with different contents of sand grains. In some areas, it becomes sandy, recrystallized, highly fossiliferous especially in the upper part, cliff forming. The second cycle consists of a marl bed of the same properties of the first cycles; the marl is capped by a highly fossiliferous limestone. The difference between the two cycles is the presence of Oyster shells in the second cycle, which were found on the top or within the bedding planes of the limestone bed, or scattered on the slope of the marl bed after the limestone bed had been eroded. The other difference was observed on the contact between marl and limestone, in some locations. In the second cycle the contact becomes gradational and the limestone bed begins to appear marly and changes upward to chalky limestone. In the first cycle, this contact is sharp in most locations. The Third cycle consists of the same rock of lower two cycles in the area of type locality of Nfayil Formation consist of alternation of marl, limestone and dolomitic limestone. a small part of third cycle crops out in the north southern desert in the mesa of Al- Amgar hill. The exposed beds of this cycle in the prementioned location consist of 1.5 m of olive green marl, soft, slope forming, with secondary gypsum and rusty materials with black dots. This is overlain by limestone bed, yellowish grey, medium tough to tough, recrystallized, porous, gradational contact capped by reddish grey limestone, tough, step forming, cavernous.

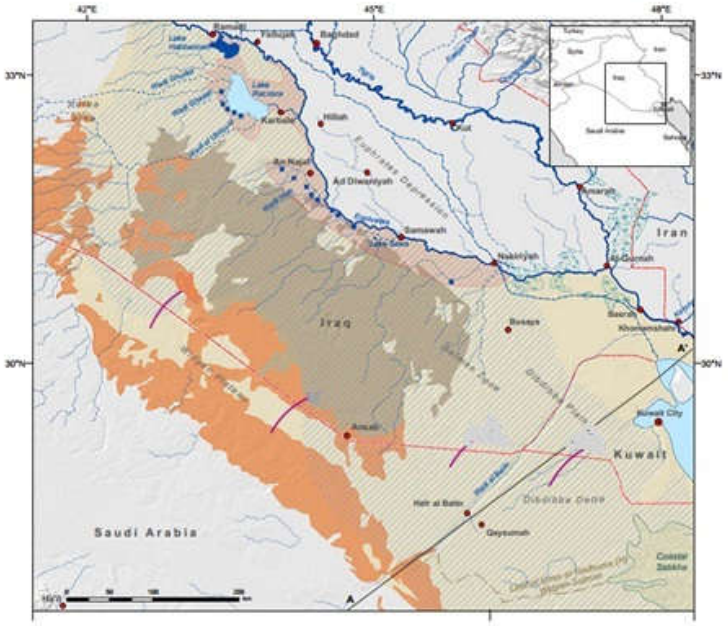


Figure 1: Location map

SAMPLING & METHODOLOGY

The petrographic study is based on 88 samples obtained from 18 surface sections includes the microscopic examination of thin section of all collected samples under polarizing microscope to give

us a clear idea about the main components and the texture of the rocks. All thin sections made in this work have been stained with Alizarine Red S according to the staining procedures of Friedman's (1959) in order to differentiate between calcite and dolomite and for estimating their percentages in thin sections. The carbonate rocks of the formations are classified after Dunham's (1962) with modification of Embry & Klovan (1971) depending on the depositional texture of the rocks. The identified microfacies Nfayil Formations are compared with Standard Microfacies Types (SMF) and Facies Zones (FZ) and their depositional environments are interpreted as categorized by Flugel (2004).

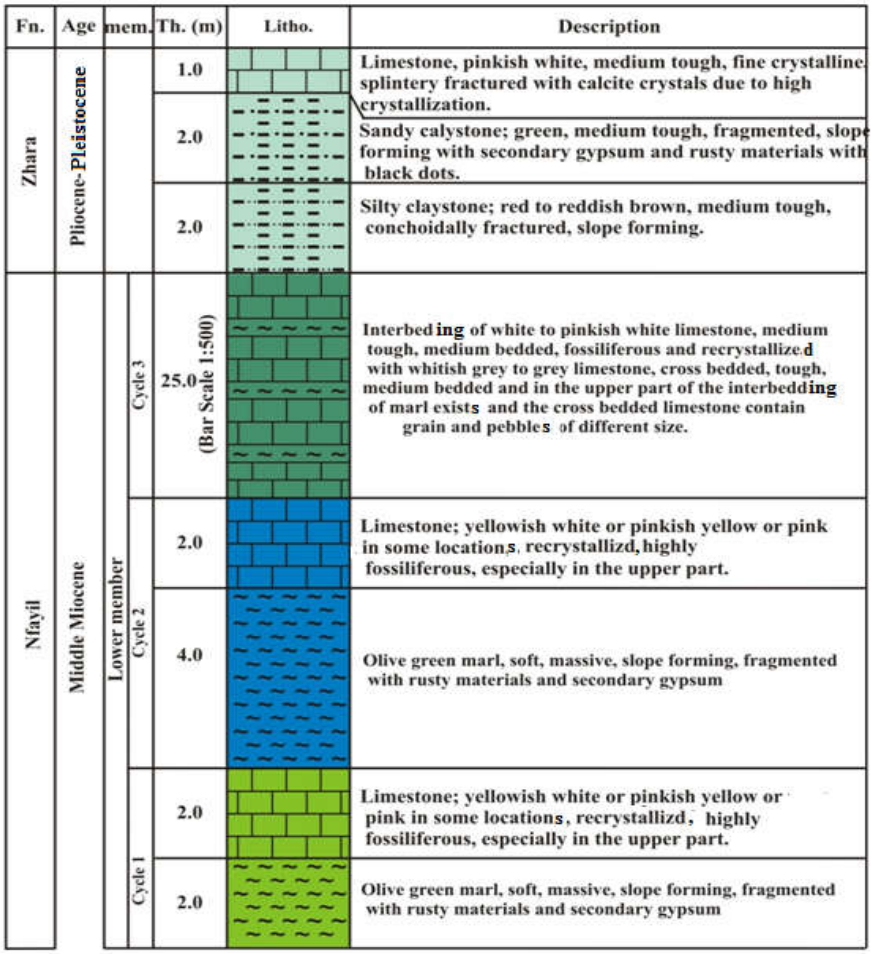


Figure 2: The stratigraphic column of Nfayil Formation

Microfacies and Lithofacies of the Nfayil Formation

In the study area, two members are recognized, the lower and the upper members. The detailed description of each member is given below:

1-Lower member of the Nfayil Formation

1-1. Mudstone this microfacies is divided into the following submicrofacies.

1-1 a. Dolomud stone

Only one sample occurs within this submicrofacies. The rock is gray to pale gray and very tough. Microscopically, this submicrofacies is unlaminated and unfossiliferous. It consists of micritic groundmass that completely replaced by very fine dolomite. Quartz grains of silt to very fine sand with anhedral shape are present within this submicofacies. Dolomitization is the main diagenetic

affects this submicrofacies. It relates to SMF23 and tidal flat (FZ8) and arid evaporitic coasts (FZ9) of Flugel (2004).

1-1b. Bioclasticdolomud stone
The rocks of this submicrofacies are pale gray to gray and pale brown and tough to very tough. Microscopic investigation reveals that this submicrofacies contain fossils <3% such as peneroplis sp. and pelecypods embedded in a micritic groundmass that completely replaced by dolomite. In addition, it contains few anhedralintraclasts. Early dolomitization, dissolution and selective cementation by gypsum are the main diagenetic processes affect this submicrofacies (Degens1965). The presences of few peneroplis sp. indicate deposition in a restricted circulation in shallow marine environment.

1.1.c. Algal laminated dolomud stone:
The rocks of this submicrofaciesare characterized by white color, chalky and gray tough. Petrographically, this submicrofacies is characterized by the presence of planer lamination within dolomitic groundmass. The lamination consists of lighter and dark layers of fine and very fine dolomite. Algal mats may induce such lamination. Close interlamination of very fine and fine indicate the very delicate control of dolomitization in the tidal flat environment Plate(1-1).

1-2. Bioclastic mudstone

Only one sample occurs within submicrofacies. The rock is white, chalky and tough. Microscopically, it consists of fossils 2% embedded in a micritic groundmass. The recorded fossils are few miliolids. Dissolution is the main diagenetic affects this rock. This submicrofacies indicates deposition in restricted shallow marine environment.

1-3. Wackestone: The following submicrofacies are recognized:

1-3.a. Shelly bioclasticdolowacke stone and bioclasticdolowacke stone:
The rocks of this submicrofacies are distinguished by pale gray and beige color, tough to very tough and enclosing abundant biomolds. Microscopically, it consists of badly preserved bioclasts>10% embedded in a very fine and fine dolomite. Most of the fine dolomite crystals have rhombic shape and inclusion of dark materials (Bathurst 1966). The recorded fossils are miliolids, peneroplis sp., Borelissp., uniserial and biserial foraminifera and shell fragments of pelecypods, gastropods and ostracods (Plate1-2). Other components present are intraclasts, dolomitized, anhedral, with a percentage up to 10 and grain size varies from fine to medium and coarse (0.2-0.4 and 1.1) mm. Dolomitization, severe dissolution and selective cementation by gypsum are the most recognized diagenetic processes influenced this submicrofacies (Choquette, and Pray, 1970). The concentration of shell fragments compared with SMF 12 that developed in platform interior settings including restricted platforms and tidal flats (FZ 8).

1-3b. Peloidalbioclasticwacke stone:
Only one sample occurs within this submicrofacies. It is beige color, medium tough and enclosing cavities filled with secondary calcitePetrographically, it consists of bioclasts (shell fragments of gastropods, pelecypods and ostracods) embedded in a microsparitic to sparitic groundmass that originally formed from recrystallization of micrite. Peloids are also present not exceeds 10%. The identified diagenetic changes are recrystallization and cementation. This submicrofacies corresponds to SMF 16 and common in shallow platform interior (FZ 8) of Flugel (2004)

1-4.Fenestral algal bioclasticpacke stone

Two samples are present within this microfacies. It characterized by pale gray and whitish gray color and very tough. Microscopically, the main characteristic feature of this microfacies is the presence of fenestral porosity with algal bioclasts. Other fairly common bioclasts are miliolids, peneroplissp., ostracods and Rotalliasp. Quartz grains constitute (1-3%), anhedral to subhedral in shape, rounded to

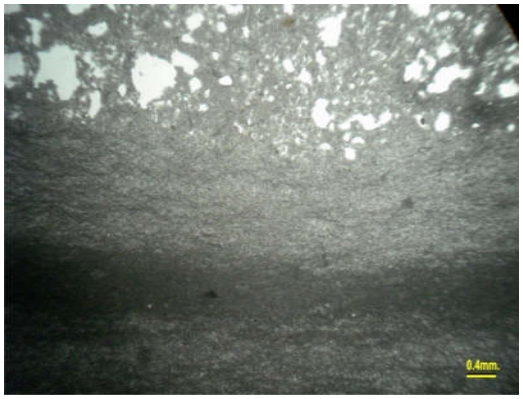
subrounded, silt to fine, medium and coarse size. This submicrofacies is subjected to many diagenetic changes such as recrystallization of some fossils, dissolution and cementation of biomolds by drusy and granular calcite. This microfacies relates to SMF 21 and typically developed in supratidal and intertidal environments (restricted lagoons, FZ8 and evaporated lagoons FZ9A) of Flugel (2004).

1-5. Crystalline dolostonelithofacies

The rocks of this lithofacies are characterized by chalky appearance, tough to very tough, grayish white to pale yellowish gray color and highly porous.
Petrographically, it consists of dolomite 100%, which present as fine, rhombohedral to euhedral in shape. Some of them show zoning. Others have inclusion of black materials. This lithofacies is subjected to diagenetic changes such as late dolomitization and dissolution (plate 1-3).

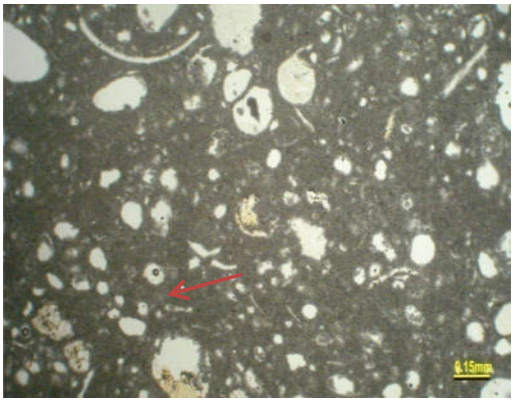
Plate (1)

Plate 1-1



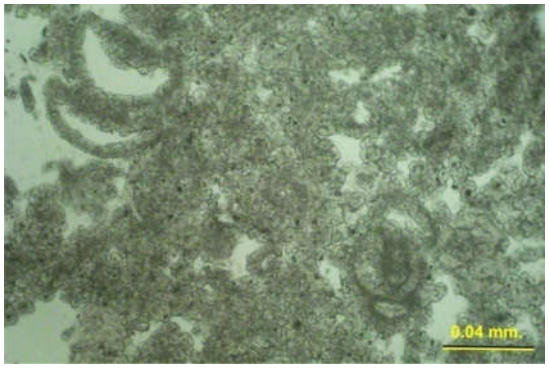
Algal laminated dolomudstone

Plate 1-2



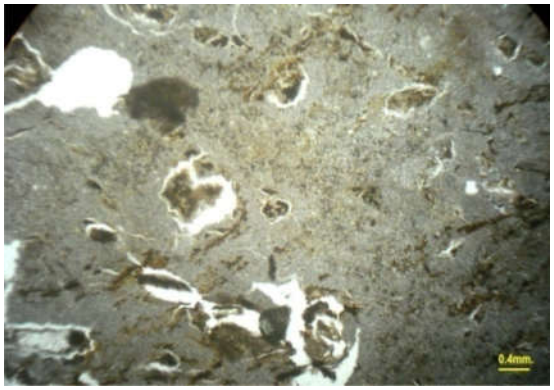
Shelly bioclasticdolowackestone

Plate 1-3



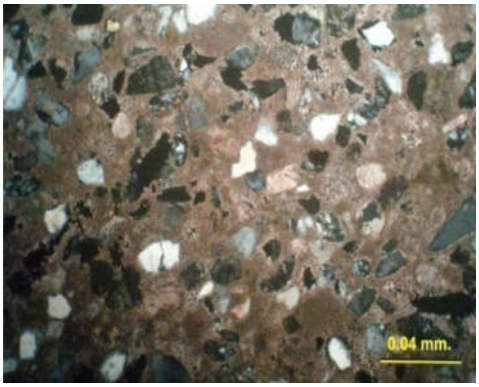
Crystalline dolostone

Plate 1-4



Clayey dolomudstone

Plate 1-5



Sandstone

2- Upper Member of the Nfayil Formation

2-1. Mudstone: The following submicrofacies are recognized:

2-1a. Bioclastic mud stone:
Only one sample is present within this microfacies. The rock is chalky, white to yellowish and brownish white color and friable to medium tough.Microscopically, calcite forms the main components (100%), present as micrite that partially recrystallized to microsparite and sparry calcite. The groundmass is intersected by many veinlets filled with secondary calcite. The bioclasts are represented by algal debris(Bathurst1975). The main diagenetic processes affects this microfacies are partial recrystallization and cementation. The presence of such submicrofacies indicates deposition in tidal flats.

2-1b. Clayey dolomud stone
One sample occurs within microfacies. It is beige to yellowish beige color and friable to medium tough. Microscopically, the groundmass consists of very fine dolomite 75%. Clay 25% is present as filling vugs and the pore space between dolomite crystals (Plate 1-4). Dolomitization is the main diagenetic processes affect this microfacies. It corresponds to SMF 23 and (FZ 8) & (FZ 9A)

3. Sandstone lithofacies

It is the only facies that made up essentially of non -carbonate sediments in the study area, representing the upper part of the upper members of the Nfayil Formation. The sediment of this lithofacies is characterized by yellowish gray color, friable to medium tough and showing laminations due to color and size variation.Petrographically, this lithofacies consist of detrital sand grains and bioclasts 3% (shell fragments of pelecypods, echinoid spine, ostracods, rotallid and other recrystallized foraminifera having micritic envelope) embedded in a micritic groundmass that partially recrystallized to microsparite. The quartz grains constitute 25%-40% of the total bulk (plate1-5). They are subrounded to subangular, anhedral to slightly subhedral, very fine, medium, coarse grained, and few of them have inclusion of zircon and epidote. Other minerals present are feldspar 3-4% (orthoclase and albite), chert fragments 3-5% (micrograined quartz, macrograined and chalcedony), calcitic grains 27% (microsparite and micritic in composition), clay fragments and metamorphic fragments with quartz and micaceous minerals (Folk., 1959).

The rest of the minerals are accessory forming about 2% and composed of zircon, muscovite, epidote, hornblende, chlorite, biotite and iron oxides. The association of marine faunal together with the sandstone in the upper part of the upper member may indicate lagoon tidal delta.

Biostratigraphy

The Nfayil Formation consists of fossiliferous sandy dolomitic limestone, with sand grain and calcareous sandstone Fossils: The fossils recorded within the formation:
PeneroplisfarsensisHENSON (Plate 2-1)
Peneroplis sp. (Plate 2-2)
Rotalia sp.
Ammonia beccariiLINNE (plate 2-3)
Elphidium sp.
Textularia sp.
Miliolids, rotalids, shell fragments, gastropods, echinoids, ostracods,
algae, bryozoa and corals(plate2-4).

Plate (2)

Plate 2-1

***Peneroplisfarsensis* HENSON, X10**

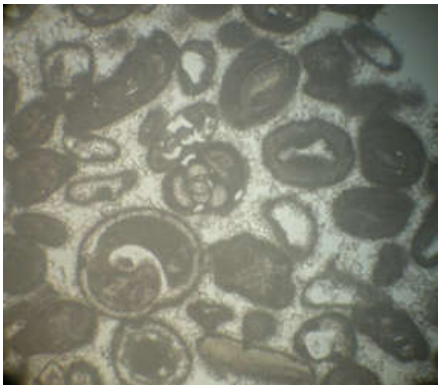
Plate 2-2

***Peneroplis* sp., X10.**

Plate 2-3

***Ammonia beccarii* LINN, X10.**

Plate 2-4



Miliolids and gastropods in oolitic limestone facies, X2.5

RESULTS & CONCLUSION

The recognized fossils assembles of Nfayil Formation were Ammonia bacari (LINNE), Rotalia, ostrscods, Algea, shell fragments, Oyster shells. The age of Nfayil Formation, depending on the fossils content, is Middle Miocene which is equivalent to Fat`ha Formation (Said, 1986, Sissakain et al. 1997 and Sissakain and Mohammed, 2007). Said (1991) in Heet-Kubaisa area mentioned Late-Middle Miocene age for the formation. Only the lower member of the Nfayil formation, which consists of cyclic deposits, is exposed in the study area. The exposed thickness is about (12.0 m). Could be

includes three cycles. The environment to Nfayil Formation restricted carination on marine platform, deposited in very shallow hypersaline lagoon Figure (3). Said (1991) claimed that the depositional environment for the formation in Heet-Kubaisa area is of closed lagoons and hypersaline conditions of intertidal-supratidal environment (Sissakain et al. 1997). Said (1986) claimed that the formation in Anah area deposited in normal-brackish lagoons, semi-closed at very shallow depth of intertidal-subtidal zone, with moderate wave action.

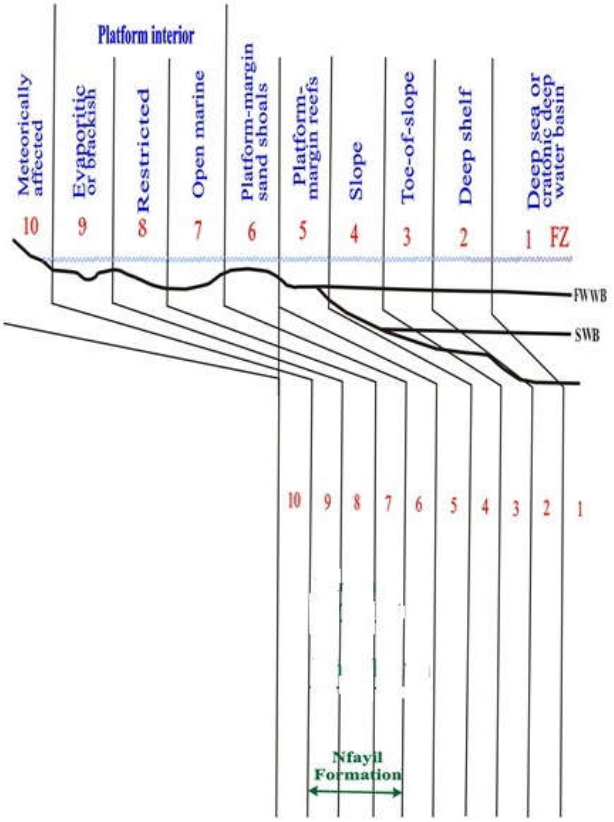


Figure 3: Depositional environments of Nfayil Formations according to Flugel (2004).

RECOMMENDATIONS

The whole area of the Southern Desert needs detailed geological survey to column stratigraphy studies to re-evaluate the biostratigraphy and petrography situation.

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