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Microfacies Analysis of Oligocene Formations in Butmah and Rafan Areas Northwest Iraq.

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ABSTRACT

Oligocene deposits in Butmah and Rafan areas northwestern Iraq were penetrated by three core holes (BW-CH1, BE-CH1 and RF-CH1). The depositional basin evolved through two stages, generating two sedimentary cycles, which were separated by exposure surface as represented by conglomerate beds in core holes BW-CH1 and RF-CH1.

Six microfacies were recognized in the Oligocene formations (Shurau Fn., Sheikh Alas Fn. and Bajwan Fn.), comprising three microfacies association allocated to: reef (Sa1) and back reef (Sh1, Sh2) in the first cycle (Early Oligocene), and back reef (B1, B2, B3) in the second cycle (Late Oligocene).

Oligocene rocks have been affected by many diagenetic processes of cementation, dissolution, dolomitization (by mixing process) and dedolomitization.

The paleogeographic distribution of the microfacies in conjunction to the previous work elucidates that the studied area is representing the eastern margin of the Sinjar Oligocene basin.

التحليل السحني لتكوينات الاوليجوسين في منطقتي بطمة ورافان شمال غرب العراق

الملخص

اخترقت ترسبات الاوليجوسين في منطقتي بطمة ورافان شمال غرب العراق ثلاث آبـار لبابيـة هـي (-CH1, BE-CH1, RF-CH1). لقد تطور الحوض الرسوبي خلال مرحلتين وافرز دورتـين ترسـيبيتين يفصل بينهما سطح تعرية متمثل بطبقات الرصيص التي ظهرت في آبار BW-CH1, RF-CH1 . لقد ميزت ست سحنات دقيقة في تكوينات الاوليجوسين (تكوينات شوراو وشيخ الاس وباجوان) وهي تمثل ترسـبات الحاجز (السحنة Sa1) وترسبات خلـف الحـاجز (السـحنة Sh1, Sh2) للـدورة الترسـيبية الاولـى (الاوليجوسين المبكر) وترسبات خاف الحاجز (السحنات B1, B2, B3) والتي تمثل ترسبات الدورة الثانيـة (الاوليجوسين المتاخر).

تاثرت صخور الاوليجوسين بعدد من العمليات التحويرية منها السمنتة والاذابة والدلمتة (بطريقة الخلط والديدلمتة. اوضح التوزيع الجغرافي للسحنات الدقيقة ان منطقة الدراسة تمثل الحافة الشرقية لحوض سنجار في فترة الاوليجوسين.

INTRODUCTION

The studied area lies 45 km to the northwest of Mosul City in northern Iraq. It embraces three structures (Butmah west, Butmah east and Rafan anticlines), three core holes (BW-CH1, BE-CH1 and RF-CH1, Fig. 1) penetrating the Oligocene formations are the concern of the present work. (Fig. 2,3,4).

The goal of the microfacies study is to infer the depositional environment of the Oligocene successions in order to approach the paleogeographic configuration of the basin and their depositional cycles.

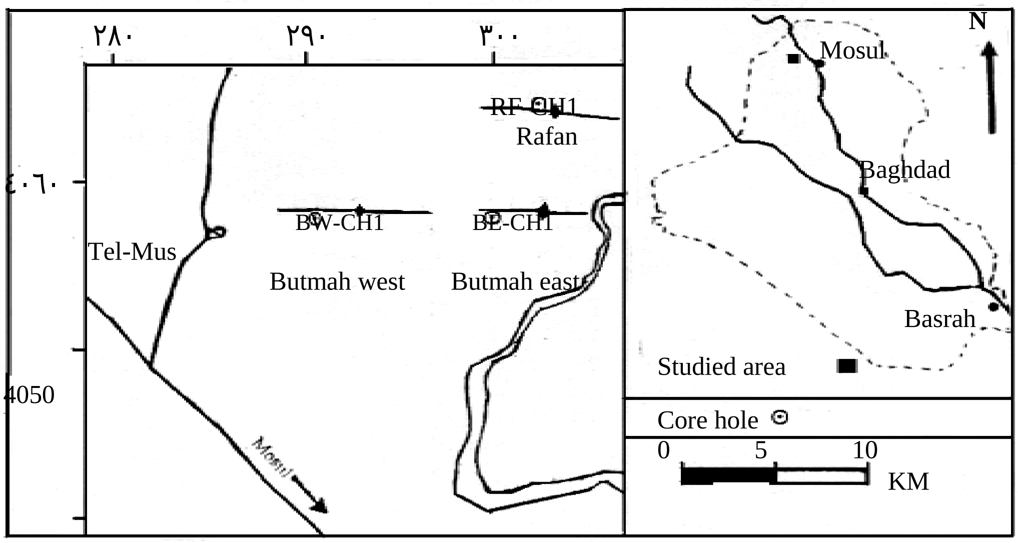

Fig. 1 Location map

STRATIGRAPHY

Primary studies of the Oligocene rocks were carried out by Bellen (1956), who introduced a tripartite vertical and horizontal division. The vertical one represented by lower, middle and upper Oligocene cycles, each cycle constitutes three facies: reef, back reef and fore reef. Buday (1980) considered some of these facies as formations. Al-Hashimi and Amer (1985) agreed with Bellen and established three cycles for the Oligocene rocks: the first cycle consists of Palani, Sheikh Alas and Shurau Formations (Lower Oligocene),

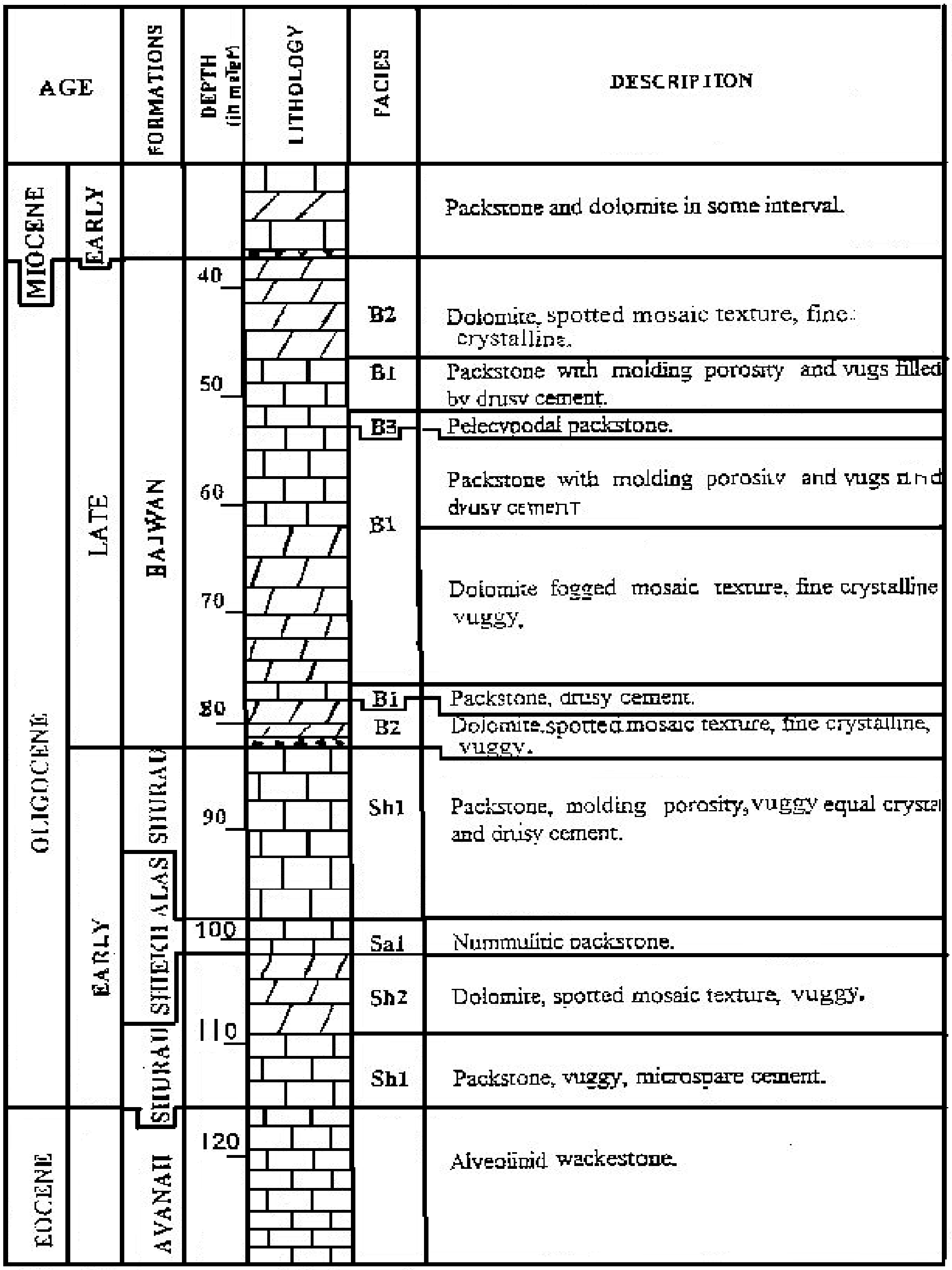

Fig. 2: Lithologic section of corehole BW-CH1

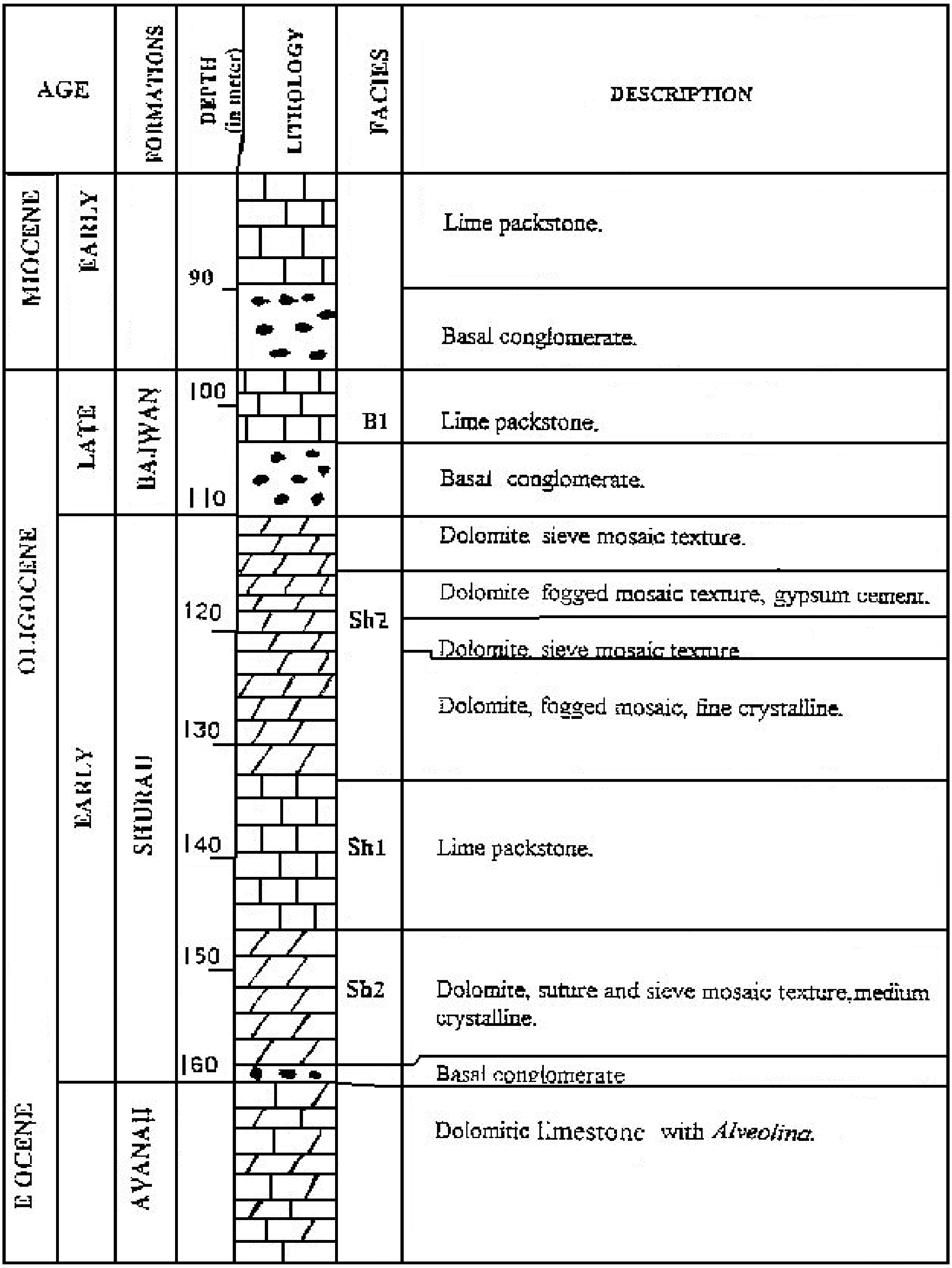

Fig. 3: Lithologic section of corehole RF-CH1.

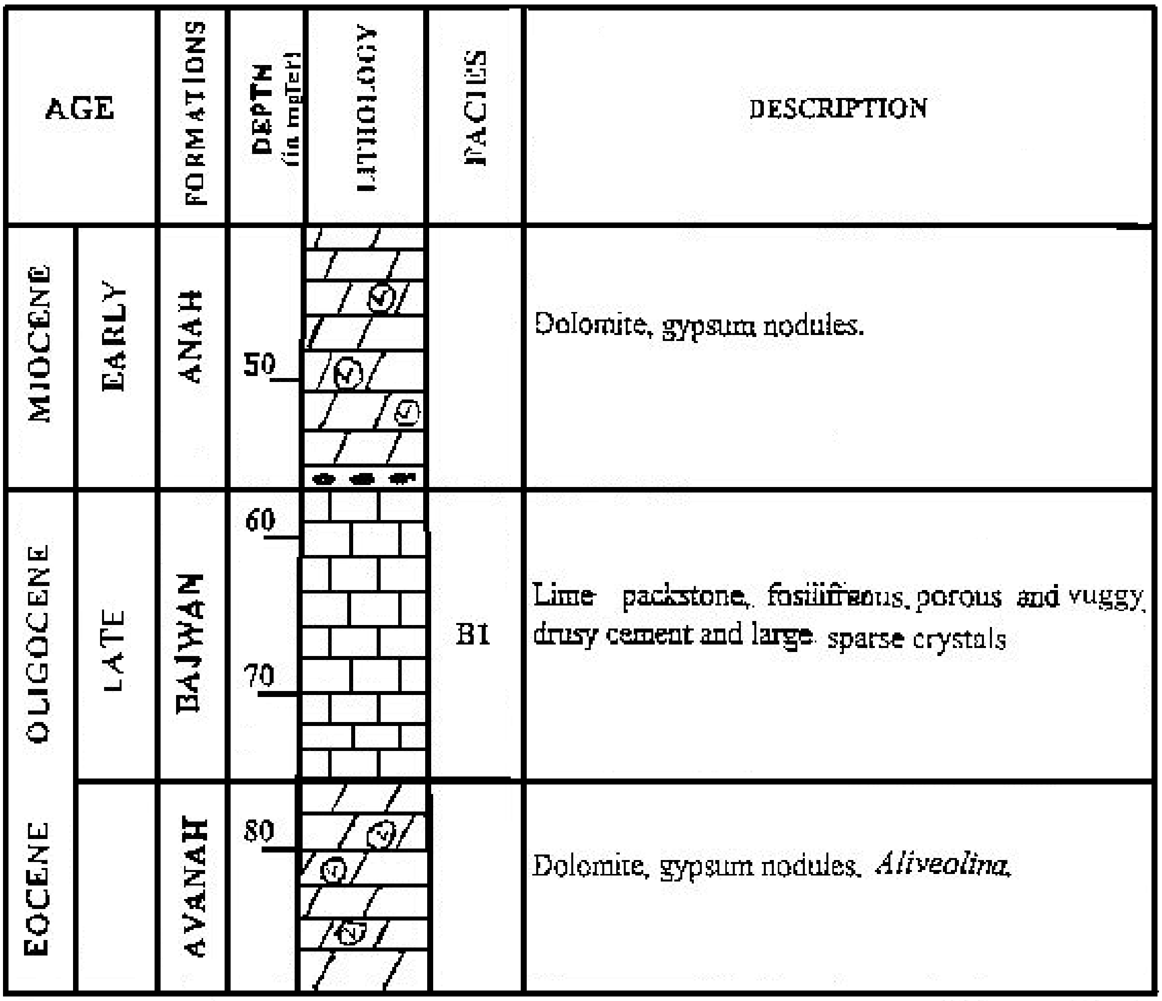

Fig.4: Lithologic section of corehole BE-CH1.

the second cycle includes Tarjil, Baba and Bajwan Formations (Middle Oligocene), whereas the third cycle reveals Ibrahim, Azkand and Anah Formations (Upper Oligocene).

Recently Al-Eisa (1992) promoted the third cycle to the lower Miocene in Kirkuk, also Al-Banna (1997) reached the same result in Sasan and Sheikh Ibrahim areas, while Al-Mutwali and Al-Banna (2002) recognized two formations (Palani Fn. and Tarjil Fn.) within Oligocene rocks in Sinjar area. Accordingly, common surability among recent research is that the Oligocene succession consists of two cycles.

MICROFACIES

Six microfacies were determined according to Dunham (1962) classification in the studied formations, these are:

Shurau Formation:

The formation is consists of gray to pale brown limestone and dolomitic limestone. The upper boundary is unconformable with the overlaying Bajwan Formation, while the lower boundary is also unconformable with underlying Avanah Formation (Fig 5). Two microfacies are recognized in Shurau Formation:

Fig.5: Alveolinid lime wackestone microfacies, x40 depth 116.0m BW-CH1,Avanah Formation.

Peneroplis lime packestone microfacies (Sh 1):

This microfacies includes benthic foraminifera forming 75%-80% of the total microfacies content, it consists mainly of *Peneroplis thomasi* Henson, *Peneroplis evolutus* Henson (Fig.6), *Austrotrillina howchini* Schlumberger, *Archaias operculiniformis* Henson and *Nummulite fichteli* Michelotti, in addition to red algae, miliolid and echinodia.

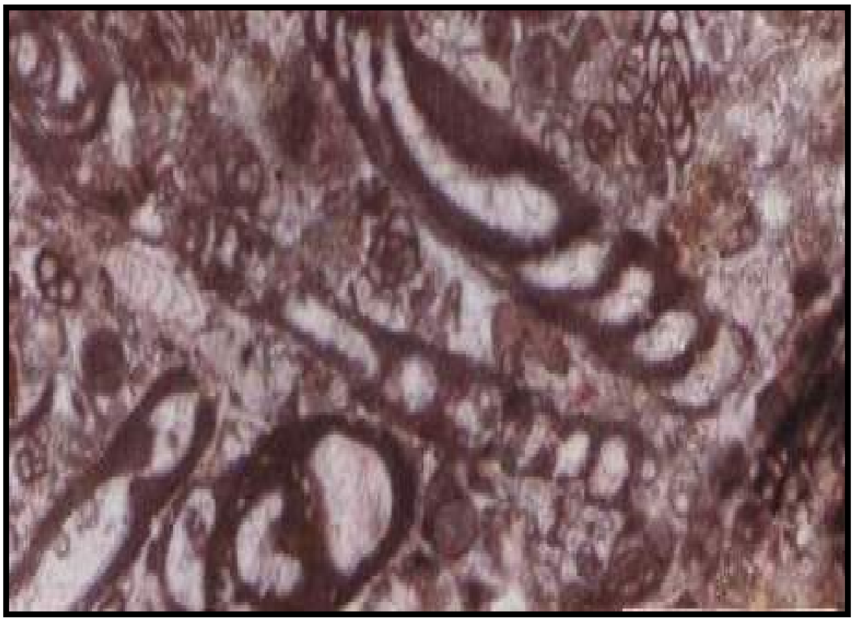

Fig.6: Peneroplis lime packstone microfacies (Sh1), x40, depth 85.0 m BW-CH1 Shurau Formation.

The occurrence of the genera *Austrotrillina* indicates a restricted platform area with a depth ranging from 0 to 30 m (Murray, 1973). Al-Hashimi and Amer (1985) mentioned that *Austrotrillina, peneroplis* and *Archaiase* occurred in a restricted marine platform (lagoonal environment). These biological features favor the comparison of this microfacies with SMF 18 in the FZ7 and FZ8 (Wilson, 1975; Flugel, 1982).

Lime mudstone - wackestone microfacies (Sh 2):

This microfacies is affected by dolomitization forming sutured mosaic fabric. According to Randazzo and Zachos (1984) the homogenous dolomitization of mudstone leads to micro-textured sutured mosaic where there are solution of allochems, likewise the wackestone generally is dolomitized to micro-texture sieve mosaic (Fig.7). Therefore we believe that the type of dolomite in Shurau Formation reflected the original fabric of the rock, which is lime mudstone-wackestone microfacies. This type of microfacies accumulates in shallow warm water in a restricted platform. This microfacies could be compared with the SMF22 within FZ-8 (Wilson, 1975; Flugel, 1982).

Fig.7: lime mudstone wackestone microfacies (Sh2), x40, depth 147.0 m RF-CH1, Shurau Formation.

Sheikh Alas Formation:

The formation consists of brown to pale gray limestone bed. It interfingers with in Shurau Formation in core hole BW-CH1.

Nummulitic packstone microfacies (Sa 1):

This microfacies is displayed as 2.05m of brown to pale gray limestone, allochems which forming 70% of the total contents, they consist mainly of *Nummulites fichteli* Michelotti and *Nummulites intermedius* (D,archiac), in addition to *Austrotrillina paucialveolata* Grimsdole (Fig.8).

The development of *Nummulites* accumulation is not only in the range of the storm wave base but it may be accumulated in deep neritic (Hauptmann et al., 2000), also in the winnowed platform edge. (Bathordy, 2000).

The presence of *Austrotrillina* indicates a hypersaline water condition in a restricted platform area with depth ranging from 0 to 10 m (Murray, 1973).

Taking all attributes into consideration; the facies was deposited in barrier environment some where to the winnowed platform edge.

Fig.8: Nummulitic packstone microfacies (Sa1) x40, depth 100.10m BW-CH1, Sheikh Alas Formation.

Bajwan Formation:

The formation is characteristically pale brown to gray limestone and dolomite. The upper and lower boundaries are unconformable with overlaying Anah Formation and underlaying Shurau Formation. In core hole BE-CH1 Bajwan Formation lies over Avanah Formation unconformably, the formation embraced three microfacies.

Miliolidal lime packstone microfacies (B):

This microfacies consists mainly of miliolidal allochems (*Pyrgo, Triloculina* and *Quainqulina*), in addition to *Spiroloculina sp*., *Archaias hensoni* Smout and Eames, *Astrotrilina howachini* Schlumberger, and *peneropis thomas*i Henson and *peneroplis evoluta* Henson (Fig. 9). Their percentage ranging between 60-80%. Equal crystal calcite, drusy and blocky cement filling vugs, molding and intergranular porosity in core holes BW-CH1 and BE-CH1. The facies is affected by dolomitization at some interval (Fig.2). The occurrence of miliolid indicate lagoonal environment with depth less than 40m (Hedly and Adams, 1976), the benthic foraminifera (*Archaias*) is representing worm water and generally present with miliolid (Moore et al., 1952) in a depth ranging between 0-30m.

The lithological and paleontological attributes of the microfacies collectively are an evidence of open and restricted platform (lagonal) environment, it is matched to a major extent by SMF-18 within FZ-7and FZ-8 respectively (Wilson,1975; Flugel, 1982).

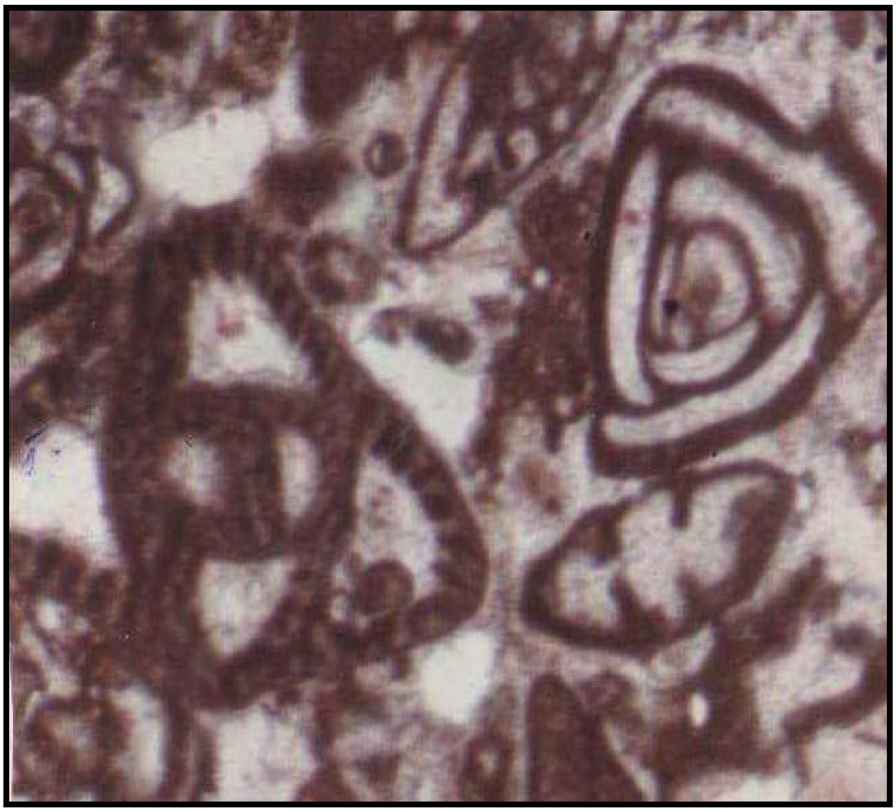

Fig.9: Miliolidal lime packstone microfacies (B1) x40, depth 47. 0 m, BW-CH1, Baiwan Formation

Lime wackestone microfacies (B 2):

This microfacies reveals allochems forming 10-20% of the total facies content and consists of miliolid and small gastropod. Generally the microfacies was dolomitized in all the studied core holes forming spotted mosaic texture (Fig.10) and sieve mosaic where there is a solution of allochems.

Lithological and paleontological characteristics indicate that this microfacies was formed as a product of chemical precipitation from shallow warm water within tidal flat area, therefore it could be compared with the SMF19 in FZ8 (Wilson, 1975; Flugel, 1982).

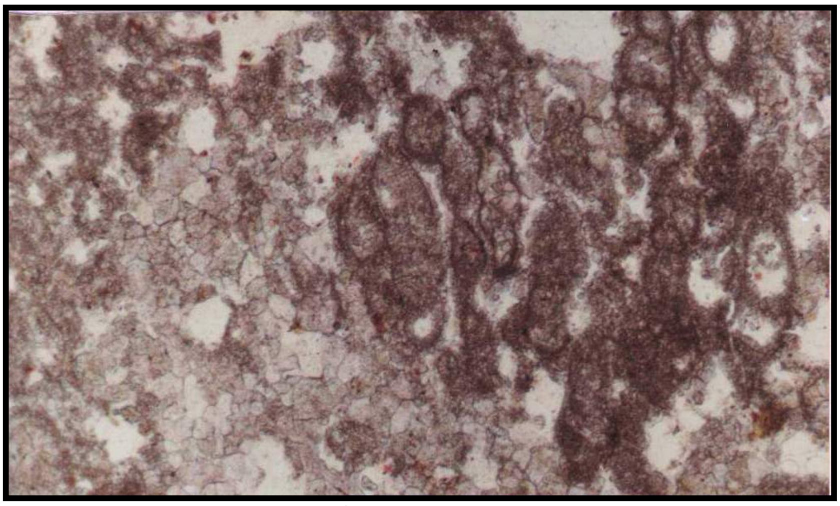

Fig.10: Lime wackestone microfacies (dolomite, spotted mosaic texture) x40 depth 80.0 m, BW-CH1 Bajwan Formation.

Pelecypodal lime packstone microfacies (B 3):

The microfacies described as a pale brown to gray dolomitic limestone. Skeletal allochems of pelecypodal shell forming the main content of allochems with few amounts of miliolid. The microfacies exhibits vugs filled by equant calcite crystal.

A large occurrence of pelecypod and gastropod is an attribute of a shallow lagoon environment (Wilson, 1975). It is correlated with SMF18 in FZ8 (Flugel, 1982).

DIAGENETIC SEQUENCES

The large number of diagenetic processes and their variable textures, making the interpretation of diagenetic sequences very difficult but the worker in this field have attempted to give ideal diagenetic sequence which can be recognized in similar rock (Carrozi, 1981; Longman, 1982).

Detailed petrographic examination of thin section has reflected the history of the diagenetic environment, which have controlled cementation, generation of porosity, dolomitization and dedolomitization of the Oligocene carbonate rock unit.

Cementation is one of diagenetic processes, which is clearly found as drusy rim cement around the bioclast with molding porosity in microfacies B1 at depth (47m, BW-CH1). The diagenetic condition corresponds to marine phreatic zone in which a drusy rim cement precipitated (Carrozi, 1981), then the sediment was exposed to marine vadose zone reflecting by the partial dissolution of bioclast forming molding porosity.

In other intervals of microfacies B1 (at depth 83-85) in core hole BW-CH1, molds and intergranular porosity lacking cement or partially cemented which indicates an upper part of fresh water vadose zone (Flugel, 1982).

The late digenetic process was dolomitization. Dolomite found in the studied section as fogged mosaic and spotted mosaic of fine to medium crystalline, Other beds show sieve mosaic and suture mosaic of medium to coarse crystalline dolomite. According to Randazzo and Zakhos (1984) the spotted mosaic produced by the dolomitization of lime wackestone, while fogged mosaic dolomite resulted from lime packstone, in which sutured mosaic and sieve mosaic produced from lime mudstone and wackestone when there are solution of allochems. In some interval sieve mosaic dolomite partially cemented by gypsum, representing the last stage of diagenesis (Carrozi, 1981).

The absence of evaporite minerals (as nodules or thin beds), the presence of dolomite beds sandwiched in limestone beds and the occurrence of limestone bed above dolomite showing unconformable surface or presence of vadose zone feature are indications of fresh water influence and collectively be used as an evidence of mixing water processes for the production of the studied dolomite (Badiozamani, 1973).

Dedolomitization found in a narrow interval in Shurau Formation at depth 98.0m (BW-CH1). The dedolomitization mean that calcite replaced dolomite. It is clearly recognized as rhomb shape calcite crystal containing fine inclusions of predolomite. The dedolomitization process is generally regarded as a surface or near surface process approaching unconformities (Evamy, 1973; Al-Hashimi and Hemingway, 1973; Amin, 1975; Budi et al, 1984), it is happened in a fresh water vadose zone when the fresh water moved throw dolomite beds (Longman, 1980; Tamer-Agha, 1984; Heekle, 1982).

DEPOSITIONAL ENVIRONMENT OF OLIGOCENE BASIN

The lower boundary of the Oligocene rock is unconformable with Avanah Formation (Middle Eocene), it is clearly reflected by the conglomerate bed in core hole RF- CH1 and by disappearing of Shurau Formation in core hole BE-CH1. During the lower Oligocene Shurau Formation deposited, their microfacies Sh1and Sh2 reflect lagoonal environment of the first Oligocene cycle; Sheikh Alas Formation was recognized by the barrier deposit (microfacies A1) that interfingers with Shurau Formation in core hole BW-CH1. Therefore it is believe that the barrier of this cycle lies to the west of the studied area. This result is conformable with other studies which mention that the deep basinal facies (Palani Formation) of the first Oligocene cycle found in Sheikh Ibrahim area (Al-Hashimi and Amer, 1986; Al-Banna, 1997) and Sasan area (while it is disappeared in Atshan area) (Al-Banna, 1997). Whereas in Sinjar area (Al-Mutwali and Al-Banna, 2002) (Fig-11) it lies farther west of the suggested barrier.

The upper boundary of Shurau Formation was also unconformable with overlaying Bajwan Formation as indicated by conglomerate beds in core holes BW-CH1 and RF-CH1. Bajwan Formation comprising microfacies (B1, B2 and B3) of lagoonal environment. The maximum thickness of the formation is found in core hole BW-CH1, whereas the minimum thickness in RF-CH1. Therefore we believe that the deepest point of the lagoon is in BW-CH1 while the other core holes (BE-CH1and RF-CH1) forming the eastern margin of the lagoon. According to previous work (Bellen, 1959; Al-Hashimi and Amer, 1985) the barrier facies of the second Oligocene cycle was Baba Formation. Although it is not recognized in core holes of the present work, we believe that it can be encountered some where to the west of the studied area; if we take into account the distribution of the deep basinal facies (Tarjil Formation) of this cycle in Sheikh Ibrahim and Sasan (while it is disappeared in Atshan area) (Al-Banna, 1997) and in Sinjar area (Al-Mutwali and Al-Banna, 2002; Al- Banna and Al-Mutwali, 2002) (Fig-12). The development of the Oligocene basin indicated that the barrier in the second cycle show lateral stacking of facies to the west of the studied area.

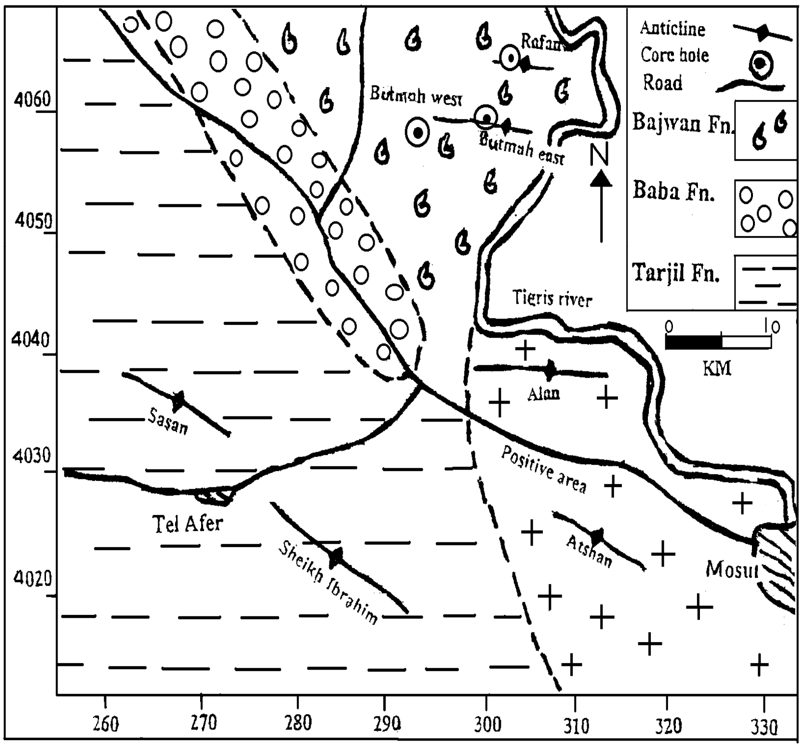

Fig. 11: Paleogeographic distribution of the Early Oligocene Formation.

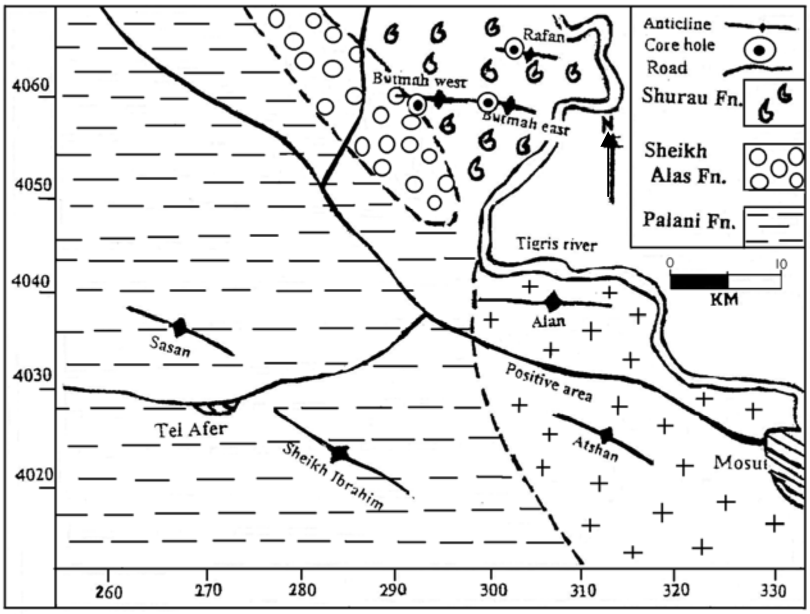

Fig. 12: Paleogeographic distribution of the Late Oligocene Formation.

CONCLUSION

Two sedimentary cycles were separated by exposure surface (conglomerate beds). The first cycle comprised Shurau Formation which is revealed by two microfacies represented back reef environment and Sheikh Alas Formation which is represented by one microfacies of barrier environment. While the second cycle included Bajwan Formation, which consists of three microfacies, allocated to back reef environment. The paleogeographic distribution of the microfacies elucidates that the studied area is representing the eastern margin of the Sinjar Oligocene basin. The development of the Oligocene basin shows lateral shift of barrier facies of the second cycle due to the fluctuation of sea level.

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