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A Stratigraphic Development of the Upper Oligocene - Middle Miocene succession in Wadi Heglan, Western Iraq

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ABSTRACT

The Upper Oligocene – Middle Miocene succession in Wadi Heglan, western Iraq was carried out to study microfacies and paleoenvironment. The Anah and Euphrates formations are exposed in this section. Anah Formation consists of massive, coralline, and dolomitic limestone, while the Euphrates Formation consists of massive and become well bedded upwards, obvious porous, marly, and dolomitic limestone. The abundance of benthic foraminifera and other fossils within these facies, the appropriate paleoenvironment for the Anah and Euphrates formations were determined. The reef and back-reef environments are recognized Anah Formation and the restricted to open marine environments are recognized Euphrates Formation. The Anah Formation exposed in this section by long episode of high stand trace (HST) which represent fall sea level of back-reef facies, while Euphrates Formation was deposited during three fourth-order cycles (A, B, and C), these cycles represent a succession episode of sea level rises (TST) and stillstands (HST). These sequences are bounded by two type-1 sequence boundary SB1. The area of study show very low rate of subsidence according to sequence development and the main factors that affect the study area is the fluctuation of eustatic sea level..

INTRODUCTION

The study area is located in the northern part of Anbar Governorate, about 123 km from Ramadi, with coordinates: longitudinal 42º36'49"E and latitudinal 34º09'18"N (Fig.1).The Oligocene succession in Iraq have a relatively narrow range of distribution and the late Oligocene is represented by the Azkand, Anah, and Ibrahim formations. Early Lower Miocene began with a major transgression, which resulted in the deposition of the Euphrates Formation in restricted to open marine environment [2].

The Anah Formation is consists of light gray, very porous, coralline, very hard, and massive limestone, while the Euphrates Formation is consists of light gray, very porous, hard, weathered massive into well bedded, fossiliferous, and dolomitic limestone in this section. Only the top of the Anah Formation appears within this section and represents a long period of fall sea level (HST). The Euphrates Formation three fourth-order (A, B, and C) cycles, which are asymmetrical cycles [5].

Each cycles represented rise in sea level (TST) and followed by fall sea level (HST). The major aim of the current research is study the Sequence Stratigraphic in wadi Heglan section by examining microfacies and their fossils content. There are many previous studies on the Anah and Euphrates formations for the various purposes, and among these studies are: [1] [2] [3] [4] [5] [6] [7] [8] [9].

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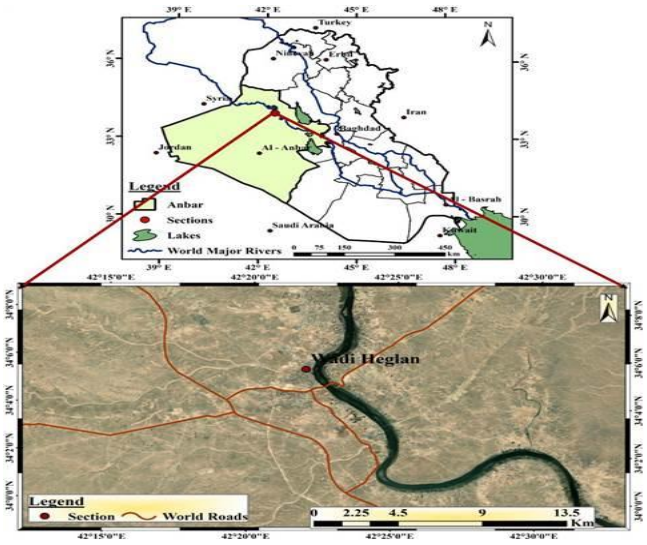

Fig.1 Location map of the study

Fig: 1 Location map of the study area

GEOLOGICAL SETTING

The area of study is located within the Western Desert of the Upper Oligocene- Middle Miocene Carbonate Platform in Haditha city. The current research study focused on the northeastern parts of the Arabian Plate within the main unit, which is the Stable Shelf. The study area bordered to the east by the Salman Zone, and from the west Syria and Jordan. This area is bounded from the north and south by two transversal faults zones, fixed by Sirwan Faults Zone and Anah- Qalat Dizah Faults Zone, within the Center Iraqi block [10]. Abu-Jir fault zone is located within the Euphrates River and it forms the main structural feature in northern and eastern parts of the lithology section, and it is represents the boundary between two major tectonic division the Stable and Unstable Shelf [11].

MATERIALS AND METHOD

It Includes both field and laboratory works, where the field work was conducted in Wadi Heglan in Hadetha area, to take encountered samples (that were not relatively affected to erosion operations), and then make thin sections for later studies, where 23 samples were collected from the section of Wadi Heglan and field measurements were also taken . As part of the lab work, roughly 40 thin sections were prepared in order to prepare them for examination under a light-transmitting microscope. By studying these microfacies, the paleodepositional environment of the Formations within the studied sections was deduced.

RESULTS AND DISCUSSION

Microfacies analysis

Five major microfacies have been identified and subdivided into twelve submicrofacies within the Anah and Euphrates formations in Wadi Heglan section.

Microfacies types of Anah Formation

Four types of submicrofacies have been identified within the Anah Formation in Wadi Heglan, which are: Miliolids Lime Packstone**,** Algae Lime Packstone, and Coral – Algae Lime Wackestone, Miliolids Lime Wackestone.

1-Miliolids Lime Packstone (MF1)

This facies has been detected inside of the Anah Formation, and is about 2.5 meters thick, in the upper part of the formation. It is containing of gray, dolomitized, and porous limestone, and it is built up by 60% of miliolids. Its consists from miliolids as *Qunequeloculina sp.*, *Triloculina trigonula* Lamark., *Pyrgo* sp. , *Austrotrilina asmariensis* , *Spiroloculina ornata* , *Rotalia viennoti* , *Textularia* sp. , and other fossils as gastropoda , coral, and algae .

Interpretation: The high diversity of miliolids in this facies suggest deposited in restricted lagoon (inner ramp) and points of a nutrient rich and slightly hypersaline and warm euphotic conditions [2], and it is indicator of tropical and subtropical shallow lagoon(back-reef) conditions [12]. This facies represents the shallowest upper part of the photic zone, very light, high translucent, and soft muddy substrate [13].

2- Algae Lime Packstone (MF2)

This facies is a meter thick and is located in the upper parts of this formation. Lithology of this facies is light gray, less hard, well bedded, high weathering, and fossiliferous limestone. It is consists of 50-60% algae.

Interpretation: Coralline algae play an important role in forming a type of reservoir rocks produced during Oligocene, which is Nullipore Limestone [14]. This facies is deposited of reef environment.

3- Coral – Algae Lime Wackestone (MF3)

This facies, which has a thickness of 1.5 meters, was found in the lowest parts of the Anah Formation. The coral – algae lime wackstone facies is contains of creamy, very pours and very hard limestone. This

microfacies is dominated by the occurrence of *Lithophylum* sp., and algae about 35% of facies.

Interpretation: the coral reef patches refer to the upper parts at a carbonate slop setting of an oligotrophic condition [15], the of present coral with Algae indicator of shallow environment down 40 meters depths during Oligocene- Miocene [16], or in middle ramp environment.

4- Miliolids Lime Wackestone (MF4)

In the lower parts of this formation, there is 2.5 meters facies thickness. The rock of this facies in the field is very hard, massive, light gray, with limestone burrows. The facies contain of miliolisd about 17% and matrix about 70%, and its dominated by the occurrence of imperforate benthic foraminifera as *Quinqueloculina* sp., *Austrotrilina howchin*, *Rotalia* sp., *Triloculina trigonula* Lamark., *Pyrgo* sp., and coral.

Interpretation: this facies is deposited in shallow marine to represent a lagoon/back-reef (inner ramp) environment [17], as indicated of low energy restricted/lagoon setting [18], and it is indicator of low diversity skeletal fauna. Stated the miliolids present in shallow marine water of barrier- reef setting.

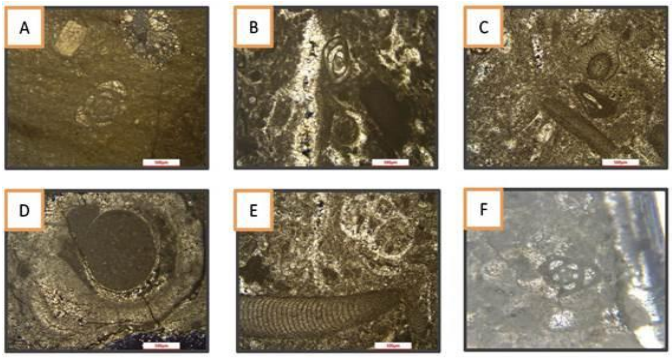

Plate: 1 Microfacies types of Anah Formation of Wadi Heglan.
1- A. and B. Miliolids Lime Packstone (MF1).
2- C. Coral Lime Wackestone (MF2).
3- D. and E. Coral- Algae Lime Wackestone (MF3).
4- F. Miliolids Lime Wackestone (MF4).

Microfacies types of Euphrates Formation

Eight microfacies types have been distinguished within the Euphrates Formation, which are: Coral Boundstone, Miliolids Lime Packstone, Coral – Miliolids Lime Packstone, *Peneroplis* Lime Packstone, Bioclastic – Algae Lime Wackestone, Algae – Miliolids Lime Wackestone, and Lime Mudstone.

1- Coral Boundstone (MF5):

Coral Boundstone facies has been marked in the lower part of the Euphrates Formation, specifically within the basal conglomerate bed, and the thickness of this facies is two meters. The facies contains a *Lithophylum* sp. decrease towards the top part.

Interpretation: this facies deposited in good water circulation of high energy. Most coral reef prefer to live in warm tropical to subtropical water and represent a productive marine environment, with a great diversity of biological contain compared to that other environment contain [19]. There are a number of factors that help coral reefs to grow, including little light, change in sea level, and water turbidity [20].

2- Miliolids Lime Packstone (MF6)

Miliolids Lime Packstone microfacies were located in lower parts of the Euphrates Formation, above the Coral- miliolids packstone, with a thickness about 1.5 meters. It is contain of *Dendritina rangi*, *Austrotrilina* sp., *Peneroplis evolutus*, small Miliolids , Borilis melo melo, and Algae.

Interpretation: the miliolids are good evidence of the open lagoonal restricted environments and descend into the middle reef slop less than 40 meters. This facies has been sedimentation of tropical neritic at open lagoon and in photic zone and well sorted of miliolids and less amount from mud evidence of high energy environment [21]. This facies is deposited in open marine environment.

3-Coral – Miliolids Lime Packstone(MF7)

This facies was distinguishes in the lower part of the Euphrates Formation above the Coral Boundstone facies, and also within the basal conglomerate bed , with thickness up to 2 meters. The facies is contains of *Quinquoloculina* sp., *Pyrgo* sp., *Austrptrilina asmariensis*, *Dendritina rangi*, and *Lithopylum* sp.

Interpretation: The microfacies are characterized by occurrence number of imperforate benthic foraminifera may evidence a slight saline environment in inner ramp (lagoonal facies) setting [17], [22]. This facies is deposited in open marine environment.

4- Peneroplis Lime Packstone (MF8)

The facies is located above Bioclastic – Algae Wackstone facies, within the middle parts of this formation, with thickness up to three meters. This microfacies consist mainly of *Peneroplis farsensis*, and *Peneroplis evolutus* about 40% and Algae 15%.

Interpretation: the association of peneroplis main evidence of shallow warm tropical environment [6].

Peneroplidis lived in shallow marine near shore weeds in setting of little sedimentation. This facies is deposited in open marine environment.

5- *Peneroplis*-Algae Lime Packstone (MF9)

The facies is distinguished in the middle part of the Euphrates Formation, above the *Peneroplis* Lime Packstone facies, with a thickness about 2meters. This facies contains of 30% *peneroplis evolutus*, 30% algae, and pelecypod.

Interpretation: This facies is deposited in inner ramp (open marine setting) with upper photic zone of less than 40 meters. All peneroplidae including the genus *peneroplis* sp. it is prefers to live in shallow marine water, nearing shore weeds [18]. The present algae in this facies is represent inner ramp setting in the tropical to polar normal marine waters, from intertidal depths [23].

6-Bioclastic – Algae Lime Wacksetone (MF10)

This facies was identified with a thickness of one meter within the middle parts of the Euphrates Formation. The facies is characterized by its containment of bioclastic and algae.

Interpretation: this facies was deposited in the lagoon /restricted and upper slope environments. Bioclastic were formed during or after the sedimentation process due to the influence of prevailing environment conditions, as biological processes, or chemical dissolution, or abrasion transport and re-sedimentation [24]. Symbiotic of fossils with algae in reef and back-reef, and in marine setting with low energy, or they are located at relatively greater depths [25].

7- Algae – Miliolids Lime Wackestone (MF11)

In the upper part of the Euphrates Formation, this facies was identified, with a thickness of up to three meters, above the lime mudstone facies. The fossils content of this facies is Algae about 15% and small Miliolids 10% as *Austrotrillina asmariensis*.

Interpretation: The presence of miliolids is a clear indication of the shallow marine environments, especially the lagoon /back reef within photic zone. The environmental conditions in which this facies was deposited within clean water of normal salinity and low energy [15].

8- Lime Mudstone (MF12)

This microfacies was widely recorded within the upper parts of the Euphrates Formation and within the lower parts, and a thickness of up 8 meters. The mine component of this facies is dolomitized, with a lesser percentage of micrite calcite and small miliolids.

Interpretation: The facies are represented of the hypersaline tidal and restricted shallow marine and low energy environment. This microfacies is affected by diagnosis processes especially by dolomitized process and other processes such as dissolution, recrystallization, and replacement processes but by little rate.

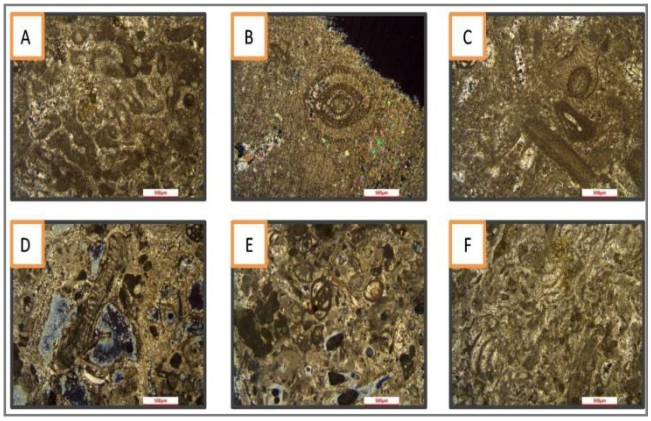

Plate: 2 Microfacies types of Euphrates Formation in Wadi Heglan.
1- A. Coral Lime Boundstone (MF5).
2- B. and C. Miliolids Lime Packstone (MF6).
3- D. and E. Coral-Miliolids Lime Packstone (MF7).
4- F. and G. Peneroplis Lime Packstone (MF8).

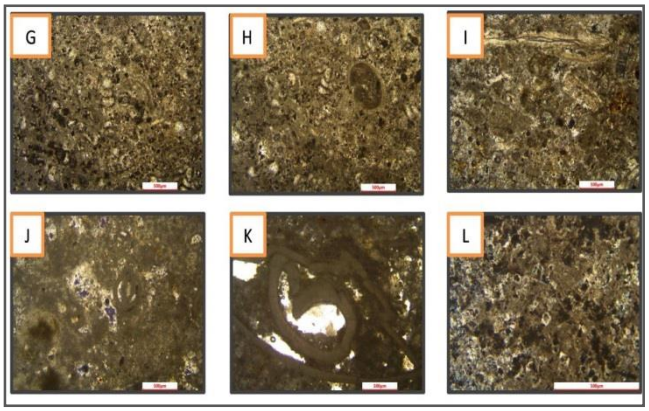

Plate: 3 Microfacies types of Euphrates Formation in Wadi Heglan.
1- H. Peneroplis-Algae Lime Packstone (MF9).
2- I. Bioclastic-Algae Lime Wackestone (MF10).
3- J. and K. Algae-Miliolids Lime Wackestone (MF11).
4- L. Lime Mudstone (MF12).

SEQENCE DEVELOPMENT

The sequence development of the Wadi Heglan succession was recognized, the Anah Formation was not fully revealed within the section except for 7.5 meters, which represents miliolids packstone (MF1), algae packstone (MF2), coral - algae wackestone (MF3), miliolids wackestone (MF4) back-reef facies of long High Stand System Tracts (HST) by back-

reef/lagoon environment, while three fourth- order cycles determined of the Euphrates Formation (A, B, and C) by 26 meters thickness. The A cycle is defined by short episode of sea level rise and represents coral-miliolids packstone (MF7) facies (open marine environment) of transgressive system trace (TST), followed by short episode of stillstand which represent a restricted facies of HST (MF14) which is deposited in restricted setting. The B cycle, represents a long (TST) bioclastic - algae wackestone (MF8), *peneroplis* packstone facies (MF10) of open marine environment, and followed by short episode of HST (MF14), which deposited of restricted marine environment. The C cycle begins with peneroplis - algae packstone (MF9), which represents open marine environment during (TST), and then follows a long episode of (HST), which represents (restricted marine environment).The bounded between the Anah and Euphrates formations represents type-1 (SB1) sequence boundary, on the other hand the main factors that affect to the exposed formation in the study area are eustatic sea level fluctuation, with very low of rate of subsidence (fig.3).

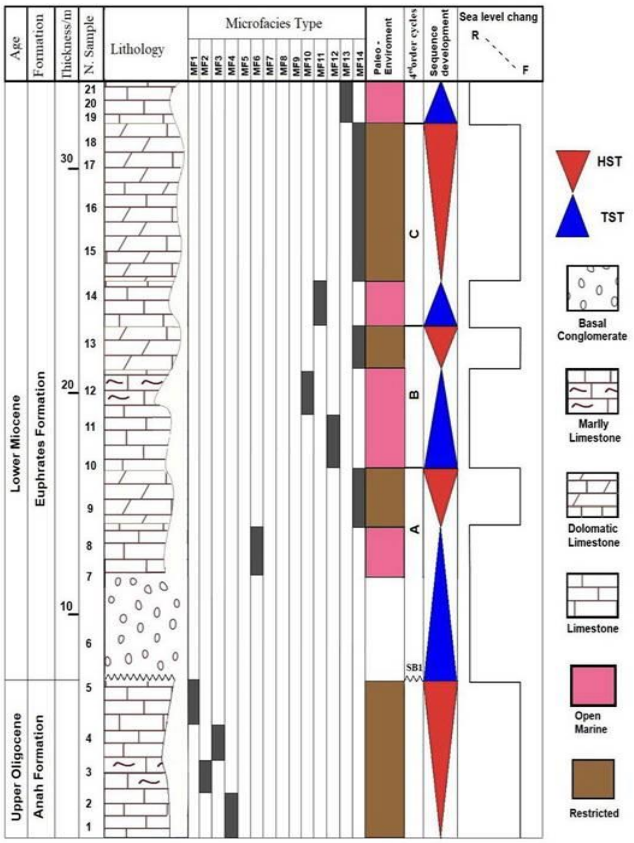

Fig:3 Vertical facies distribution showing paleoenvironment and Sequence Stratigraphic of Wadi Heglan section

CONCLUSION

The Formations that are exposed in the wadi Heglan in western Iraq are Anah of Upper Oligocene and Euphrates of Lower Miocene formations. Anah Formation is characterized by light gray, coralline, very hard, tough, porous, and massive limestone, by 7.5 meters thick. It is also distinguished by the containing the following facies Miliolids lime packstone, algae lime packstone, miliolids lime wackstone, coral-algae lime wackstone, and it is represented by long episode high system trace (HST).The sequence bounded is type-1 boundary (SB1) from the top with Euphrates Formation. While the Euphrates Formation contains gray, hard, very porous, massive this turn towards the top into well-bedded, weathered, and dolomitized limestone, by a thickness of up to 26 meters. The facies within this formation are distinguished within as: coral boundstone, miliolids lime grainstone, coral-miliolids lime packstone, peneroplis lime packstone, bioclastic-algae lime wackstone, algae-miliolids lime wackstone, and mudstone. The three fourth- order cycles (A, B, and C), which are recognize in Euphrates Formation. Each cycle beginning represents a rise in sea level TST, and followed by a fall in sea level HST. The lower bounded of this Sequence is type-1 sequence boundary (SB1) with Anah Formation. The studied succession shows very low of subsidence, where eustacy is the main factors affect the exposed Formations sequence development.

References

[1] Al-Dabbas M. A., Awadh, S. M. , and Zaid, A. A., 2014. Facies analysis and geochemistry of the Euphrates Formation in Central Iraq. *Arabian Journal of Geosciences*,7: 1799-1810.

[2] Al-Ghreri, M.F.,2015. Benthic Foraminifera biostratigraphy of the Euphrates Formation (Early Lower Miocene – Middle Miocene) in selected sections, Western Iraq. *Iraqi Journal of Science* .56(1B):424-434.

[3] Al-Qayim, B., Ibrahim, A., and Kharajiany, S., 2016. Microfacis and sequence stratigraphy of the Oligocene–Miocene sequence at Golan Mountian, Kurdistan, Iraq. *Carbonates and Evaporites*, *31*, 259-276.

[4] Al-Nuaimy Q. A. M., 2018. Morphometric analysis of chattian- Early Aquitanian Miogypsinidae from Iraq and their stratigraphic

distribution in the Arabian Tethys . *Arabian Journal of Geosciences* 10:542, 2-17.

[5] Alkhaykanee, M. H., and Al-Dulaimi, S. I., 2019. "Biostratigraphy of Euphrates, Dhiban, and Jeribe Formations in Ajil oil field, Salah Al-Deen Governorate, central Iraq." *Iraqi Journal of Science* 263-276.

[6] Ameen F. A. , Fattah A. I. , and Qader B. O., 2020. Microfacies and depositional environment of Upper Oligocene and lower Miocene successions from Iraqi Kurdistan Region . *Kuwait Journal of Sciences*. 47(4).

[7]Abdulrahman A., and Awadh S.M., 2021. Depositional Environment of the Ibrahim Formation and Determining the Oligocene- Early Miocene Boundary in Eastern Iraq. *The Iraqi Geological Journal*, 85-97.

[8] Qader F. M., and Ali S. M., 2022. Reservoir Characteristics of the Lower Miocene Carbonate Formation in Kor Mor Gasfield, Kirkuk Area, NE Iraq. *Tikrit Journal of Pure Science*, 27(3): 43-52.

[9] Turki, F. H., and Awadh, S. M. (2023). Discrimination Reef and Non-Reef Environments, Using REE Geochemistry. *The Iraqi Geological Journal*, 1-11.

[10] Jassim, S. Z., and Goff, J. C., 2006. Geology of Iraq, 1st. Edited by Lea Novotna. Dolin, Hlavni 2732, Prague and Moravian Museum, Zelny trh 6, Brno, Czech Republic, 362 P.

[11] Fouad, S. F. A., 2007. Tectonic and Structural Evolution of Iraqi. Bulletin of Geology and Mining, Special Issue . *Geology of Iraqi Western Desert*.

[12] Geel, T., 2000. Recognition of stratigraphic sequences in carbonate platform and slope deposies: empirical models based on microfacies analysis of Paleocene deposits in southeastern Spain ,Paleogeography ,Paleoclimatology , Paleoecology 155: 211-223.

[13] Edgell, H. S. (1997). Significance of reef Limestones as oil and gas reservoirs in the Middle East and North Africa. 4-5 www.google.com.tmsoc.org.

[14] Flugel , E. 2010. Microfacies of carbonate rocks : analysis, interpretation and application, 2nd ed. Springer, Berlin 929 p.

[15] Hassan, S. H. and Ghosh, A. K., 2003. Early Oligocene non-geniculate coralline algal assemblage from Al-Bayda Formation, Northeast Libya Current Science, , 84(4): 552-587.

[16] Romero, J. E., and Rossel , J., 2002. A model for the palaeoenvironmental distribution of larger foraminifera based on Late Middle Eocene deposits on the margin of the South Pyrenean basin. Palaeogeography, Palaeoclimatol , Palaeoecol 179 : 43– 56.

[17] Al-Ghreri, M. F., Al-Hetty, S. O., and Al-jibori, A. S., 2016. Facies characteristics, depositional environment and sequences stratigraphy of the Euphrates Formation in Hadetha Area, Western Iraq." *Al-Nahrain Journal of Science* 19(2)69-79.

[18] Gayara A.D., and Taha L.S., 1989. Microfacies analysis of the Euphrates Limestone Formation. *Northern Iraq Jour Geol Soc Iraq* 22(1):123–129.

[19] Bosellini, F. R., Russo, A., & Vescogni, A., 2002. The Messinian reef complex of the Salento Peninsula (southern Italy): stratigraphy, facies and paleoenvironmental interpretation. *Facies*, *47*, 91-112.

[20] Bassi, D. , Hottinger ,L. , and Nebelsick , H., 2007. Large Foraminifera from the Upper Oligocene of the Venetian area, northeast Italy: Paleontology 5 (4) :845-868.

[21] Brandano , M. ,Frezza ,V. ,Tomasstti , L., Cuffaro , M., 2009 . Heterozoan carbonate in oligotrophic tropical waters: The attard member of the lower coralline limestone Formation (Upper Oligocene, maltal). Palaeogeography, Palaeoclimatology, Palaeoecology, 272: 1-10.

[22] Ghosh , A. M., 2002. Cenozoic coralline algal assemblage from southwestern kutch and its importance in palaeoenvironment and palaeobathymetry . Current science, Vol . 83 , No.2 ,pp.153-158.

[23] Flugel , E., 2004. Microfacies of carbonate rocks . Analysis interpretation and application. Springer, Berlin , 976 p.

[24] Beavintone , S. J. ,and Racey , A., 2004. Ecology of extant nummulitids and other large benthic Foraminifera. Applications in Palaeoenvironmental analysis: Earth Science Review 67 (3-4): 219-265.

[25] Rasser , M. W. , Scheibner , C. , and Mutti , M., 2005. A paleoenvironmental standard section for lower Ilerdian tropical carbonate factories (Pyrenees , Spain : +Corbieres . France) . *Facies* , 51 : 217-232.

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التطور الطباقي لتتابع الأوليجوسين الاعلى – المايوسين الاوسط في وادي حجلان، غرب العراق

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الخلاصة :

اجريت الدراسة الحالية في مقطع وادي حجلان ضمن العمر الاوليجوسين الاعلى–المايوسين الاوسط، غرب العراق. ظهر في هذا المقطع تكويني عنه والفرات. يحوي تكوين عنه على صخور جيرية فاتحه اللون و كتليه عاليه المساميه ومتصلبه و مرجانية ومتدلمته. يتكون تكوين الفرات من صخور جيرية فاتحة اللون وكتلية تتحول الى صخور جيدة التطبق باتجاه الاعلى ومساميه متجويه ومتصلبه ومتدلمتة. تم استنباط البيئة الترسيبية لتكويني عنة والفرات من خلال وفره الفورامنفيرا القاعيه والمتحجرات الاخرى ضمن سحنات هذا المقطع. ميزت البيئة الترسيبية لتكوين عنة ضمن المقطع المدروس وهي بيئة الشعاب وخلف– الشعاب وبيئه تكوين الفرات هي البحر المفتوح الى البيئة المحصوره. تميز تكوين عنة في هذا المقطع بفتره طويلة من اثر النظام العالي، والتي تتمثل بنقصان مستوى سطح البحر لسحنات خلف– الشعاب بينما تميز تكوين الفرات بثلاثه دورات ترسيبية ذات المرتبة الرابعة تمثل هذه الدورات فتره ارتفاع في مستوى سطح البحر ومن تم النقصان في مستوى سطح البحر. الحدود بين هذه التتابعات هو النوع الاول من الحدود التتابعية. تظهر منطقة الدراسة نسبه قليلة جدا من الانخفاض حدث ضمن تطور التتابع والعامل الرئيسي المؤثر على منطقه الدراسة هو التذبذب في ايوستاتيكية مستوى البحر.

الكلمات المفتاحية: التطور الطباقي، التحليل السحني، وادي حجلان، غرب العراق.