

Properties of the Reservoir Rocks – Jdeir Formation In Sabratah BasinFathi Ghanem¹, Osama A. Abdelkader¹, Salah Eldin Elgarmadi¹, Haithem Minas²¹ Department of Earth and Environmental Science, College of Science, Elmergib University, Libya² Department of Geology Science, College of Science, Thi.Qar University, Iraq¹ fbghanem@elmergib.edu.ly, ¹ ofabdelgader@elmergib.edu.ly¹ sealgarmadi@hotmail.com · ² Dean_Dr.haithem@sci.utq.edu.iqCorrespondence E-mail : fbghanem@elmergib.edu.ly**ملخص:**

يتكون تكوين الأيوسين الجدير المبكر في شمال غرب بحوض ليبيا صبراتة من سلسلة سميقة ≈ 450 قدمًا من الكربونات البحرية الضحلة المغطاة بتكوين حرشة وتكوين غليل وتحت تكوين بلال وتكوين الجيراني. تقوم هذه الدراسة بتقييم تحليل النسيج الحيوي وتفسير التراكمات الهيكلية المكونة من اختبارات نوموليت (فورامينيفيرا أكبر) بناءً على: ميزات التداخل ونسبة الأجسام الصغيرة أ إلى الأجسام الكبيرة ب- أشكال تكوين جدير شمال غرب ليبيا ، تم عرض نوموليت في أربعة أقمشة حيوية: نوموليت صغير قوي ، نوموليت صغير مسطح ، نوموليت كبير قوي ونوموليت مسطح كبير. ومع ذلك ، تعكس درجات مختلفة من إعادة العمل الرسوبية وتذرية الطبقة السفلية الأصلية من خلال العمليات الفيزيائية. بالنسبة لأحجار الرزم ذات التشابكات الحادة والأشكال A التي تهيمن بشدة على الأشكال B ، يمكن استنتاج التذرية في الموقع للمصفوفة الدقيقة بواسطة الموجات. في المقابل ، تقترح أحجار الرزم المكونة من أشكال B المتشابهة الفرز الهيدروليكي والإزالة الانتقائية للأشكال A بالتيارات. تمثل أحجار الرزم المكونة بالكامل تقريبًا من أشكال A رواسب Allochthonous مرتبة بالنقل. وبالتالي ، يسمح لنا تحليل النسيج الحيوي بفهم ديناميكيات دراسة هذه الدراسة للمسامية بشكل أفضل وقد وجد أن: $\Phi = 5$ إلى 10٪ (مقبول) والنفاذية $P = 40$ إلى 60 md. هذا يدل على نوعية جيدة من الخزان.

الكلمات المفتاحية : B8-NC41 ، الشاطئ البحري ش غ ليبيا ، حوض صبراتة ، مكنم تكوين اجدير ، أيوسين.

ABSTRACT:

The Early Eocene Jdeir Formation in NW offshore Libya Sabratah Basin consists of a thick sequence ≈ 450 ft of shallow marine carbonate that is overlain by Harshah Formation, Ghalil Formation and underlain by the Bilal Formation, Jirani Formation. This study evaluate the Biofabric analysis and interpretation of skeletal accumulations consisting of nummulite tests (larger foraminifera) based on : the imbrication features & on their ratio of small-bodies A-Forms to large-bodies B-Forms the Jdeir Formation NW Offshore Libya, Nummulites were displayed into four biofabrics : Small robust nummulite, Small flat nummulite, Large robust nummulite & Large flat nummulite. however, reflect various degrees of sedimentary reworking and winnowing of the original substratum by physical processes. For packstones with edge-wise imbrication and A-Forms strongly dominating over B- Forms, in situ winnowing of fine-grained matrix by waves can be inferred. In contrast, packstones composed of imbricated B-Forms suggest hydraulic sorting and selective removal of A-Forms by currents. Packstones composed almost entirely of A-Forms represent transport-sorted Allochthonous deposits. Biofabric analysis thus allows us to understand better the dynamics of this study measurement of porosity has found that: $\Phi = 5$ to 10% (fair) and permeability $P = 40$ to 60md. This indicates a good quality of reservoir.

Keywords : B8-NC41, Eocene, Jdeir Formation Reservoir, Sabratah Basin, NW Offshore Libya.

1- Introduction

The accumulations of large foraminifera are common in Cenozoic, warm, shallow marine, shelf carbonates from North Africa to India and western Pacific. Amongst these, nummulitic limestones are common, and range in age from Paleocene to Eocene in Libya and Tunisia (Figure 1). Nummulites, *Aveolina* are the most commonly occurring genera and are often found in rock forming quantities in the Eocene limestones associated with other larger foraminiferal genera including *Discocyclina*, *Somalina*, *Lokhartia*, *Operculina*, *Fabiania* (Arni, 1965; Blondeau, 1972).

Significant hydrocarbon accumulations have been discovered in western Libyan offshore in the Ypresian Nummulitic carbonate reservoirs (Figure 1). The most important hydrocarbon exploration target in offshore Libya is the nummulitic-rich lithofacies of the Jdeir Formation of Lower Eocene age, especially in the giant El-Bouri Oil Field which is located in Sabratah Basin.

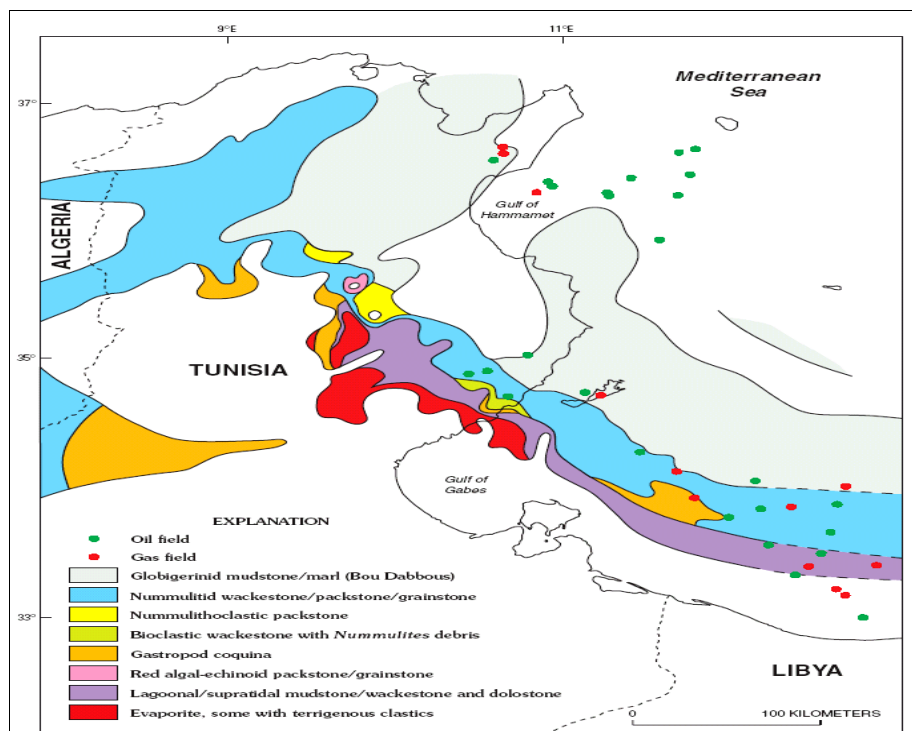


Figure (1) Lithofacies map of the Metlaoui (Farwah) Group (Excluding the Chouabine and Tselja formations) and locations of oil fields with reported oil and gas volumes in Bou Dabbous–Tertiary Total Petroleum System (204801) (modified from Bishop, 1988; Petroconsultants, 1996). Dashed lines, approximate location. White areas, rock section is absent (Klett, 2001).

The nummulites are very common distinctive fossils in the Jdeir Formation. Nummulite is a large lenticular fossil, characterized by its numerous coils, subdivided by septa into chambers (Figure 2) They are the shells of the fossil and present-day marine protozoan Nummulites, a type of foraminifera. Nummulites commonly reach 6 cm (2.4 inches) in diameter, and are common in Tertiary marine rocks, particularly around the Mediterranean Sea (e.g. Eocene limestone in Libya and Tunisia) Jorry et al, (2003)). Fossils up to 6 inches wide are found in the Middle Eocene rocks in Jdeir Formation.

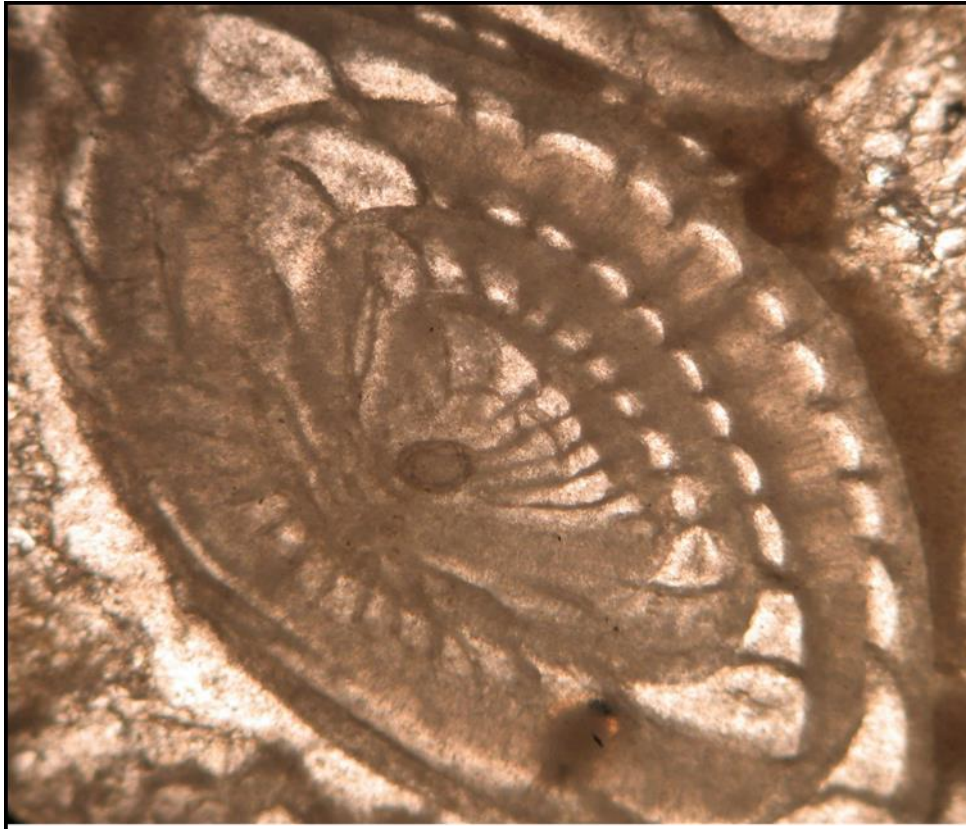


Figure (2) Nummulite fossils from well B8-NC41, selected from Jdeir Formation depth (8647 ft) clarify the chambers which display the intra skeletal porosity (X5)

The nummulitic accumulation represents about 35Ma of geological record, they emerged in Early Eocene and vanished in the Middle Oligocene. They are the main components of the Eocene rocks, extending from western pacific, through central Mediterranean, to the Atlantic Ocean. Because of its dominance in the studied sediments which represented by Jdeir Formation, they can be used as biofabric tool.

The presence of rich fossils such as nummulites, and Aveolina commonly reflect shallow marine Ypresian carbonate environments (Flugel, 2004). These fossils form important potential reservoirs throughout North Africa and Middle East which display different kinds

of biofabrics. Thus, the identification of biofabric types will support the evaluation of reservoir quality.

The most porous and permeable layers are represented by the nummulitic-rich facies of the Jdeir Formation which was accumulated on a carbonate banks, and by the fine-grained dolomite of the Jirani Formation. Biofabrics in the Eocene Limestones of Northern Africa could be typical of many tethyan Paleogene carbonates.

2- Study Area

The study area is located on the offshore NW Libya, (Sabratah Basin) at longitude $12^{\circ}27'40''E$ and latitude $33^{\circ}55'10''N$ (Figure 3) This study is based mainly on certain depth intervals from Well B8-NC41, which cover the cores of Jdeir Formation. The lower boundary is presented at depth of 8690ft (Jirani Formation) while its upper boundary presented at 8296ft of depth (Harshah Formation).

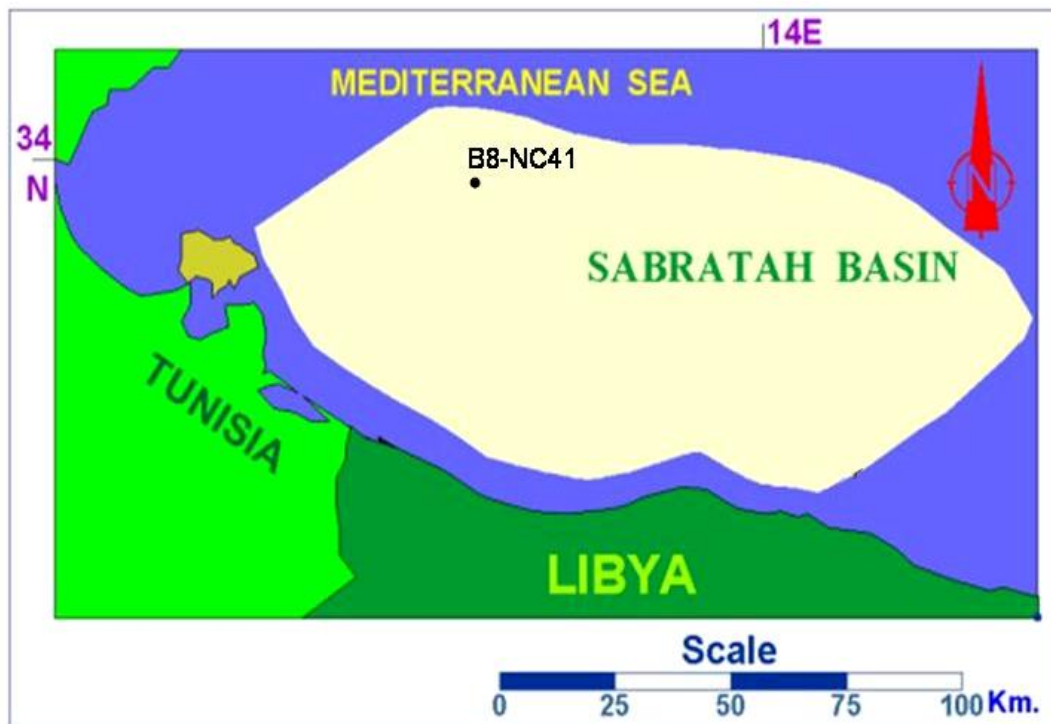
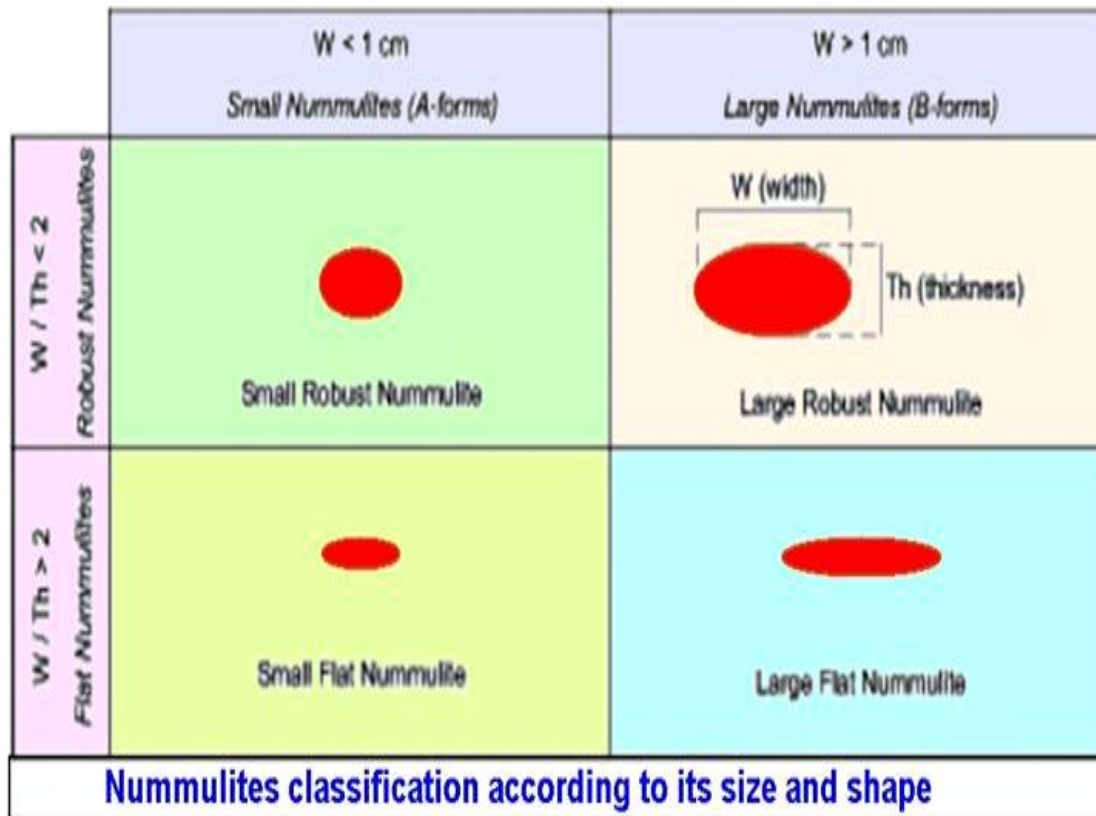


Figure (3) Location map of well B8-NC41, which belong to El-Bouri Field in Sabratah Basin.

3- Study of core data

Nummulites classification shape (robust or flat) and size (small or large) was estimated also according to (Jorry et al. 2003) classification (Figure 4).

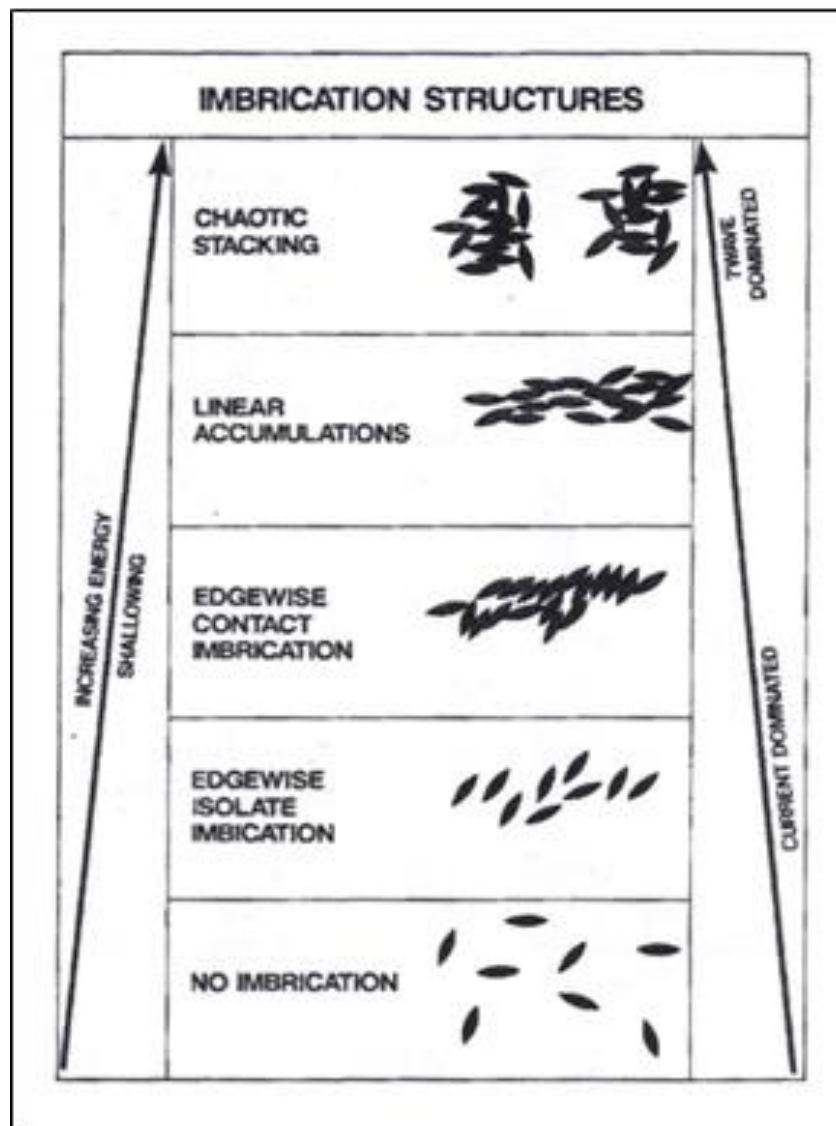


Jorry, Davaud, and Caline(2003)

Figure (4) Shape and size classification of Nummulites, on the basis of its dimensions (Jorry, et al 2003). W= width, Th= thickness, B-form= large Nummulite, A-form= small Nummulite.

4 - Measurement imbrication structure

Classification of the studied cores reflects different nummulite structures such as No imbrication, edgewise isolated or contact, linear accumulation, and chaotic stacking. The fabric classification on the basis of imbrications is very important to reconstruct the relative paleo-water depth and the dominancy of the energy and current.



(Figure 5). On the other hand, the paleo-environmental significance, was very important also for evaluation the reservoir quality (Racey, 1994), to clarify the biofabrics facies that will reflect the best reservoir quality.

4.1 Imbrication Structure

Imbrication of (A- B- C –D –E Form) of nummulites is common whereas: Form A No imbrication. Form B Edgewise isolate imbrication. Form C edgewise contact imbrication. Form D linear accumulation. Form E chaotic stacking.

From the studies of core sample well B8-NC41 and knowing kind of nummulite deposited in this well from where shape and structure is connected and/or effected by transport

processes of current (Allochthonous or Autochthonous) from characterization. (Figure 6) is showing common linear accumulation in this well indicator bring under high pressure given imbrication structure model play role measuring for percentage of all structures found in this well.

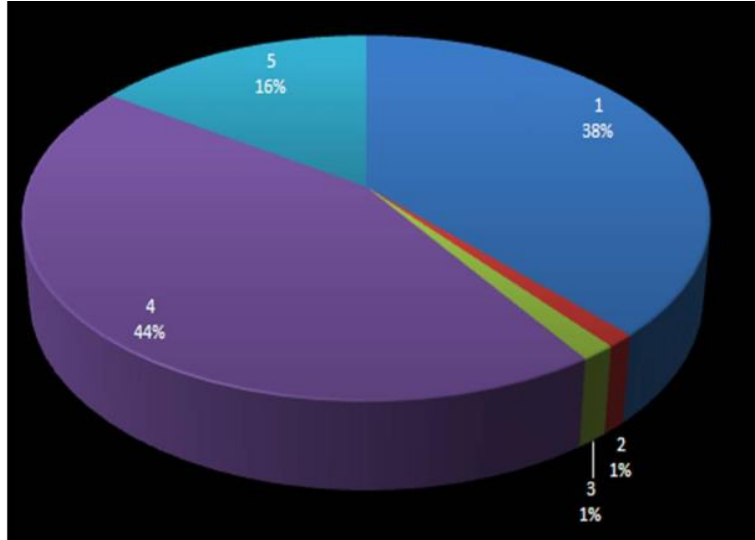


Figure (6) imbrication structure was 1.No imbrication 38% 2.Edgewise isolated imbrication 1% 3. Edgewise contact imbrication 1% 4.Linear accumulation 44% 5. Chaotic stacking 16% of the well B8-NC41.

5- Descriptions core data and thin section

Descriptions from core data and thin sections by petrography analysis (Petrography thin sections done by the binocular microscope to clearly identified the imbrication structure.

5.1 No imbrication structure

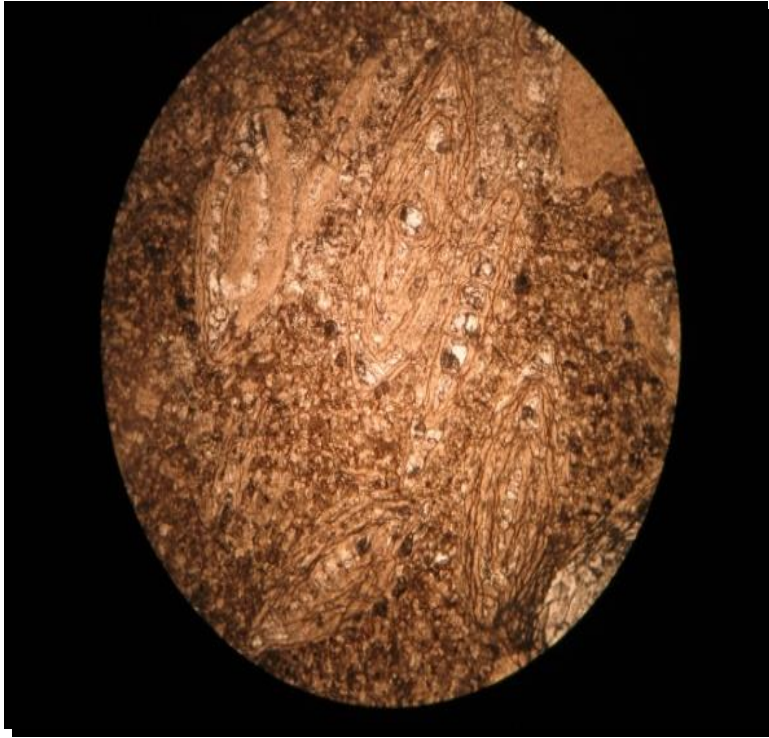


Figure (7) Thin section No imbrication structure.

5.2 Edgewise Isolate and Contact Imbrication

This Facies have been deposited in the lower part of the bank, suggesting that current action was more dominant than wave action (Figure 8).

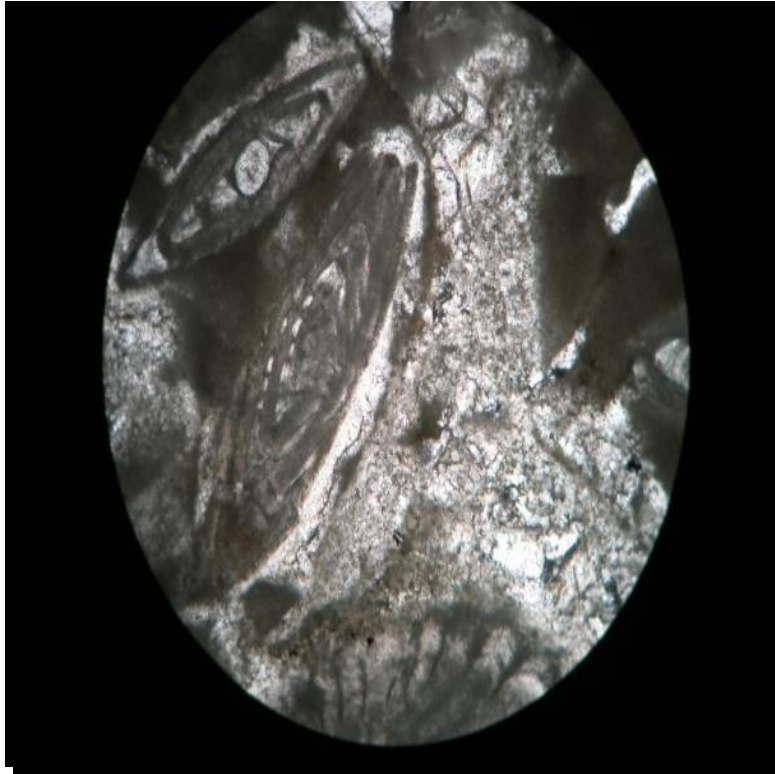
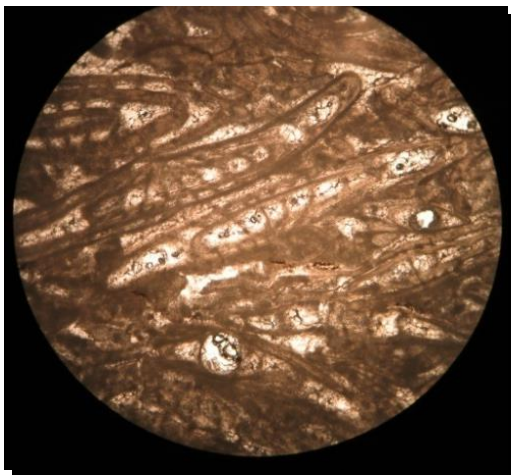


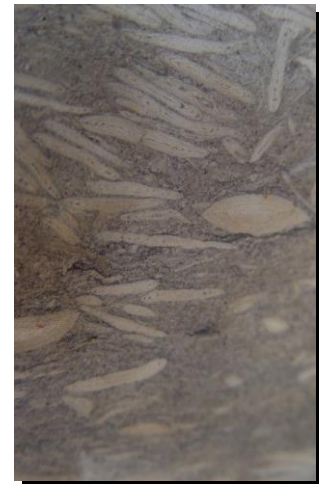
Figure (8) Thin section Edgewise Isolate and Contact Imbrication

5.3 Linear Accumulation

The studied Nummulites fossils mostly re-worked within Jdeir FM of the Basin. linear accumulation structures reflect the heights foundations in the rocks of Jdeir Fm. In Well B8- NC41(9) , its reach to 44%.



Thin section



core data

Figure (9) Linear accumulation imbrication structure.

5.4 Chaotic Stacking

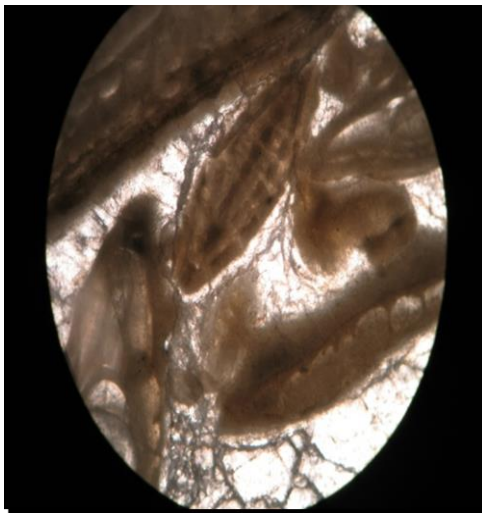
The chaotic stacking facies indicator of many factors deposited of granular and fitted grainstone from high energy transport with oriented and fraction and breaking of nummulites given nummulithoclasts by increasing of energy and shallowing of water. This facies is composed mainly of nummulite. Shown in core data and thin sections (Figure 10) are represented this kind of structure at depths as following (8286ft to 8287ft - 8397ft to 8429ft - 8595ft to 8597ft - 8623ft to 8628ft) deposited in wave dominated current and main biofabric Allochthonous and shallow water condition indicator nummulithoclasts fabric consist aggregation of skeletal and mixed of remaining and different size of fossil indicative high porosity and permeability will clearly reflect the best reservoir quality.

**core data****Thin section****Figure (10)** Chaotic Stacking imbrications structure.

6-Order Classification

From this study (order *Nummulites* classification) four order:

- Small robust *nummulite* (19%). Figure (11)
- Small flat *nummulite* (59%). Figure (11)
- Large robust *nummulite* (01%). Figure (12)
- Large flat *nummulite* (21%). Figure (12)
- Small *Nummulite*



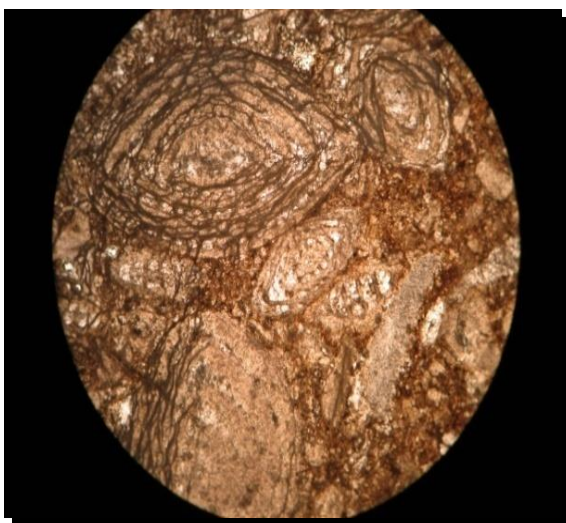
Flat



Robust

Figure (11) small flat and small robust *Nummulite*.

- Large *Nummulite*



Flat



Robust

Figure (12) large flat and large robust Nummulite.

In other word, the nummulite biofabrics, imbrication, and shape is a response of a different levels of dynamics and kinetic energy as which in turn effect on porosity and permeability distribution within facies and micro facies of the B8-NC41 well. Figure (13)

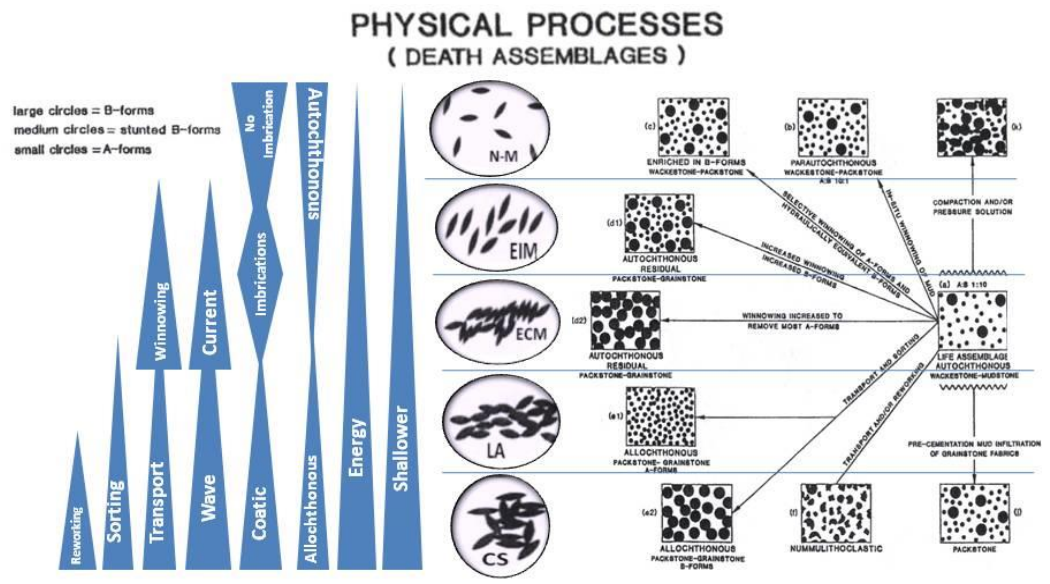


Figure (13) main physical processes nummulite biofabrics imbrication and shape of dynamics and kinetic energy.

7- Conclusions

- Other structure also present but with rare effect such as edgewise contact imbrication (1%), edgewise isolated imbrication (1%) and chaotic stacking (16%) which reflect an increasing in wave kinetic energy and shallower part from the depositional environment.
- The bed sorting of nummulites in some level in Well B8-NC41, show a simultaneous sedimentation of A-Form and B-Form, forming hydraulic equivalent event.
- The biofabrics of Jdeir Formation classified into Autochthonous A-Form nummulites, which dominantly associated with wackstone facies, back-bank environment and physical process no winnowing.
- This suggest that the depths 8487ft - 8300ft reflect high porosity and permeability which indicate a good reservoir quality in these depths.

8- Acknowledgment

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