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Microfacies and paleoenvironment of the Mishrif Formation (middle Cenomanian–early Turonian), in Nasiriyah oil field in Southern Iraq

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***Abstract*---**The Microfacies analysis of the Cretaceous Mishrif Formation was studied in Nasiriyah oil field in Nasiriyah Governorate, southern of Iraq using integrated borehole data set that included, core samples and well logs in newly drilled well to analyze the microfacies and the Diagenesis Process of the formation, 100 thin sections for selected well. The results show that the formation composed of: (top to base) a fine-grained, limonitic fresh water limestone containing Charophytae. Four facies' associations were distinguished in the Mishrif Formation. These include: - These include: - Restricted shallow Open Marin environment is represented by Wackstone and Mudstone to Wackstone. The shallow open marine environment is represented by bioclastic wackestone and packestone, as well as rudistid floastone in rare situations. Shoal Environmentis represented by bioclastic packstone to grainstone, as well as rudstone. Deep Marine environment is represented by mudstone to packstone. six diagenetic processes affected on Mishrif Formation: Cementation, Micritization, Recrystallization, Dissolution, Compaction and Pressure Solution (Stylolization), and Dolomitization, found in thin sections.

***Keywords*---**facies analysis, Mishrif formation, southeastern of Iraq, environment, diagenesis.

Introduction

Many studies have been conducted on all geological aspects of the Mishrif Formation in the different oil fields in southern Iraq, but these reservoirs are still

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at an early stage of development in many oil fields, for example, has been collected from the Mishrif formation reservoirs at the oil field of Nasiriyah (fig-1). Other oil fields are the northern Rumaila field, West Qurna, southern Rumaila, Buzurgan, Ratawi, and Zubair. This study complements the previous studies and evaluates the oil reservoir in terms of studying the Microfacies analysis and the diagenetic processes, (Rabanit in Van Bellen, 1952) described Mishrif Formation for the first time in Zb-3 well within the upper part, calling in the (Khutiah Formation) within (Wesea group). He divided it into three Formations (Mishrif, Ahmady, and Rumaila) and (Mahdi *et al.*, 2013) stated that the best reservoir units occur in rudist rich facies including both shoal and rudist biostrome where aragonitc component have been dissolved under shallow vadose and meteoric diagenetic environment. The Mishrif Formation showed different diagenetic processes; neomorphism, stylolization and pressure solution, cementation, dissolution, and dolomitization. processes were documented on Longmans (1982) for diagenesis.

Figure 1. Location Map Nasiriyah oil field, Mees journal ,2018

Materials and Methods

In this study, core samples were collected for the newly well, according to the changes in the lithology. 100 thin section were prepared in the workshop of the Department of Geology- College of Science-University of Baghdad and in the laboratories of the Oil Exploration Company and Department of Earth Science by using a polarized microscope to delineated the mircofacies and dinginess process.

Results and Discussions

Petrography is a geological description of the rocks supported by microscopic polarization of thin sections. Detailed studies of diagenetic characteristics and changes in porosity distribution in thin sections were used to assist in evaluating heterogeneity. Although, there are numerous carbonate classification schemes available (most are very useful), the scheme adopted by the petroleum geology is “Dunham classification system” (Flugel, 2004).

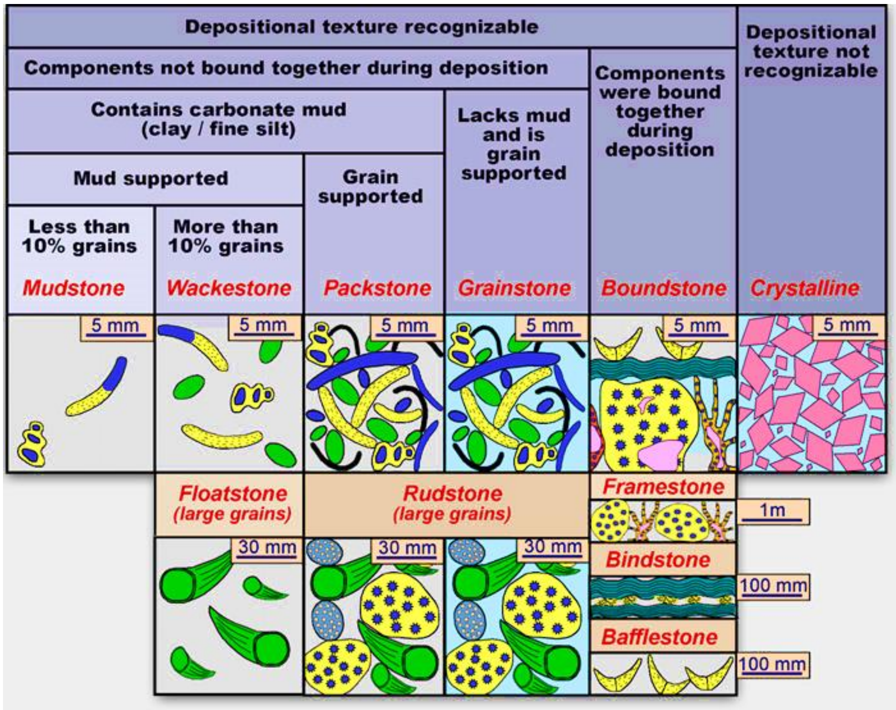


Figure 2. Embry and Klovan's Classification of carbonate (Embry & Klovan, 1971)

Facies Association

Mishrif Formation has four main facies associations, they are Restricted shallow Open Marin environment, Shallow open marine, shoal environment and deep marine. Figure.3.

Restricted Shallow Open Marin Environment Facies Association

Dark argillaceous shale has been discovered to reflect the confined shallow environment. The facies association is mostly composed of benthonic Foraminifera Wackstone and Mudstone to Wackstone. Cisalveolinafallax, Cycledo miairanica, Rhiidionina, Pseudolituonesp, Quniqueloculinasp, Nuzzazatagr.gyre, Vavulamminapicord, and other benthonic foraminifera are plentiful and diversified. Larger benthonic foraminifera have taken advantage of an excellent bio-indicator of a low-energy constrained open inner shelf lagoon adjacent to an inter-bank depositional context. The principal digenesis processes impacting diverse particles include dolomitization, cementation, neomorphism, and dissolution (Plate-2, A) (Mahdi, 2004).

Shallow Open Marine Facies Association

One of the most dominate facies associations in the Mishrif platform most of the time in the research region is the shallow open marine facies relationship. It is distinctively positioned seaward and downslope in the environment of the rudist biostrome, and its textural constituents are mostly bioclastic wackestone and packestone (Plate-1, A). And in rare cases, rudistid floastone. The bioclasts size from silt to sand and, in some cases, coarser, and appear at different phases of the succession. particularly rudist bioclasts, may predominate (Plate-1, C). There are also worn (sand-silt or coarser) angular or tabular grains. Benthonic foraminifera are another important fossil (Plate-1, B), such as Dicyclina and Praealveolina (most of which are badly preserved). Calcareous green algae. Coral and coralline algae coexist alongside echinoderms and gastropods (Plate-1, A). Sponge spicules, bryozoa brachiopods, and pelagic forminifera were rare. The shallow oper marine facies association was formed on the foreslope section of the Mishrif Formation carbonate structure, and the sediments are mostly composed of bioclasts generated from the destruction of rudist biostromes by tidal currents or stroms (Burchette and Britton, 1985). these facies into lower, middle, and higher units because they were on the foreslope, and this subdivision was supported by the presence of rudist bioclasts flowing upward. Such gradation was discovered in the Mishrif Formation, and turbidites and slump structures were lacking, implying a low-angle local slope. The depositional environment was found to be between fair-weather and storm wave bases (Mahdi, 2004).

Shoal Environment Facies Association

The shoal provides a barrier that absorbs the majority of the open ocean's wave energy (Nichols, 2009). This is the Mishrif Formation's most common coarsegrained facies association. The shoal association is made up of off-white, poorly sorted bio clastic packstone to grainstone, as well as rudstone. Rudistids are primarily the bioclasts. It is made up of deposits of low energy shoals and deposits along the platform margin (Burchette, 1993). This habitat has been found inside the reservoir units in the upper portion of Formation based on log analysis and thin section investigation. It has a low gamma ray index and a modest porosity. These facies are composed of coarse to medium to grained rudist in a rudisted packstone microfacies (Plate-2, B), (Plate-2, C), and (Plate-3, F).

Deep Marine Facies Association

Deep marine facies association consists of fine grain (silt size) skeletal lime mudstone to packstone. The skeletal grains are mostly made up of planktonic foraminifera such as Hedbergella, Hetrohelix, and Oilgostiginids. Many sponge spicules and a lower quantity of tiny echinoids were also present. Among the study wells, it was noticed that through transgressive depositional cycles of the

Mishrif Formation, Deep marine facies association gamma ray log values increased gradually Figure (2), notably at higher levels, producing gamma ray log peaks that were well recognized in all wells. They were also tied to the presence of shale or marl units. The presence of organic substances and/or clay is responsible for the high radioactivity (Schlumberger, 1982). These units represent deep marine to sub-basinal environment below the storm wave base (Mahdi, 2004).

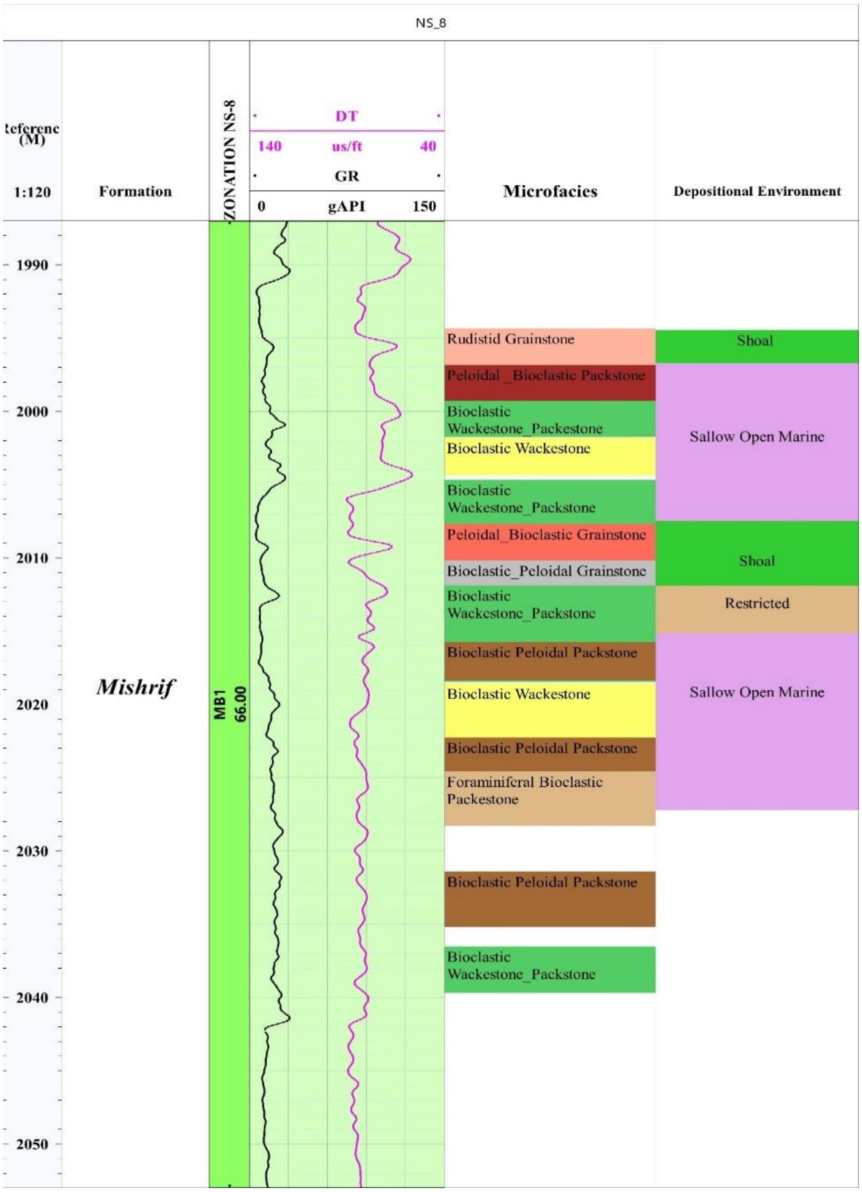


Figure 3. Microfacies with Gamma ray and sonic logs for NS-8.

Diagenetic Processes

Physical, chemical, and biological processes refer to diagnosis. Carbonate minerals generally are more sensitive than most silicate minerals to diagnostic changes, such as dissolution, recrystallization, and replacement. Therefore, the petrophysical properties of the diagenetic processes and their impact clarify the Mishrif Formation rocks (Shakeri, 2012).

Cementation

It consists of mechanisms leading to mineral precipitation in primary or secondary pores as well as the need for super saturation of the mineral pore fluids (Flugel, 2004). The procedure has an adverse effect on the permeability and porosity of the Mishrif Formation in the field, two types of cement have been recognized within the carbonates of Mishrif Formation in the study area:

- A characteristic cement type in ancient carbonate rocks is syntaxial calcite overgrowths on echinoderm grains. The majority of geologists believe these are the result of meteoric diagenetic activity. Many, on the other hand, originated in the marine. Even when there is an early marine overgrowth zone, subsequent meteoric phases are more likely to build up a larger amount of this cement. Because marine overgrowths are frequently so thin, sampling for geochemical analysis is frequently difficult. Regardless, the early marine overgrowths provided a significant amount of initial cement (Kenneth and Walker *et al.,* 1990).
- Drusy mosaic cements are made up of calcite rhomb mosaics that line and fill pores and intraskeletal chambers. Calcite rhombs commonly grow in size towards the center of void spaces. They are commonly found in meteoric and burial environments, where they may be overly fibrous and bladed cements (plate-4, B) (Folk, 1965).

Micritization

Organics play a variety of roles in carbonate deposits. During the deposition of carbonate sediment, organisms may decompose skeletal grains and other carbonate minerals. Organic deterioration caused by the formation of finer grains is a type of sedimentation process. However, because it changes previously produced sediments, it is included here as a very early type of diagenesis. The most common type of biogenetic alteration of sediments is organism drilling activity. Boring by algae, fungi, and bacteria is a significant mechanism of skeletal and carbonate grain material modification. If long-term and vigorous drilling operations are carried out, the entire surface may be influenced by this boring of aragonite or Mg calcite, resulting in the formation of a thin layer of micrite within the grain. A micritic cover is the name given to this layer. More boring may result in total grain boring, resulting in the destruction of all internal textures and the formation of a sort of peloid. The Mishrif Formation rocks in the research area have been severely damaged, resulting in the destruction of most fossil skeletal grains (Plate-4, E) (Folk, 1959).

Recrystallization

This relates to variations without changes in mineralogy in crystal size, crystal shape, and crystal mesh orientation (Flugel, 2004). This process has influenced the development of some sections of the micrite to the microsparite (Plate-4, D)

Dissolution

Undersaturation of carbonate pores causes the disintegration of metastable carbonate grains and cement in shallow meteoric settings, deep depths, and cold waters (Steinsund and Hald 1994; Berelson *et al.,* 1994), dissolution is extremely effective. The obvious and favorable result of this procedure is the enhancement in porosity and permeability of the Mishrif Formation rocks (Flugel, 2004).

Compaction

Reflect the mechanical and chemical reactions that occur from increasing silt loads and rising temperature and pressure conditions during entertainment. A stylolite is a sutured seam distinguished by its surface and is usually covered with insoluble materials such as clay or organic debris. Stylolites are generally parallel to depositional beds but can also occur at different angles of bedding such that reticulating or nodule-bounding patterns can be created (Plate-4, A) (Ahr, 2008).

Dolomitization

During deposition, magnesium (Mg) ions eventually replace half of the calcium (Ca) ions in limestone. (Bacha *et al.,* 2017). Dolomitization of CaCO3 sediment is a type of replacement process in which one element dissolves and is replaced by the almost simultaneous precipitation of another mineral with a different concentration (Lin, 2001). Calcium in the rock can be exchanged for magnesium in the solution if the circulating pore water includes large quantities of magnesium cation. The resultant dolomite will be more porous because the ionic volume of magnesium is substantially lower than that of the calcium it replaces. When calcium is totally replaced by magnesium, porosity increases by 12-13% (Plate 4-C).

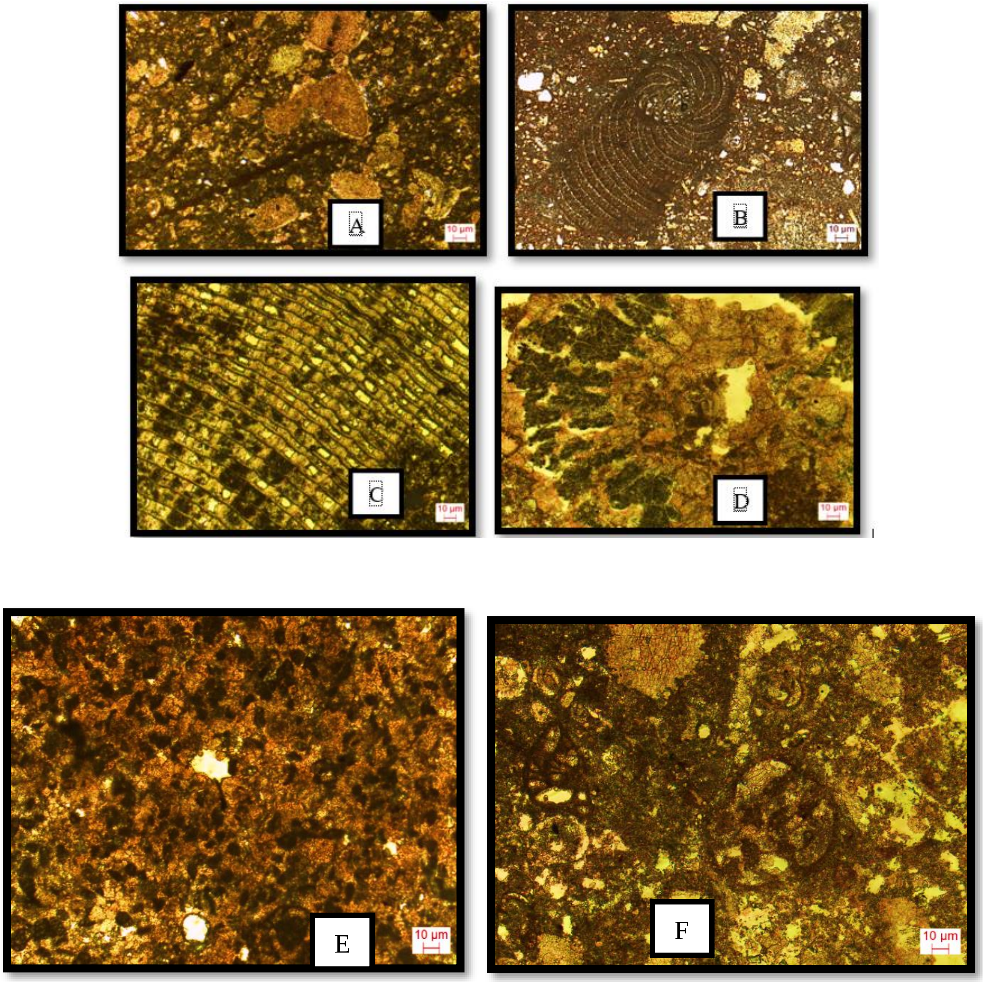
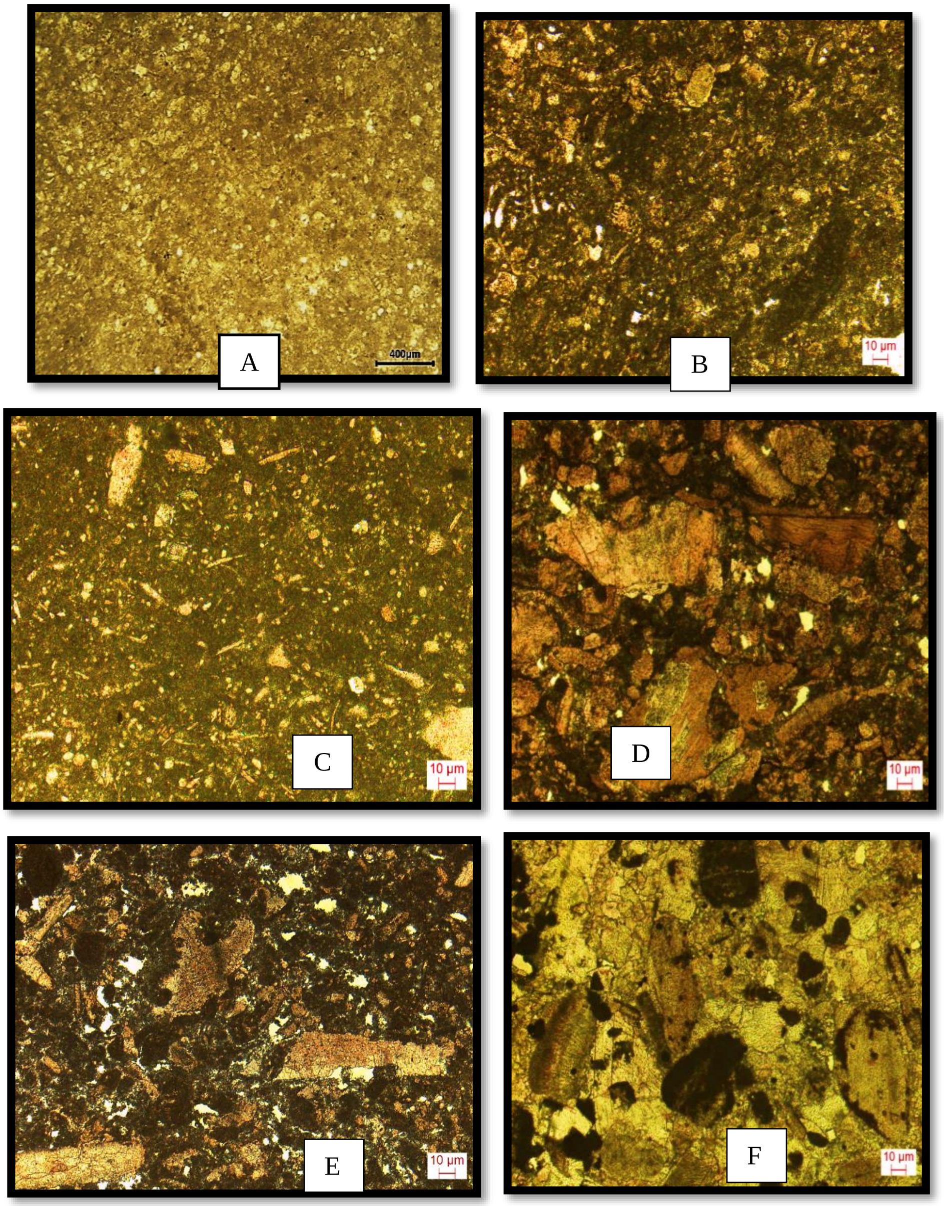


Plate 1: (Facies)

A. Bioclastic wackestone-packstone, Algae, Echinoderm, 2036 m.
B. Foraminiferal-bioclastic wackestone, Benthic foraminifera, 1998.25 m.
C. Bioclastic packstone, rudist, 2001.7 m.
D. Bioclastic packstone, Coral, 2001.40 m.
E. Peloidal-bioclastic grainstone, Peloids, 2011.45 m.
F. Foraminiferal-bioclastic wackestone, benthic foram, 2012.5 m.


A
400µm
B
10 µm
C
10 µm
D
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F
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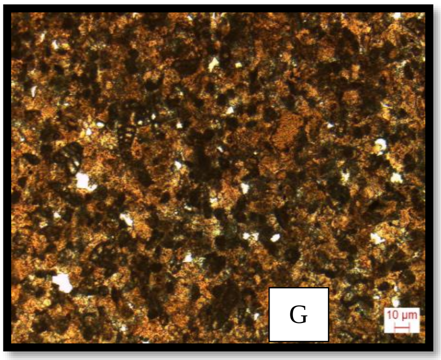


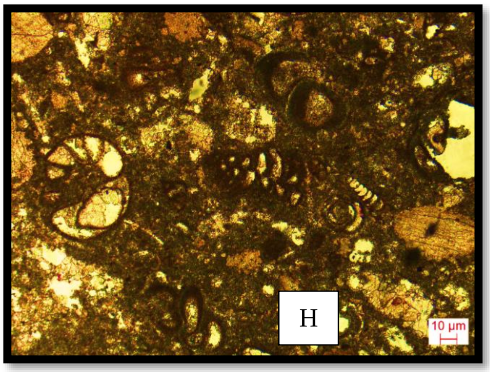
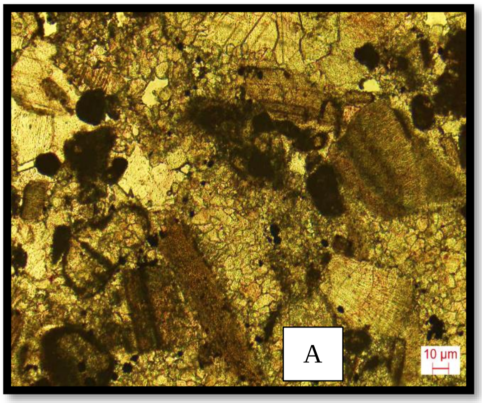
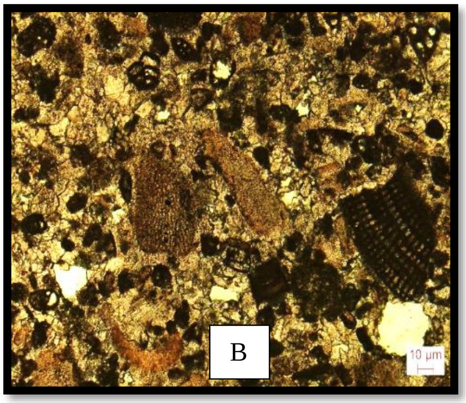


Plate 2 (Microfacies & Facies Associations)

A. Planktonic foraminiferal wackestone (Deep marine Environment), 1926 m.
B. Foraminiferal-bioclastic wackestone (Shallow open marine Environment), 2036m.
C. Bioclastic packstone (Shallow open marine Environment), 1998.65m.
D. Rudistid packstone (Shallow open marine Environment), 2013.5m.
E. Peloidal-bioclastic packstone (Shallow open marine Environment), 1996.35m.
F. Rudistid grainstone (Shoal Environment), 1995.8m.
G. Bioclastic-peloidal grainstone (Shoal Environment), 2011.45m.
H. Benthic foraminiferal mudstone (Restricted Environment), 2012.5m.





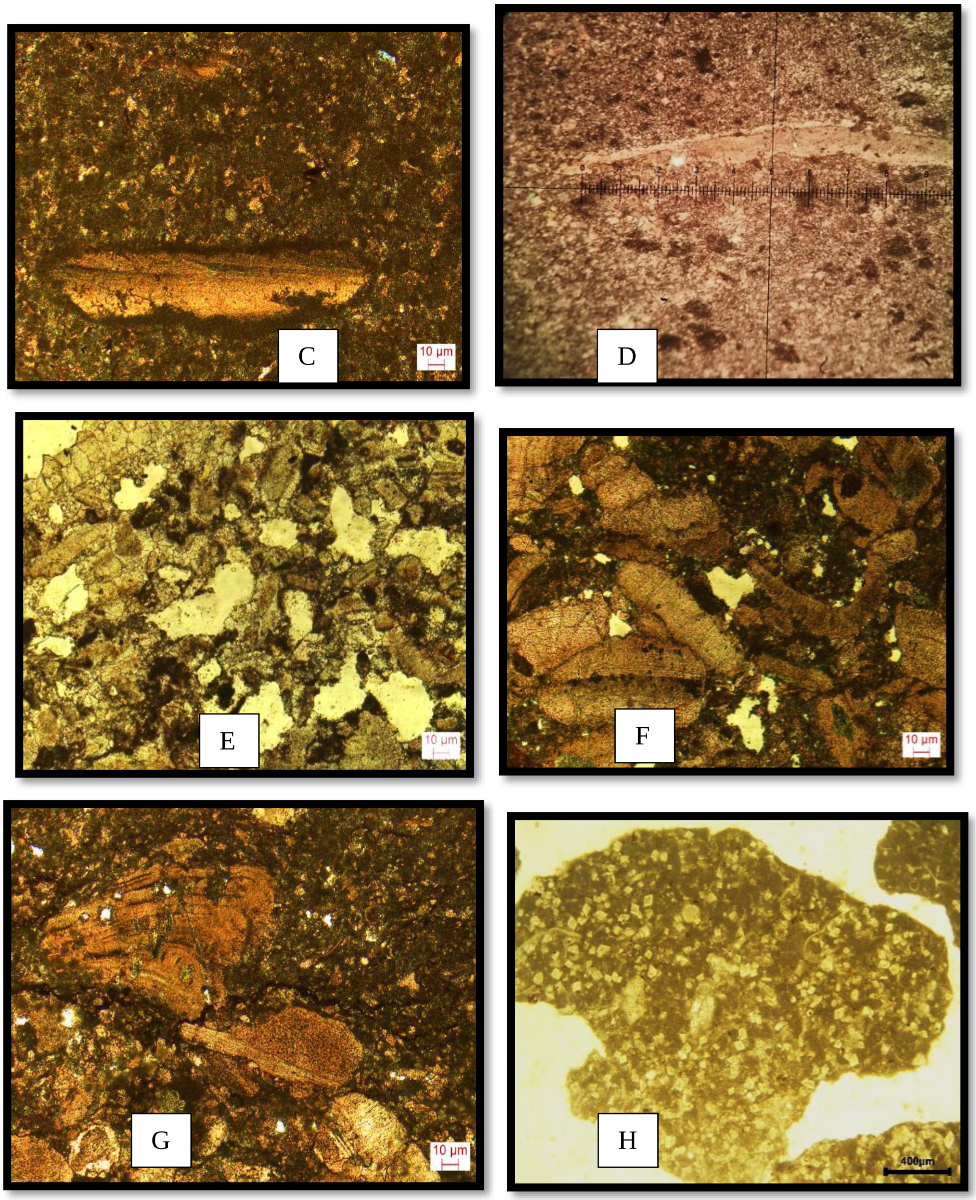


Plate 3 (Diagenesis)

A. Cementation (Drusy mosaic cement), 1995.80 m.
B. Cementation (Syntaxial Rim cement), 2011.9 m.
C. Micritization, 2019 m.
D. Recrystallization, 1932 m.
E. Dissolution, 1995.25m.
F. Compaction (Mechanical Compaction), 2013.5 m.
G. Compaction (Stylolitization- chemical Compaction), 2013.5 m.
H. Dolomitization, 1949 m.

Conclusion

- Eight microfacies are present in Mishrif Formation for Nasiriyah field:
  - Bioclastic Wackestone-Packstone
  - Bioclastic Wackestone
  - Rudistid Grainstone
  - Bioclastic Packstone
  - Foraminiferal Bioclastic wackestone
  - Bioclastic Peloidal Packstone
  - Peloidal-Bioclastic packstone
- There are four environmentally significant facies on the Mishrif Formation carbonate platform: Deep marine, Shallow open marine, Shoal, and Restricted shallow open marine.
- Six diagenetic processes affected on Mishrif Formation: Cementation, Micritization, Recrystallization, Dissolution, Compaction, and Dolomitization.

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