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Microfacies analysis and petrographic study of the Mishrif Formation, in selected wells from southeastern of Iraq.

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Abstract

Mishrif carbonates formation, is a major reservoir in southeast of Iraq and is one of the principle carbonate reservoir in central and southern Iraq, which is of Late Cenomanian to Early Turronian. A petrographic and depositional Environment study has been carried out by examining available thin sections in the Ministry of Oil for wells (No-1, No-2 (Noor field), Am-1(Amara field) and Hf-1 (Halfaya field)).

The main skeletal grains of the Mishrif formation include coral, Rudist, large and small benthonic Foraminifera & planktonic Foraminifera (Planktonic Foraminifera are common in the lower part of the Mishrif Formation), ostracods, echinoderms, and molluscs. The Rudist were found in small to large fragments; and as a complete fossil covering the whole thin section. The Non-skeletal grains included peloids, and micrite.

The most important diagenetic processes affecting on the Mishrif Formation are dolomitization, dissolution, cementation, micritization, recrystallization and Stylolite.
Mishrif succession comprises six paleoenvironments which are deep marine, shallow open marine, rudist biostrome, shoal, back shoal, and lagoon.

Keywords: Facies analysis, Mishrif Formation, southeastern of Iraq.

Introduction:

The purpose of this study is to identify the facies and depositional Environment of the Mishrif Formation, in selected wells from southeastern of Iraq. The Cenomanian Mishrif Formation is the main carbonate Cretaceous reservoir in southern Iraq, which belongs to the Cenomanian cycle, although this cycle probably ended during the early Turonian. In addition to the Mishrif, the cycle includes the Rutbah Sandstone Formation (mainly found in the Western Desert), the Ahmadi Shale Formation, the Rumaila and Kifl formations (both of southern Iraq), and the Gir Bir, Dokan and Balambo formations (of northern Iraq) [1].

The Mishrif formation is unconformably overlain by Khasib formation (late Cretaceous) at the top and gradationally underlain by basinal limestones of the Rumaila formation at the bottom. The Mishrif was deposited on an unstable platform where environments of deposition were generally shallow water limestones with rapid vertical changes.

The study area is located in the southeastern of Iraq in Missan province to the northeast of the Amara City, Missan Governorate, four wells (Noor-1, Noor-2, Amara-1 and Halfaya-1) have been studied, 2 wells from Noor field, 1 well from Amara field and 1 well from Halfaya field. Figure (1) shows the location of these fields.

This study aimed to study the Petrographic, facies and depositional environments of Mishrif Formation in southeastern of Iraq, Missan province.

1-Regional geological setting

The study area lies within the Mesopotamian basin as shown in Figure (2) according to the tectonic zones of Iraq [2]. The lower contact of the Mishrif with the Rumaila Formation is gradational; the formation is underlain by a deeper water carbonate shelf or ramp deposit, the Rumaila Formation, and overlain by the mid-Turonian unconformity. The top seal of the Mishrif reservoir comprises interbedded shale and deep-

Water limestone of the basal Khasib Formation [3, 4].

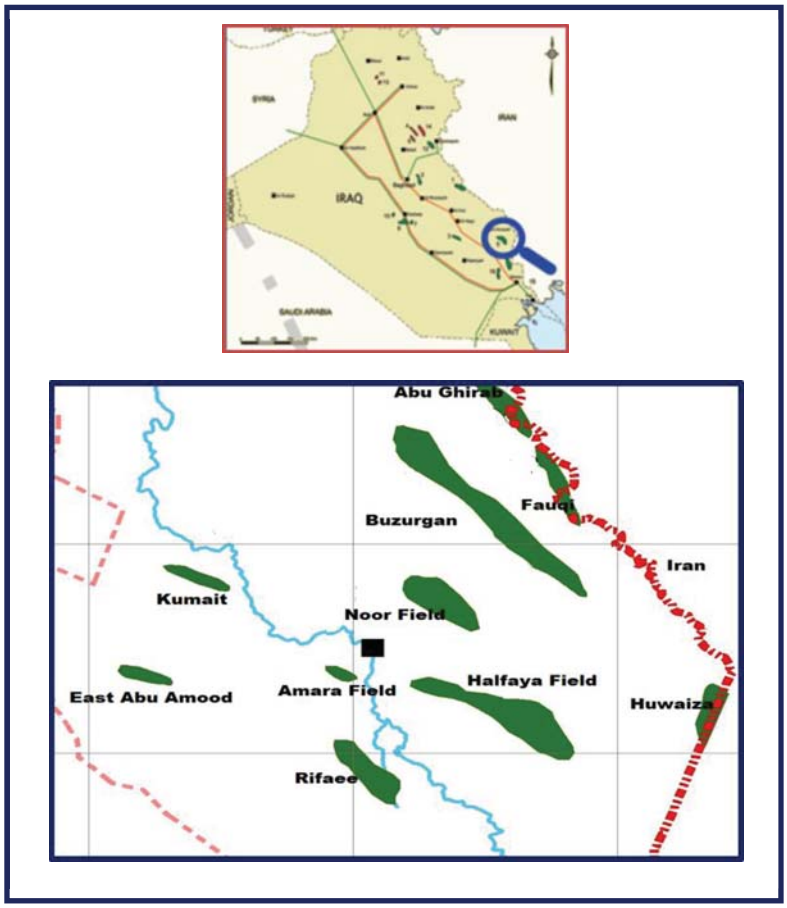


Fig. (1) Map of fields location in southeastern Iraq.

Mishrif Formation on the other hand was deposited in a shallow neritic environment. In the late stages of this cycle, Kifl evaporate formation was deposited in the central part of the basin; where it formed a cover of evaporate rocks on Rumaila Formation and some parts of Mishrif Formation [3]. Mishrif Formation, part of the Wasia Group, is a widespread Cenomanian-Turonian carbonate

Succession in the Arabian Gulf and surrounding areas. It is a prolific hydrocarbon reservoir and host to a number of giant oil fields Gulf [5].

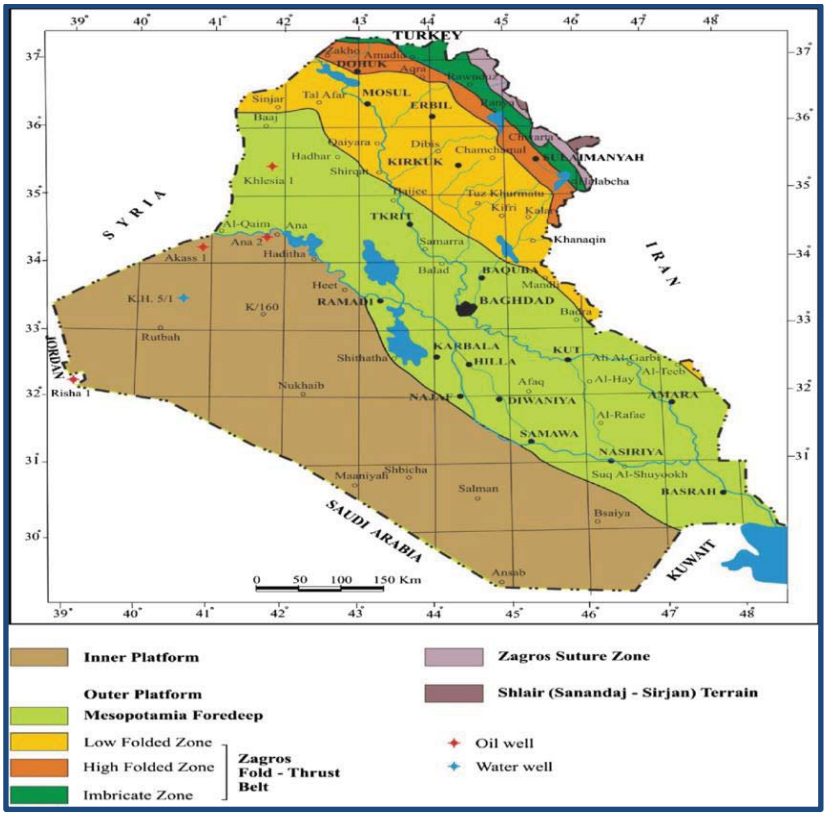


Fig. (2) Main Tectonic Zones in Iraq [6].

2- Petrography

The petrographic analysis study for Mishrif formation have been carried out , which show that the Mishrif formation consists from skeletal grains (rudist, coral and calcareous algae, Foraminifera, echinoderms, ostracods, and molluscs), Rudist is common in Cretaceous platform, ramp and reef carbonates exhibiting a biofacies suspense to the windward/leeward position and shallowing-up wards cycles [7].

The Rudist is important in the building of the Mishrif formation and are found in two forms, small to large fragments (Plate 1-1, 1-2).

Corals are common in the Mishrif formation, were recognized within the rudist biostrome and as coral fragment associated with other organisms (Plate 1-3).Foraminifera are founded in two types, both benthonic and planktonic Foraminifera are found in the

various facies of the Mishrif Formation and Indicate to the lagoon, shallow open marine, deep marine and shoal environments. Planktonic Foraminifera (Plate 1-4) founded distinctly located in the lower part of the Mishrif Formation, which indicate to the deep marine environment of the Rumaila formation, many kinds of the planktonic Foraminifera recognized in the Mishrif formation (*Hedbergella*, *Hetrohelix,* and *Oligostiginids)*. Benthonic Foraminifera (Plate 1-5) the most common skeletal grains in the Mishrif formation (*Miliolids*, *Alveolinids*, *Nezzazata)*, and many others; benthonic Foraminifera is common in slope, lagoon, and shoal environments.

Calcareous algae are abundant in the Mishrif Formation (Plate 1-6) like green algae.

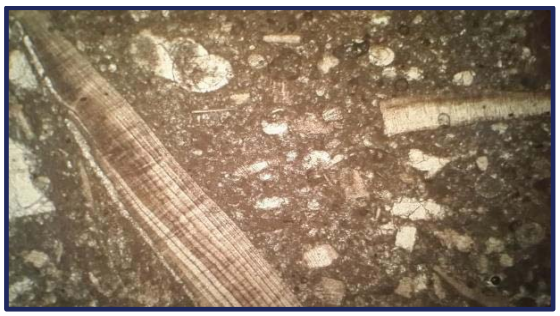
Non-skeletal grains are those not obviously derived from the skeletal material of micro-organisms, invertebrates or the thalli of calcareous plants [8]. The main non- skeletal grains recognize in the Mishrif formation are peloids and micrite.

The pelloids are recognize in the Mishrif Formation and the size of these peloids is between (0.02-1mm) (Plate 1-7).

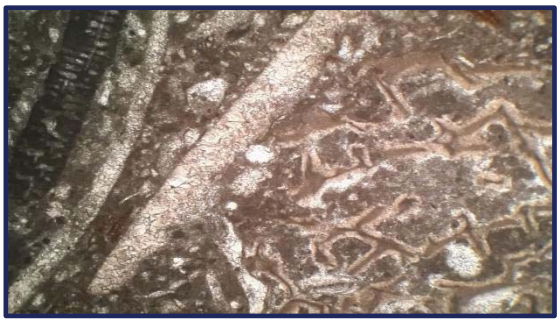
The micritic matrix is present in all thin section of the Mishrif Formation and founded in a high percentage is microcrystalline and represents the matrix of most facies types (Plate 1-8), filling the space between the fossils.

Plate -1

1- Rudist (Hf-1 2888.75 m ×35).

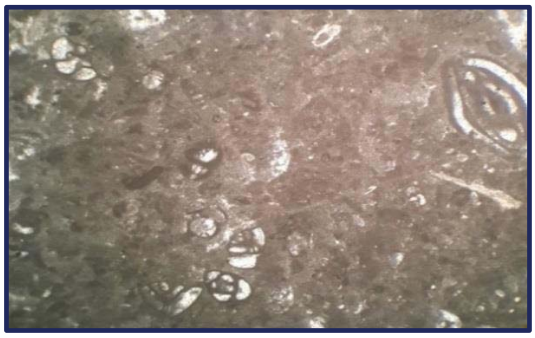


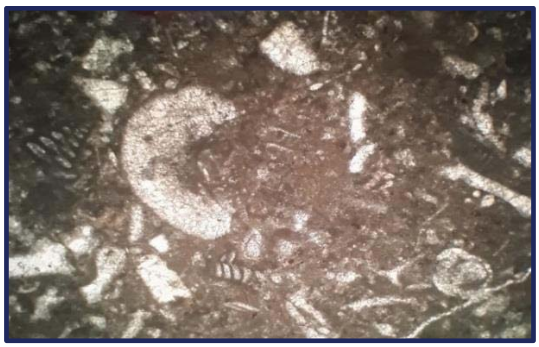
2 - Rudist shell fragments (Am-1, 3036 m ×35).



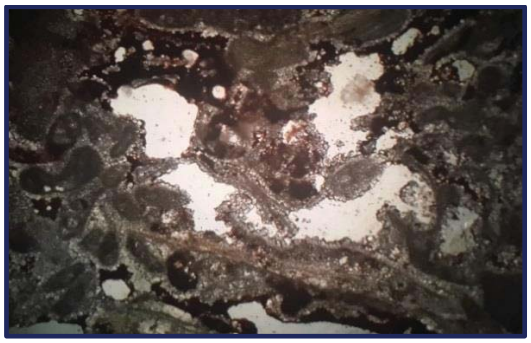
3- Coral fragment (Hf-1, 2988 m ×35).

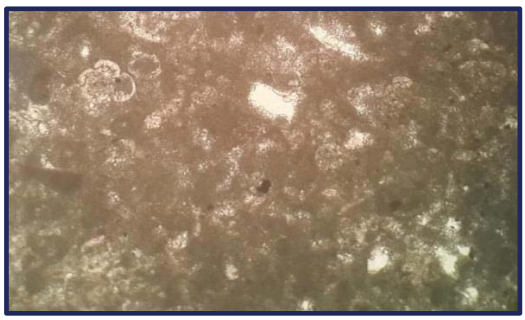
4- Planktonic Foraminifera (Am-1 2034m, ×35)





5- Benthonic Foraminifera (Am-1 2034 m, c-13 ×35). 6- Calcareous algae (Am-1,3044.30 m ×40).





7- Pelloids (Am-1, 2891.40 m ×40).

8- Matrix (micrite), (Hf-3200 m, c-10)

3- Diagenetic processes

Mishrif formation affecting by many kinds of the diagenetic processes and the most important diagenesis process are dolomitization, dissolution, cementation, micritization, recrystallization and Stylolite (pressure solution).

There are several types of dolomite texture in carbonate rocks. Three dolomite textures were recognized in this study (Plate 2-1). This process has been observed in the shoal and Rudist Biostrome and in the shallow open marine environments, this process founded in all studied wells particularly in the wells (No-1 & No-2) which concentrated around the Stylolites.

Dissolution process can be clearly recognize, which has effect in improving reservoir properties through increasing the secondary porosity (Plate 2-2), in the Am-1 & Hf -1 wells, the dissolution process is largely developed which improve the porosity more than No1 and No-2 wells depended mainly on the sediment conditions, especially on the depth of the deposits.

Two kinds of cementation have been recognized in Mishrif Formation, syntaxial rim cement and granular cement (Plate 2-3, 2-4). This process observed more in the wells (No-1 & No-2) which effect on the porosity of these two wells.

Micritization is the earliest diagenetic process developed during post depositional algal and bacterial activities in a stagnant marine phreatic zone [9].

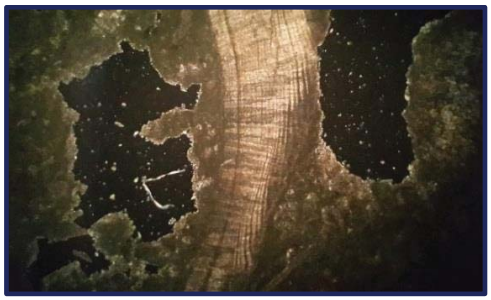
Micritization process has been observed practically in the shallow open marine environment, and comprises the boring process, and these voids were filled in with micrite material after death of organism (Plate 2-5).

Recrystallization is primarily a change in size or shape of crystals (e.g. increase or decrease in the size of calcite crystals) where no change in mineral composition takes place [10]. Recrystallization in the Mishrif formation is characterized by transformation of micrite

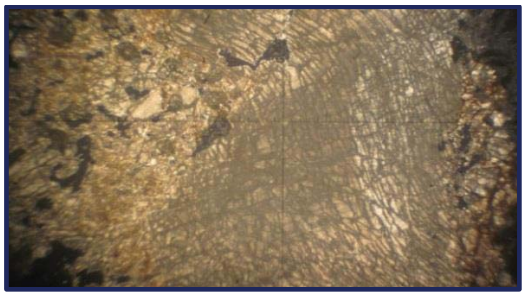
to microsparite (Plate 2-6).

Stylolization has a very good effect in enhancing the reservoir characteristics of Mishrif Formation. Some of the stylolite found in this study (Plate 2-7) this process has been observed more in the No-1 and No-2 wells due to it is developed particularly in lagoon, shallow open marine and deep marine environment which contain high amounts of micrite.

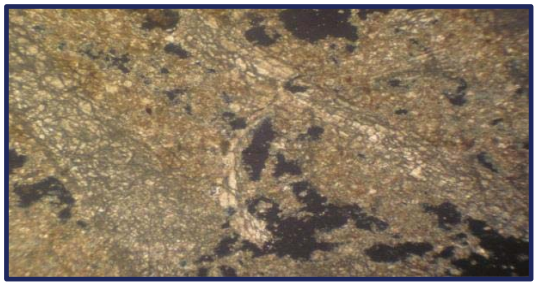
Plate -2-

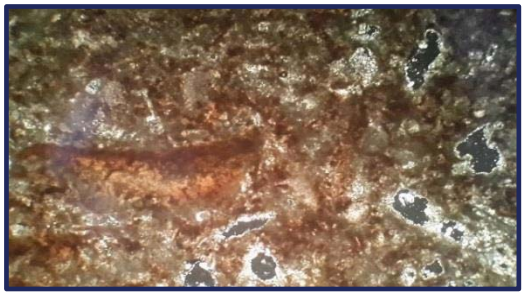


1- Dolomitization process, (Am-1, 2996.5 m C-12). 2- Dissolution process, (Am-1, 3053.5 m C-14).

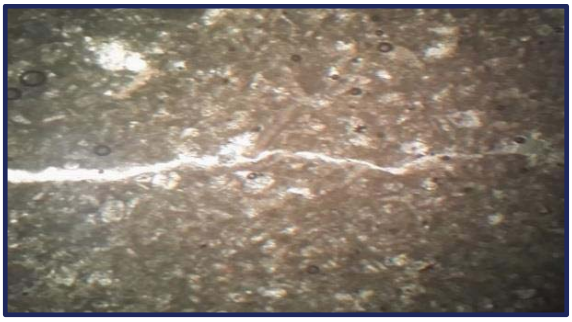


3- (Blocky) cement, (Am-1, 3059 C-14). 4- Syntaxial rim cement, (No-2, 3887 m).





5-Micritization process, (No-2, 3881 m). 6-Recrystallization process, (No-1, 3413 m).



7-Stylolite process, (No-2, 3416.3 m).

4- Microfacies Analysis

The available thin sections for selected wells in southeastern of Iraq have been examined, which shows that the Mishrif succession comprises six paleoenvironments which are:

4-1 Deep marine environment

These facies consist of mudstone to wackestone with small Bioclastic debris and consist mainly from planktonic Foraminifera such as *Hedbergella,* as well as Spicules and amounts of small echinoderms present (Plate 3-1).These facies exist mainly in the lower parts of the Mishrif Formation.

4-2 Shallow open marine environment

This environment is consist from benthonic and planktonic foraminifera in foraminiferal bioclastic Wackestone and Packstone, as well as, sponge spicules, molluscs, calcareous algae, coral, and echinoderms (Plate 3-2). This environment made up of wackestone with bioclastic debris, echinoderms, and the main diagenesis process exist are Stylolites, dissolution and Micritization.

4-3 Rudist Biostrome environment

This environment is composed from very coarse grained of Rudstone with Packstone/Grainstone facies, and characterized by skeletal debris of rudist, some calcareous algae, sponge and coral (Plate 4-1).

This Rudist Biostrome thickness observed that increase in the crestal part of the structure of Mishrif formation particularly in the Halfayah field (well Hf-1), and decreasing in the flanks along the axis parts, which indicate on the relationship of the growth of the Rudist Biostrome with the structure.

4-4 Shoal environment

The Shoal facies in Mishrif Formation consider important facies, consists from calcareous algae, Rudist, peloids, echinoderms, and benthonic Foraminifera (Plate 4-2). This environment is characterized by grain-supported and represent high energy level, have good reservoir potential and good porosity which enhanced by dissolution, no argillaceous and Stylolites.

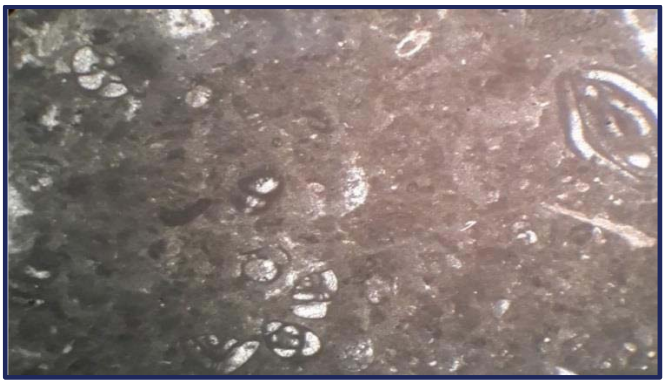
4-5 Back shoal environment

This environment is characterized by mud-supported, and the major faunas include in are benthic Foraminifera, Chondrodonta, wackestone–packstone, and bioclastic foraminiferal wackestone–packstone facies (Plate 4-3).

4-6 Lagoonal environment

The lagoon environment exists in the top and middle part of the Mishrif Formation, consist mainly of benthonic foraminiferal wackestone and mudstone to wackestone. The benthonic Foraminifera are abundant and diverse including *miliolids*, *Nezzazata*, *Alveolinids*, and *Textularia* (Plate 5-1). This environment is mostly compact, dense with low porosity and the joint and Stylolites are common in this environment.

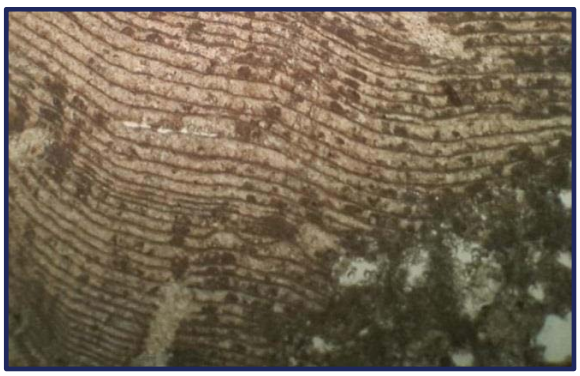
Plate -3-



1- Deep marine environment (Am-1 2034 m, c-13 ×35)

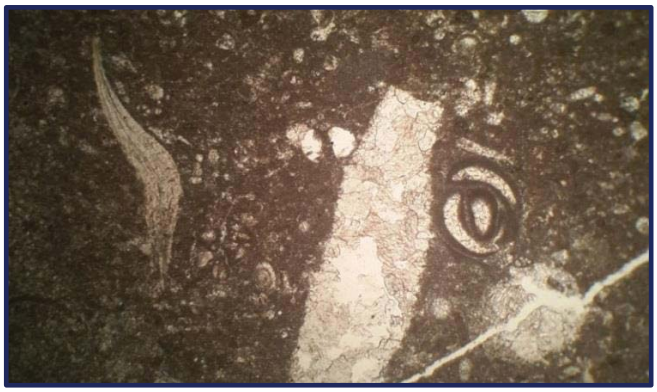
2- Shallow open marine environment, (Hf-1, 3858 m c-3).

Plate -4-



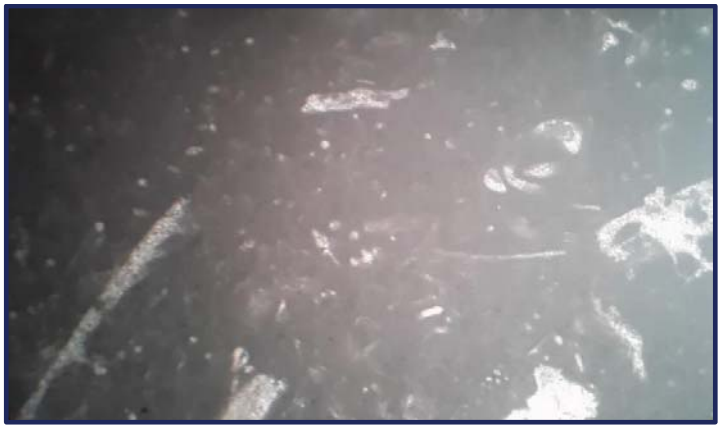
1- Rudist Biostrome environment, (Hf-1, 2888,75 m, c-3)

2- Shoal environment, (Hf-1, 3000 m, c-10).



3- Back shoal environment (Hf-1, 2902,30 c-3).

Plate -5-



1- Lagoon environment, (Am-1, 2926 m, c-6).

5- Conclusion

This study is of a diagenetic and depositional Environment impact on carbonate rocks quality in the Mishrif formation has been carried out by examining available thin sections in the Ministry of Oil for wells (No-1, No-2 (Noor field), Am-1(Amara field) and Hf-1 (Halfaya field)), the following conclusions may be drawn: -

1- A petrographic study shows that the main skeletal grains in the Mishrif formation include rudist, Foraminifera, algae, coral, echinoderms, Foraminifera found in the various facies, both benthonic and planktonic, planktonic Foraminifera are common in the lower part of the Mishrif Formation, and the non-skeletal grains included peloids, and micrite.

2- The diagenetic processes affecting in the Mishrif Formation are dolomitization, dissolution, cementation, micritization, recrystallization and Stylolite (pressure solution), some of these processes improve the reservoir quality of the Mishrif formation, such as dolomitization, dissolution and the Stylolization, the others diagenesis process has negative influence on the petrophysical properties of the Mishrif formation, such as the cementation and recrystallization process.

3- The environment analysis has been carried out by examining available thin sections for wells (No-1, No-2, Am-1 and Hf-1). Six main environment facies were recognized in the Mishrif Formation. These environments included deep marine, shallow open marine, rudist biostrome, shoal, back shoal, and lagoon. The most important facies are included the rudist and shoal environments and to some extent within the back-shoal environment.

Reference:

1. Sadooni, F.N., 2005, The nature and origin of Upper Cretaceous basin-margin rudist buildups of the Mesopotamian Basin, southern Iraq, with consideration of possible hydrocarbon stratigraphic entrapment, Cretaceous Research 26 (2005) 213e224.
2. Jassim S. Z. and Goff J. C., 2006. Geology of Iraq, Doline, Prague and Moravian museum, Brno, 341p.
3. Al-Khersan, H. (1973) Mishrif Formation—regional study. INOC library, Baghdad.
4. Sherwani, G.H. (1983) Depositional environment and stratigraphic relationships of Mishrif Formation and equivalents in selected bore- holes, southern and middle Iraq. Unpublished M.Sc. Thesis, University of Baghdad, 119 pp. (in Arabic).
5. Burchette, T.P. (1993) Mishrif Formation (Cenomanian-Turonian), southern Arabian Gulf: carbonate platform growth along cra- tonic basin margin. In: Simo, J.A.T., Scott, R.W., and Masse, J.P. (eds.), Cretaceous carbonate platforms. AAPG Memoir 56, p. 185-199.
6. Fouad, S.F. and Sissakian, V.K. (2011) Tectonic and Structural Evolution. Geology of the Mesopotamia Plain, Iraqi Bulletin of Geology and Mining, Special Issue No. 4, 33-46.
7. Flugel, E. (2004) Microfacies of carbonate rocks. Springer-Verlag, 976 P Ginsburg, N. (1957) Natural resources and economic development 1. Annals of the Association of American Geographers.
8. Trucker, V, M. E., and Wright. P., 1990, Carbonate sedimentology, Oxford, Blackwell scientific publications, 482p.
9. Longman, M., W., 1980. Carbonate Diagenetic Textures from Near Surface Diagenetic Environments, AAPG Bulletin, V.64, and PP461-487.
10. Boggs S Jr (2009) Petrology of Sedimentary Rocks.2nd Edition, Cambridge University Press, New York, pp 602.