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Late Cretaceous Foraminiferal Biozonation in Selected Wells of Nasiriya Oilfield, Southern Iraq

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Abstract

Mishrif Formation is considered to be a very important Cretaceous reserve, many authors have focused on its petrophysical characterization and diagenetic operations. This study focused on the biozonation and age determination of the formation in three selected subsurface sections of Nasiriya Oilfield which is situated in Thi Qar Governorate, South of Iraq. The results show that in these two sections, only on benthic foraminifera biozone was discriminated which is: *Nezzazata simplex-Nezzazata conica* Interval Biozone, dated as Middle-Late Cenomanian (early Late Cretaceous), which indicates the highest occurrence of two successive taxa. The thickness of this biozone is 42 meter in well NS-7 and the lithology is brown-light brown, slightly hard, fine - medium crystalline limestone, and in parts compact white, moderately hard, fine crystalline limestone, and in well NS-8 the lithology is, brown to light brown, slightly hard, medium crystalline, porous, vuggy limestone, the thickness is 36.9 meter. However, NS-4 is fossil baren.

Key Words: biozone, Benthic foraminifera, Mishrif, Cenomanian, Nasiriya Oilfield, Southern Iraq.

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Introduction

Mishrif Formation is a huge carbonate storage in Southern and Central of Iraq, and is considered to be a part of the Wasia Group. Mishrif Formation was initially defined by [1] in an unpublished paper, and then a complete detail was by [2] in well Zubair-3 in southern Iraq. Economically and geologically, it regards one of a major important reservoir in Iraq, the formation is precipitated in Cretaceous age as essential carbonate petroleum reserves in Iraq [3].

Mishrif Formation comprises multi-layers thick carbonates that were precipitated on a wide platform which ranged between lagoonal inner shelf to open marine inner shelf that was influenced with a large global transgression, began in early Late Cretaceous. The formation conformably overlies the Rumaila Formation's oligosteginal carbonates, and unconformable upper contact with Kifl Formation in the study area and most parts of Iraq [4]. The area of study is situated in southern Iraq, Nasiriya Oilfield. It is located in Thi-Qar Governorate, 38 km northwest of Nasiriya [5]. The geographic coordinates of the oilfield are (Longitude 45° 47′ 55″ - 46° 09′ 30″) and (Latitude 31° 16′ 35″ - 31° 27′ 55″) Figure (1). The coordinates of the studied wells are listed in Table (1). This research aims to determine the fossil biozonation and age of Mishrif Formation.

Table 1: Geographic coordinates (degree-minute-second) and thicknesses of the Mishrif Formation

Well	Longitude	Latitude	Top m. R.T.K. B	Bottom m R.T.K. B	Thickness m.
NS-4	45° 56′ 30″	31° 21′ 55″	1931	2096	165
NS-7	45° 56′ 05″	31° 19′ 15″	1914	2090	176
NS-8	45° 59′ 10″	31° 22′ 05″	1908.5	2092	183.5

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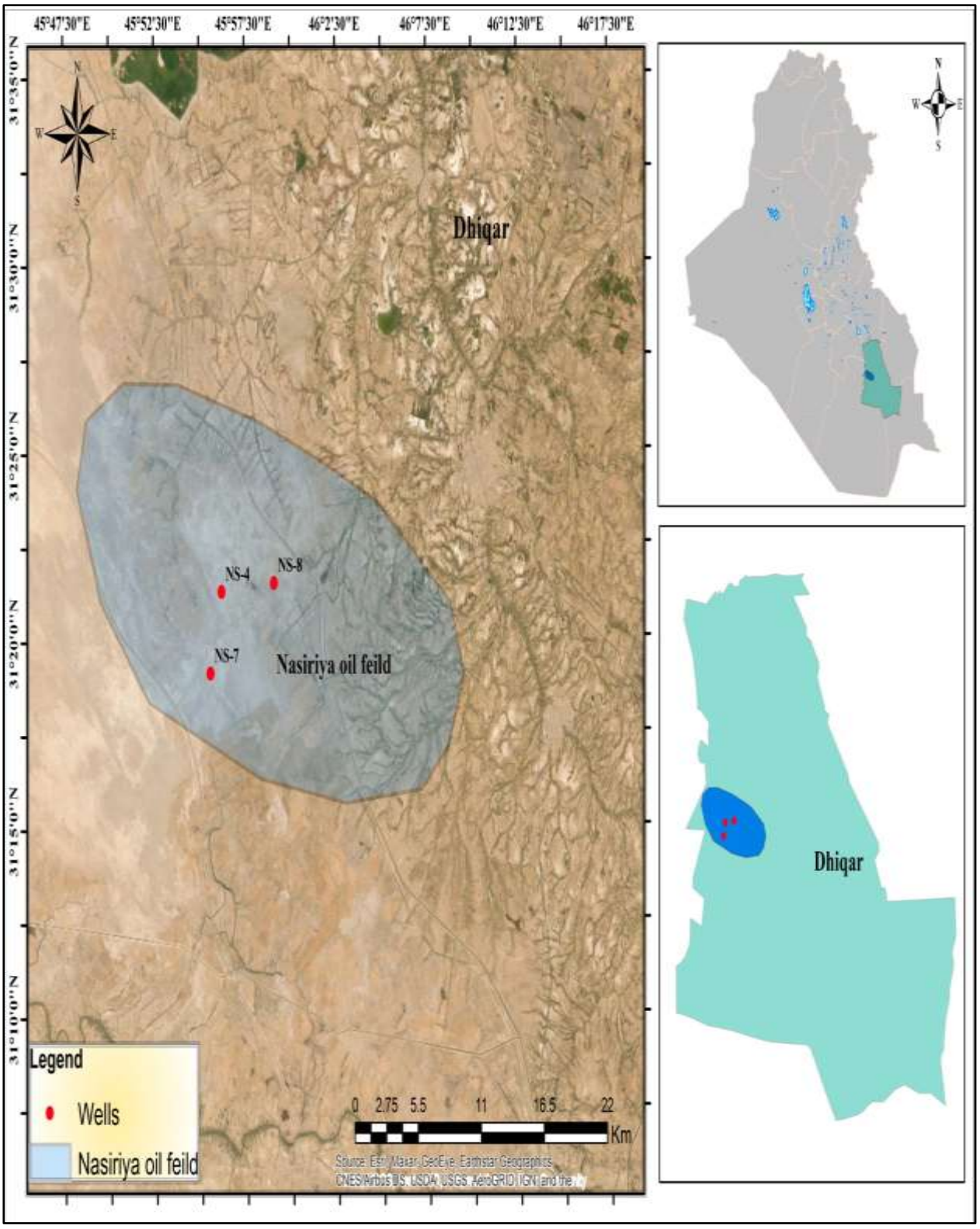

Figure 1: Satellite image of the study area

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Materials and Methods

Fifty-five thin sections were provided by Laboratory Center-Oil Exploration Company-Ministry of Oil. These thin sections are carefully examined using binocular microscope type (Leika) to discriminate the benthic foraminifera in addition to classify their taxa, and also determined the association occurrence of different other fossils especially foraminifera to support the age determination. The selected index taxa were plotted along vertical lithologic column to identify the thickness of the biozone and to complete the distribution of the other fossils.

Results

Biostratigraphy

The main objective of biostratigraphy is to determine the stratigraphic age of the formation under study to know more about its position in geologic column, and also to discriminate if there are gaps in the succession due to the unconformities. This carries out after distributing all biozones along the stratigraphic column from the oldest the youngest [6].

Fossils occurrence

Thin section examination of wells NS-7 and NS-8 reveals the following fossils in the succession of Mishrif Formation.

- *Nezzazata simplex*: This species was first described by [7] from the Early Cenomanian, western coast of Sinai, Egypt, as having single-layered wall, single-walled septa and calcareous granular, finely perforate wall structure. The age of *Nezzazata simplex* is Middle to Late Cenomanian according to [8, 9] and Late Cenomanian by [3, 10] and Middle Cenomanian as mentioned by [11]. Nezzazatidae and the Cuneolinidae are found mainly in lagoonal facies together with Miliolidae and Verneulinidae [12]. *Nezzazata simplex* and *N. conica* was regarded as Cenomanian by [13, 14, 15 and 16], *Nezzazata simplex* was reported from Cenomanian succession in Egypt [17], *Nezzazata simplex* and *N. conica* was recorded as Middle Cenomanian for Mishrif Formation at Majnoon and Zubair oil fields, southern Iraq by [18], this species was recorded from Middle Cenomanian in Mishrif Formation, Southern Iraq by [19] . In this study, *Nezzazata simplex* is found in well NS-7 at depth interval (1992.5 -2028.4 m), Plate (1-A) and well NS-8 at depths (1995.8 – 2032.7 m), Plate (1-B).

- *Nezzazata conica*: *Nezzazata conica* (Smout, 1956) differs from *N. simplex* by holding a very arched umbilical side and a smaller umbilicus [20]. This species was recorded form Early Cenomanian in southern Tibet, China [21], and recorded as Middle to Late Cenomanian in Turkey [8], also Mid-Late Cenomanian by [9], Late Cenomanian by [3], and Early-Middle Cenomanian by [10, 11] in southwest Iran. this species was recorded by [19] from Middle Cenomanian in Mishrif Formation, Southern Iraq. In this study, *Nezzazata conica* is found in well NS-7 at depth interval (2025.5- 2037 m), Plate (1-C) and well NS-8 at depths (2032.7 and 2034 m), Plate (1-D).

- Miliolids: are a group of foraminiferal organisms with minimal salinity requirements. They can be observed in environments with saline and brackish waters, but their presence is frequently limited to only a few depths and temperatures. Miliolids are excellent markers of shallow depths, particularly ocean waters; they are found in back-reef lagoons and reef flats [22]. Miliolids recorded from Late Cenomanian by [8, 3 and 19]. They are common in the fine sands and scarce in the deeper environment and flourished at 6-9 meters at the back-reef [23, 21]. In this study, miliolids are found in well NS-7 at depths (1992.5-1994.85 and 2020.5 m), Plate (1-E) and well NS-8 at depths (1998.25, 2005.95 and 2038 m), Plate (1-F).

- *Chrysalidina gradata*: This species prefers shallow marine, back-reef environment [24]. The species was proposed by [25] as Late Cenomanian in Central Italy; it recorded by [9] form Mid-Late Cenomanian in Italy, and Late Cenomanian by [8, 3, 18 and 19]. the age of *Chrysalidina gradata* was regarded by [11] as Late Cenomanian in Sarvak Formation, Southwest Iran. In this study, Chrysalidina gradata found in well NS-7 at depths (1992.5-1994.85 and 2004.6 m), Plate (1-G) and absent in well NS-8.

- *Pseudolituonella reicheli*: The species was proposed by [25] as Late Cenomanian in Central Italy, and recorded as Mid-Late Cenomanian in Turky by [8]. The species was registered by [18, 19] form Late Cenomanian succession of Mishrif Formation, Southern Iraq. *Pseudolituonella reicheli* also registered by [10 and 11] form Late Cenomanian in Southwest Iran, and Mid-Late Cenomanian in Italy by [9]. in this study, *Pseudolituonella reicheli* found in well NS-7 at depths (1994.85 and 2009.5 m), Plate (1-H) and well NS-8 at depths (1998.25, 2005.95, 2008.90 and 2032.70 m), Plate (2-A).

- *Pseudorhapdionina dubia*: this species was regarded by [3] as Late Cenomanian, Southeastern Iraq, also, [19] recorded this species from Late Cenomanian, Southern Iraq. In this study, *Pseudorhapdionina dubia* found only in well NS-7 at depth (2012.5 m), Plate (2-B).

- *Pseudorhapydionina laurinensis*: Saint-Marc (1975): in [26] proposed Early-Late Cenomanian for this species for shallow marine facies in Lebanon. Later [25] recorded the species form Late Cenomanian back-reef and inner carbonate platform. While [8] recorded this species form Mid-Late Cenomanian in Turky, *Pseudorhapydionina laurinensis* regarded as Late Cenomanian in Southern Italy by [9]. In this study, *Pseudorhapydionina laurinensis* found only in well NS-7 at depths (2020.5 and 2034.5 m), Plate (2-C).

- *Praealveolina tenuis* Reichel, 1933: Larger benthic foraminifera (LBF), which are single-celled creatures with distinctive endoskeletons, include the Alveolinidae as an example. Alveolinoids are present in shallow-marine carbonates and are widespread throughout the world from the Cretaceous period to the recent. They are significant biostratigraphic index fossils and frequently related to hydrocarbon reservoirs. Alveolinoids also exhibit provincialism, with many of their distinctive genera being restricted to the American, Tethyan, or Indo-Pacific provinces [21]. the species was diagnosed by [3] from Early Turonian and consider it as range zone for Mishrif Formation in well Amara-1, Southern Iraq. *Praealveolina tenuis* was recorded by [10, 11] from Middle to Mid-Late Cenomanian respectively in Sarvak Formation, Iran as diagnosed foraminifera within *Nezzazata conica-Nezzazata simplex* biozone. The age of the species was regarded by [18] as Middle Cenomanian from Mishrif Formation, Southern Iraq according to the association occurrence of *Nezzazata simplex – Nezzazata conica* Concurrent Biozone, and Mid-Late Cenomanian by [19] from Southern Iraq. In this study *Praealveolina tenuis* is found in well NS-7 at depths (2020.5 and 2025.5 m) Plate (2-D) and in well NS-8 at depth (2032.7-2034 m) Plate (2-E).

- *Praealveolina cretacea* (d'Archiac, 1837): This species was recorded by [8] form Mid-Late Cenomanian in Turky, and [3] diagnosed the species from Late Cenomanian and considered it as partial range zone for Mishrif Formation in well Amara-1, Southern Iraq. Later [11] recorded this species as Late Cenomanian in Sarvak Formation, Iran as investigated foraminifera associations within *Nummoloculina heimi* zone. While [22] regarded the age of the species as

early Late Cenomanian for Mishrif Formation, Southern Iraq according to the association occurrence of *Pseudorhapydionian laurinensis – Praealveolina cretacea* Concurrent Biozone. The species was diagnosed by [19] from early Late Cenomanian, Southern Iraq association foraminifera of *Praealveoilina cretacea-Pseudorhapydionina* Concurrent Biozone. In the present work, *Praealveolina cretacea* is existed in well NS-7 at depths (2025.5 and 2034.5-2037 m) Plate (2-F) and in well NS-8 at depths (1998.25, 2019.8 and 2034 m) Plate (2-G).

- *Trochospira avnimelechi* Hamaoui and Saint-Marc: at first, [25] recorded the species form Late Cenomanian in Central Italy. While [8] recorded this species form Late Cenomanian in Turky. Later [9] regarded *Pseudorhapydionina laurinensis* age as Mid-Late Cenomanian in Southern Italy, this species was recorded by [11] as Late Cenomanian in Sarvak Formation, Iran as investigated foraminifera associations within *Nezzazata concava* and *Praealveolina cretacea*. The species was diagnosed from early Late Cenomanian, Southern Iraq as *Praealveolina tenuis-Cisalveolina lehneri* Concurrent Biozone [19]. in this study, *Trochospira avnimelechi* found only in well NS-7 at depth (2020.5 and 2034.5-2037 m), Plate (2-H).

- *Biconcava bentori* (Hamaoui and Saint-Marc, 1970): The species was proposed as Late Cenomanian in Central Italy [25]. While [8] recorded this species form Early-Middle Cenomanian in Turky. Later [11] recorded this species from Middle Cenomanian as foraminifera association of *Conicorbitolina conica* Taxon Range Zone in Sarvak Formation, Iran. Also [18] regarded the age of the species as Middle Cenomanian from Mishrif Formation, Southern Iraq according to the association occurrence of *Nezzazata simplex – Nezzazata conica* Concurrent Biozone. Finally, [19] diagnosed the species from early Late Cenomanian, Southern Iraq as association foraminifera of *Pseudorhapydionian laurinensis-Praealveoilina cretacea* Concurrent Biozone. in this study, *Biconcava bentori* found only in well NS-8 at depth (2019.8 and 2032.7 m), Plate (3-A).

- *Qataria dukhani* Henson, 1948: This species was diagnosed from Late Cenomanian and consider it as Partial Range Zone for Mishrif Formation in well Amara-1, Southern Iraq [3]. Later [18] regarded the age of the species as Middle Cenomanian from Mishrif Formation, Southern Iraq according to the association occurrence of *Nezzazata simplex – Nezzazata conica* Concurrent Biozone. While [19] diagnosed the species from early Late Cenomanian, Southern

Iraq as association foraminifera of *Pseudorhapydionian laurinensis-Praealveoilina cretacea* Concurrent Biozone. in this study, *Qataria dukhani* found only in well NS-8 at depth (2034 m), Plate (3-B).

Biozonation

Depending on the data available and identification of fossils in this study, there is only on biozone can be recognized, this is:

Nezzazata simplex-Nezzazata conica Biozone.

- Category: Interval zone.
- Age: Middle – Late Cenomanian (early Late Cretaceous).
- Definition: Interval from Highest occurrence (HO) of *Nezzazata simplex* to (HO) of *Nezzazata conica*.
- Thickness of the zone: In well NS-7, the lithology is brown-light brown, slightly hard, fine - medium crystalline limestone, and in parts compact white, moderately hard, fine crystalline limestone, the biozone thickness is 42 m, Figure (2) and in well NS-8, the lithology is, brown to light brown, slightly hard, medium crystalline, porous, vuggy limestone, the thickness is 36.9 m, Figure (3).
- Fossils association: Numerus fossils has been associated with this biozone, Miliolids of Late Cenomanian; *Chrysalidina gradata* of Middle to Mid-Late Cenomanian; *Pseudolituonella reicheli* of Middle to Mid-Late Cenomanian; *Pseudorhapdionina dubia* of Mid-Late Cenomanian; *Pseudorhapydionina laurinensis* of Middle to Mid-Late Cenomanian; *Praealveolina tenuis* of Middle to Mid-Late Cenomanian; *Praealveolina cretacea* of Late Cenomanian; *Trochospira avnimelechi* of Mid-Late to Late Cenomanian; *Biconcava bentori* of Middle and Late Cenomanian; *Qataria dukhani* of Middle and Late Cenomanian.

Discussion

The subsurface (drilled downward) was mentioned that an interval zone is a stratigraphic section bound by the highest known occurrences of two specified taxa going downwards, making it a highest-occurrence zone [27].

Locally, *Nezzazata simplex-Nezzazata conica* Interval Zone is equivalent to *Nezzazata simplex – Nezzazata conica* Concurrent Biozone from Middle Cenomanian of Mishrif Formation which recorded by [18] in Southern Iraq; and equivalent to *Nezzazata simplex – Nezzazata conica* Concurrent Biozone from Middle Cenomanian and *Pseudorhapydionian laurinensis-Praealveoilina cretacea* Concurrent Biozone of Early-Late Cenomanian of Mishrif Formation which recorded by [19] in Southern Iraq; and equivalent by *Praealveolina cretacea* biozone of Late Cenomanian by [28] Southern Iraq; and [29] in Southeast Iraq; and [30] in South Iraq, and *Praealveolina tenuis* biozone in South Iraq [31].

Regionally, [10] recorded *Nezzazata conica-Nezzazata simplex* biozone from Middle-Late Cenomanian in Sarvak Formation, Iran.

Nezzazata simplex-Nezzazata conica Interval Zone is equivalent to *Pseudolituonella reicheli - Pseudorhapdionina dubia* Concurrent Range Zone from Middle-Late Cenomanian in Turkey which recorded by [8], and equivalent to *Rotalipora reicheli* Total Range zone of Late Cenomanian from South Palmyrides, Syria which recorded by [32].

Nezzazata simplex-Nezzazata conica Interval Zone equivalent to *Rotalipora cushmani* Taxon Range Zone of Middle-Late Cenomanian which recorded by [33] in Gabal Nezzazat, southwestern Sinai, Egypt; and [34] and [35] in their general zonation; and [36] in the boreal and Tethyan region; [37]. *Nezzazata simplex-Nezzazata conica* Interval Zone is equivalent to *Pseudorhapdionina dubia - Pseudorhapdionina laurinensis* Concurrent Range Zone from Middle-Late Cenomanian in Italy which registered by [38] and equivalent to *Pseudolituonella reicheli* Assemblage Zone and *Nezzazatinella picardi* Interval Zone of Middle-Late Cenomanian from Central–Eastern Mexico which recorded by [20] and Equivalent to upper part of *Favuselle washitensis*-Oligosteginids, *Simplalveolina simplex – Orbitolina conica* and *Praealveolina cretacea- Nezzazata conica* Assemblage Zone of Late Albian-Late Cenomanian from Sarvak Formation in the Fars Zone, Zagros, Iran which diagnosed by [39].

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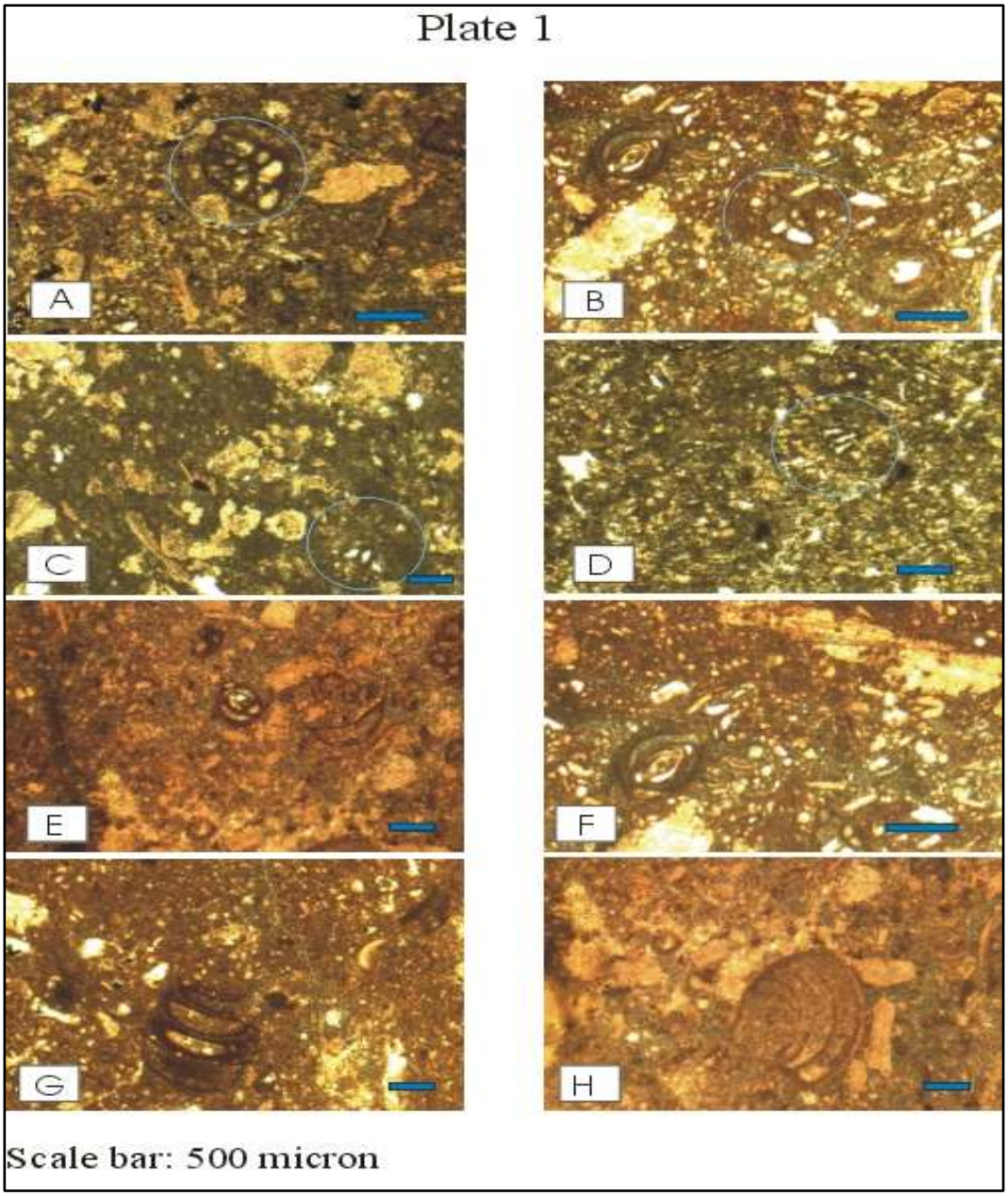

Plate 1: A- *Nezzazata simplex*, well NS-7, depth 1992.50 meter. **B-** *Nezzazata simplex*, well NS-8, depth 1998.25 meter. **C-** *Nezzazata conica*, well NS-7, depth 2034.50 meter. **D-** *Nezzazata conica*, well NS-8, depth 2032.70 meter. **E-** Miliolids, well NS-7, depth 1994.85 meter. **F-** Miliolids, well NS-8, depth 1998.25 meter. **G-** *Chrysalidina gradata*, well NS-7, depth 1992.50 meter. **H-** *Pseudolituonella reicheli*, well NS-7, depth 1994.85 meter.

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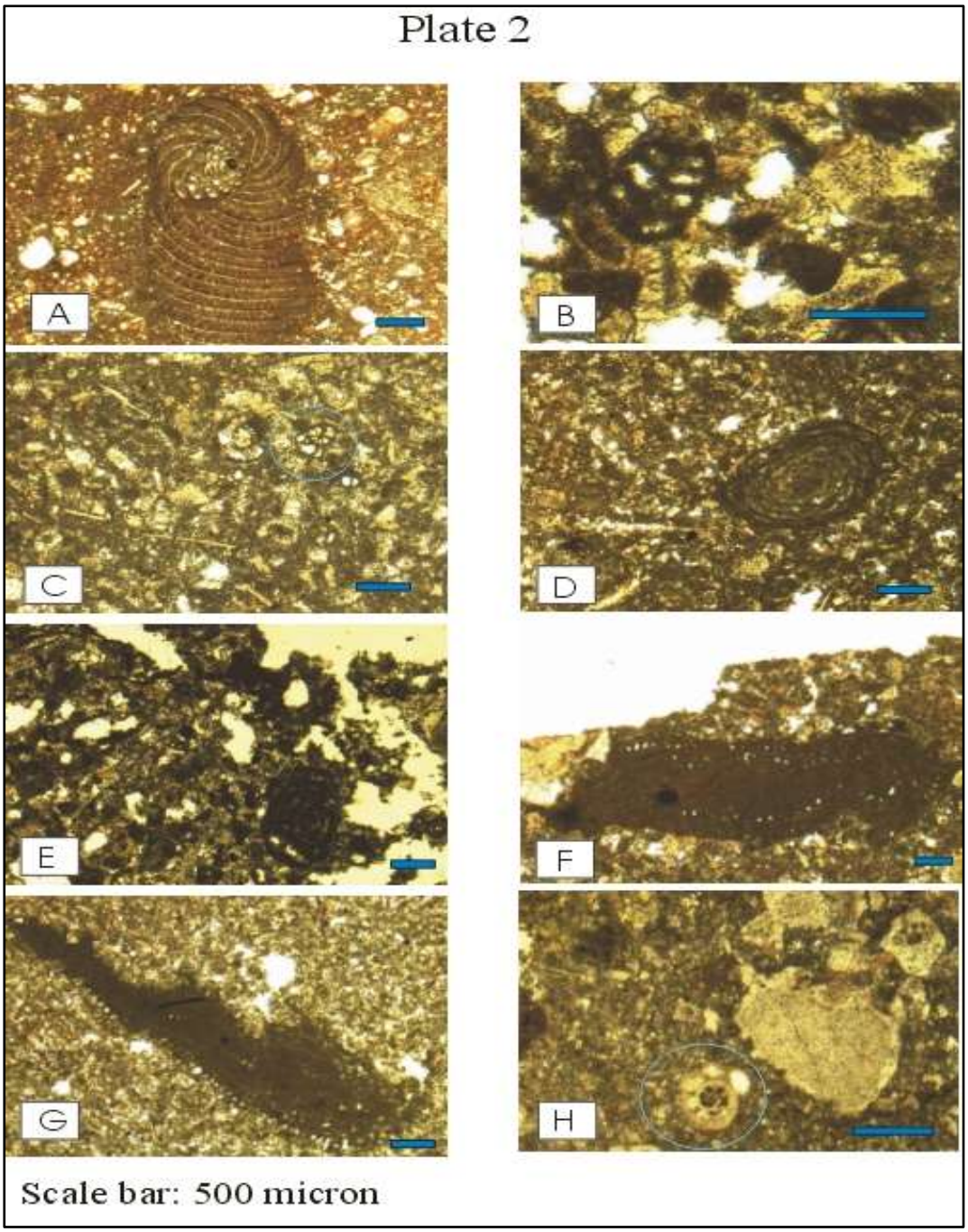

Plate 2: A- *Pseudolituonella reicheli*, well NS-8, depth 1998.25 meter. **B-** *Pseudorhapdionina dubia*, well NS-7, depth 2012.50 meter. **C-** *Pseudorhapydionina laurinensis*, well NS-7, depth 2020.50 meter. **D-** *Praealveolina tenuis*, well NS-7, depth 2025.50 meter. **E-** *Praealveolina tenuis*, well NS-8, depth 2034 meter. **F-** *Praealveolina cretacea*, well NS-7, depth 2037 meter. **G-** *Praealveolina cretacea*, well NS-8, depth 2034 meter. **H-** *Trochospira avnimelechi*, well NS-7, depth 2037 meter.

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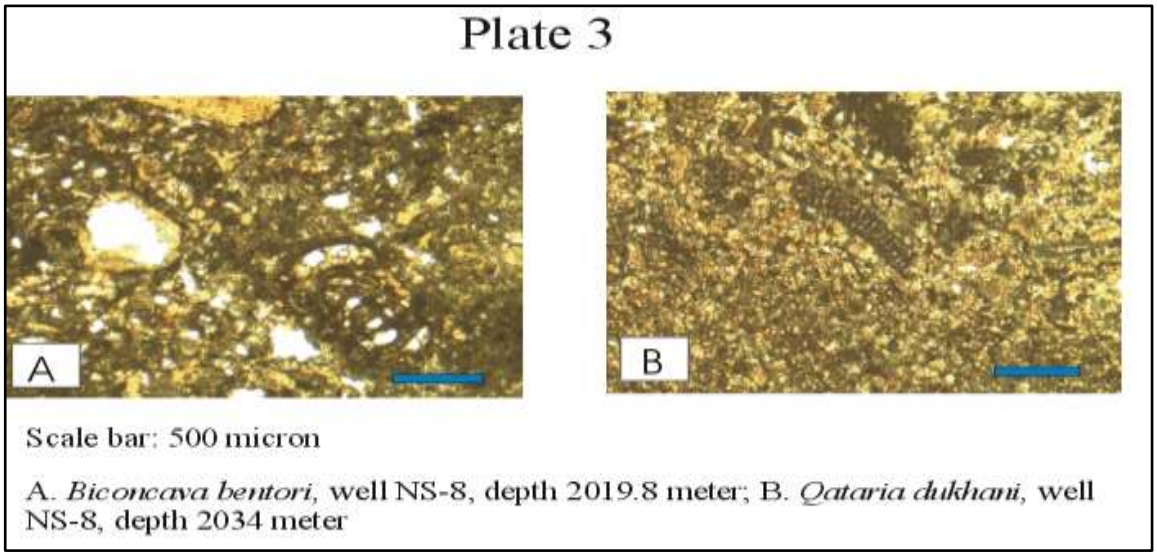

Plate 3: A- Biococava bentori well NS-8, depth 2019.8 meter, **B-** Qataria dukhani, well NS-8, depth 2034 meter

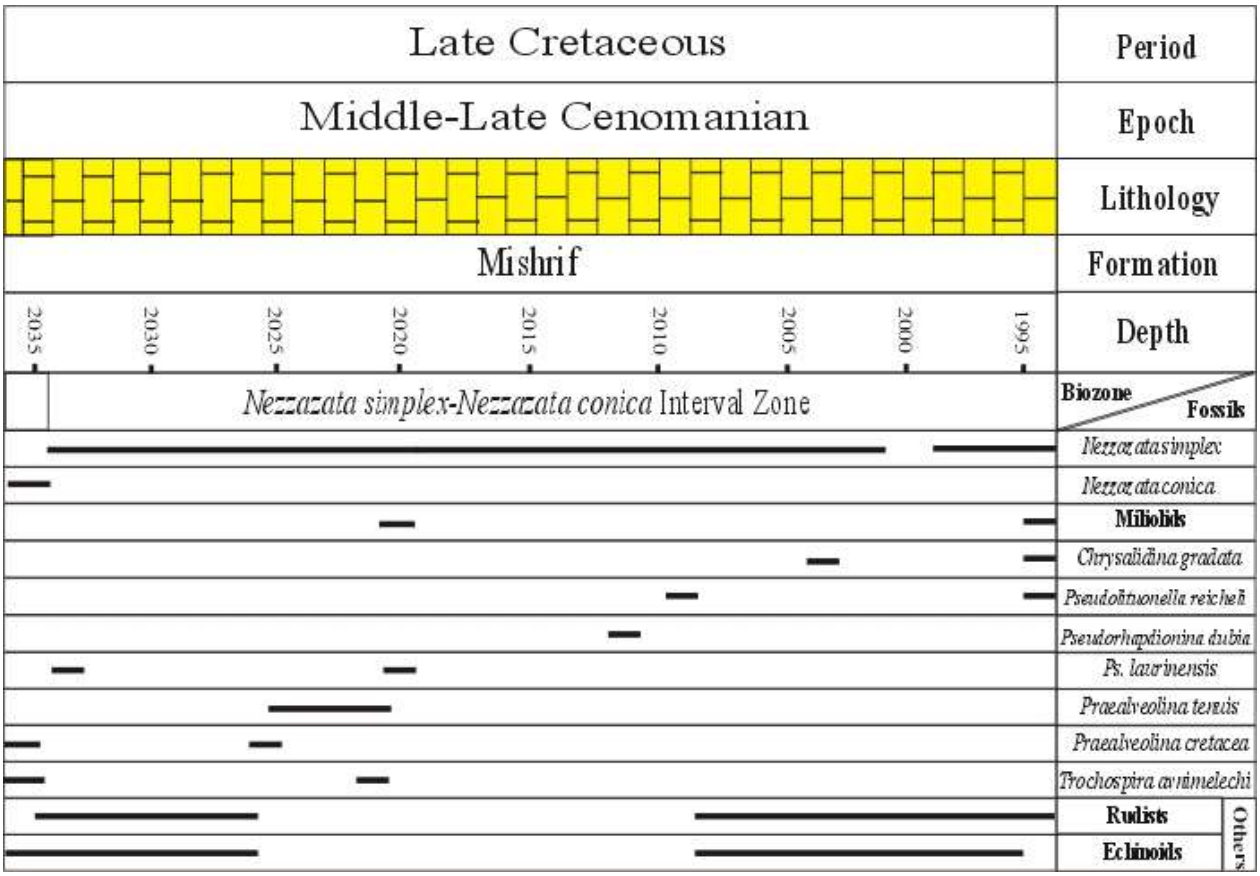

Figure 2: Biozone of Mishrif Formation in well NS-7

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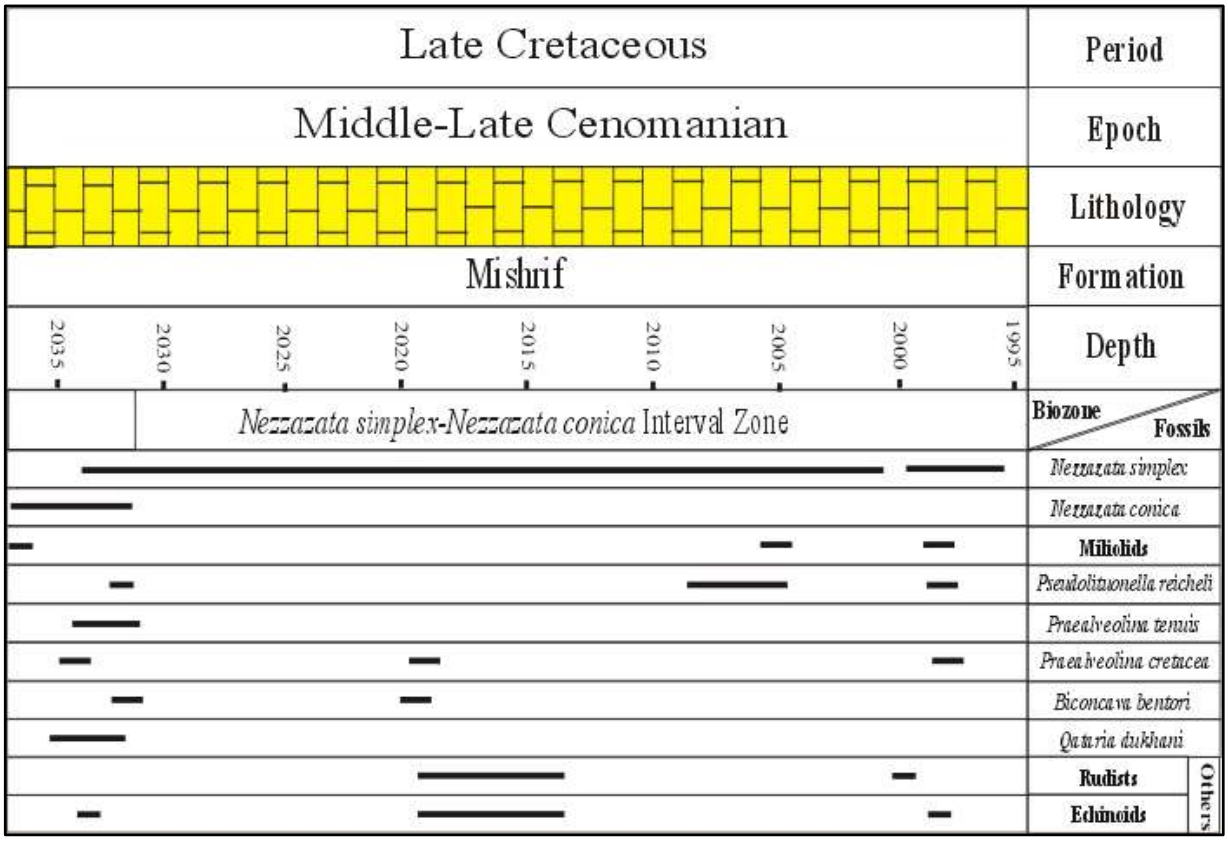

Figure 3: Biozone of Mishrif Formation in well NS-8

Conclusions

Mishrif Formation is studied in three wells belong to Nasiriya Oilfield, Southern Iraq in order to determine the biozones and stratigraphic age. One well which is NS-4 was fossils baren, therefore, two wells, NS-7 and NS-8 were included in this paper. *Nezzazata simplex-Nezzazata conica* Interval Zone is benthic foraminiferal biozone which found in the both wells and dated as Middle-Late Cenomanian, also many other fossils were associated with this biozone which indicate and support the age determination.

References

1. P. M. V. Rabanit, Rock units of Basrah area. Unpublished, Basra Petroleum Company (BPC), Iraqi National Oil Company Archives, (Baghdad, No. BGR), 8, (1952)

2. R. M. S. Owen, S. N. Nasr, The stratigraphy of the Kuwait-Basrah Area, Special Publication, American Association of Petroleum Geologists, Habitat of Oil Symposium, 1252-1278(1958)
3. R. T. Al-Dulaimy, S. S. Al-Sheikhly, Biostratigraphy of the Mishrif Formation form well Amara-1 Southeastern Iraq, Iraqi Bulletin of Geology and Mining, 9(2), 1-14 (2012)
4. A. A. M. Aqrawi, J. C. Goff, A. D. Horbury, F. N. Sadooni, The petroleum Geology of Iraq, (Scientific press, 2010), 424
5. J. Ghazwan, A preliminary study to evaluate Mishrif carbonate reservoir of Nasiriya Oil Field, International Journal of Engineering & Technology, 13(5), 69-82(2013)
6. M. Brian, Biostratigraphy, Microfossils and Geological Time, (Cambridge University press, 2005), 477
7. S. Omara, New Foraminifera from the Cenomanian of Sinai, Egypt, Journal of Paleontology, 30(4) 883-890(1956)
8. B. Sari, K. Tasli, S. Ozer, Benthonic Foraminiferal Biostratigraphy of the Upper Cretaceous (Middle Cenomanian−Coniacian) Sequences of the Bey Daglari Carbonate Platform, Western Taurides, Turkey, Turkish Journal of Earth Sciences, 18, 393‑425(2009), DOI(https://doi.org/10.3906/yer-0612-5)
9. L. Spalluto, M. Caffau, Stratigraphy of the mid-Cretaceous shallow-water limestones of the Apulia Carbonate Platform (Murge, Apulia, southern Italy), Italian Journal of Geoscience, 29 (3), 335-352(2010), DOI(https://doi.org/10.3301/IJG.2010.18)
10. M. Afghah, H. R. Fadaei, Biostratigraphy of Cenomanian succession in Zagros area (south west of Iran), Geosciences Journal, 1, 212-228 (2014), DOI(https://doi.org/10.1007/s12303-014-0045-3)
11. M. Afghah, A. Yousefzade, S. Shirdel, Biostratigraphic Revision of Middle Cretaceous Succession in South Zagros Basin (SW of Iran), Journal of Earth Science & Climatic Change, 5(8), 1-10(2014), DOI(https://doi.org/10.4172/2157-7617.1000216)
12. M. K. BouDagher-Fadel. Evolution and geological significance of larger benthic foraminifera, (Elsiever, London, 2008), 571

13. H. F. Filkorn, R.W. Scott. Microfossils, paleoenvironments and biostratigraphy of the Mal Paso Formation (Cretaceous, upper Albian), State of Guerrero, Mexico, Revista Mexicana de Ciencias Geológicas, 28, 175-191(2011)
14. O. H. Orabi, R. A. Osman, G. M. El Qot, A. M. Afify, Biostratigraphy and stepwise extinctions of the larger foraminifera during Cenomanian (Upper Cretaceous) of Gebel Um Horeiba (Mittla Pass), west-central Sinai, Egypt Revue de Paléobiologie, 31, 303-312(2012)
15. H. Ghanem, J. Kuss, Stratigraphic control of the Aptian-Early Turonian sequences of the Levant Platform, Coastal Range, Northwest Syria, GeoArabia, 18, 85-132(2013), DOI(https://doi.org/10.2113/geoarabia180485)
16. O. H. Orabi, M. M. Hamad, Biostratigraphic implications of the Cenomanian larger benthic foraminifera of Gebel Arief El Naqa, Egypt. Egyptian Journal of Geology, 62, 463-476(2018)
17. A. Husinec, I. Velic, L. Fucek, I. Vlahovic, D. Maticec, Mid Cretaceous Orbitolinid (foraminiferida) record from the islands of Cres and Losinj (Croatia) and its regional stratigraphic correlation, Cretaceous Research, 21, 155-171 (2000), DOI(https://doi.org/10.1006/cres.2000.0203)
18. S. I. M. Al-Dulaimy, Y. K. Ibrahim, F. T. Abdallah, Biozonation (benthic foraminifera) of Mishrif Formation at Majnoon and Zubair oil fields, southern Iraq, Bulletin of the Geological Society of Malaysia, 73, 79-89(2022), DOI(https://doi.org/10.7186/bgsm73202207)
19. A. A. Al-Salihi, Y. K. Ibrahim, Larger Foraminifera of Middle and Late Cenomanian (Biostrome Association), Southern Iraq, Iraqi Geological Journal, 56 (1A) 196-207 (2023), DOI(https://doi.org/10.46717/igj.56.1A.15ms-2023-1-27)
20. L. Omana, R. López-Doncel, J.R. Torres, G. Alencaster, I. López-Caballero. Mid–late Cenomanian larger benthic foraminifers from the El Abra Formation W Valles-San Luis Potosi Platform, central–eastern Mexico: Taxonomy, biostratigraphy and paleoenvironmental implications, Boletín de la Sociedad Geológica Mexicana, 71 (3), 691-725(2019), DOI(https://doi.org/10.18268/bsgm2019v71n3a5)

21. M. K. BouDagher-Fadel, X. Hu, G. D. Price, G. Sun, J. Wang, W. An, Foraminiferal biostratigraphy and palaeoenvironmental analysis of Mid-Cretaceous limestones in the Southern Tibetan Plateau, Journal of Foraminiferal Research, 47 (2), 188–207(2017), DOI(https://doi.org/10.2113/gsjfr.47.2.188)
22. B. K. Ghose. Paleoecology of the Cenozoic Foraminifera and Algae, Paleogeography, Paleoceanography, Paleoecology, 22 (3), 231-256(1977)
23. M. M. A. Al-Mutwali, Foraminifera, stratigraphy and sedimentology for U. Cretaceous – L. Tertiary succession within selected boreholes in Khelesia-Anah-Rammadi, Ph.D. Thesis, University of Mosul, 273, (in Arabic), (1992)
24. S. A. Mohsin, A. H. Mohammed, F. M. Alnajm, Facies Architecture and Depositional Marine Systems of the Yamama Formation in Selected Wells, Southern Iraq, Iraqi Journal of Science, 64 (2), 730-749 (2023), DOI(https://doi.org/10.24996/ijs.2023.64.2.21)
25. M. Chiocchini, New benthic foraminifers (Miliolacea and Soritacea) from the Cenomanian and Upper Turonian of the Monte Cairo (Southern Latium, Central Italy), Memorie Descrittive della Carta geologica d'Italia, 84, 171-202(2008)
26. N. Aguilera-Franco, U. Hernandez-Romano, P. A. Allison, Biostratigraphy and environmental changes across the Cenomanian–Turonian boundary, southern Mexico, Journal of South American Earth Sciences, 14 (2), 237-255 (2001), DOI(https://doi.org/10.1016/S0895-9811(01)00014-1)
27. N. MacLeod, Biozones, In Selley, R. C., Morrison, C. L. R., Plimer, I. R. (Eds.), Encyclopedia of geology, (Elsevier Academic, 2005), 1-5
28. B. M. Abdul-Kareem, Y. R. Yousif, Biofacies of the Mishrif Formation, Rumaila North Oil Field, Southern Iraq, part 1. University of Baghdad, Petroleum Research Center, Petroleum Engineering Department, (1990)
29. M. Y. Al-Therb, Biostratigraphy and Microfacies to Cenomanian – Early Turonian Rocks in Center of Iraq. Unpublished M.Sc. Thesis, University of Baghdad, College Science, 163(1996)

30. K. M. Sharbazhery, Biostratigraphy of the Mishrif Formation (Middle Late Cenomanian – Early Turonian), Amarah well-1, southern Iraq, Department of geology, College of Science, University of Sulaimaniyah, Kurdistan Region, Northern Iraq, 511 – 530(1999)
31. R. T. Al-Dulaimy. Biostratigraphy of the Mishrif Formation. Unpublished M.Sc. Thesis, University of Baghdad, College of Science, 60(2010)
32. H. Ghanem, M. Mouty and J. Kuss. Biostratigraphy and carbon-isotope stratigraphy of the uppermost Aptian to Upper Cenomanian strata of the South Palmyrides, Syria GeoArabia, 17 (2), 155-184(2012), DOI(https://doi.org/10.2113/geoarabia1702155)
33. A. Shahin, Oxygen and Carbon isotopes and foraminiferal biostratigraphy of the Cenomanian-Turonian succession in Gabal Nezzazat, southwestern Sinai, Egypt, Revue de Paléobiologie, 26(2), 359-379(2007)
34. H. M. Bolli, Zonation of the Cretaceous to Pliocene sediments based on planktonic foraminifera, Boletin Informativo Asociacion Venezolana de Geologia, Mineriay Petroleo, 9, 3-32(1966)
35. M. Caron, Cretaceous planktonic foraminifera, In: Bolli, H. M., J. B. Saunders, K. Perch-Nielson (Eds), Plankton stratigraphy, (Cambridge University Press, 1985), 17- 86
36. F. Robaszynski, M. Caron, Atlas des foraminiferes planctoniques du Cretace moyen (Mer Boréale et Tethys), premiere partie, Cahiers de Micropaleontologie, 1, 185(1979)
37. R. M. Leckie, Mid-Cretaceous planktonic foraminiferal biostratigraphy off central Morocco, Deep Sea Drilling Project Leg 79, Sites 545 and 547, Initial Reports of Deep-Sea Drilling Project, 79, 579-620(1984)
38. M. Chiocchini, A. Mancinelli, Sivasella monolateralis Sirel and Gunduz, 1978 (Foraminiferida) in the Maastrichtian of Latium (Italy), Revue de Micropaléontologie. 44, 267−277(2001), DOI(https://doi.org/10.1016/S0035-1598(01)90099-6)
39. B. Parnian, V. Ahmadi, H. Saroii, M. Bahrami, Biostratigraphy and palaeodepositional model of the Sarvak Formation in the Fars Zone, Zagros, Iran, Journal of Himalayan Earth Sciences, 52 (2), 197-216(2019)