



Biostratigraphy of Lower Cretaceous from Selected Borehole in central Iraq

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Received: 20 August 2023

Accepted: 18 September 2023

DOI: <https://doi.org/10.24237/ASJ.02.01.804B>

Abstract

Sarmord Formation is a significant formation that was deposited in the Lower Cretaceous in North and Central Iraq. It has been studied for biostratigraphic purposes in two subsurface sections of Tikrit oil field wells: T.K.3 and T.K.5 in Tikrit governorate. The formation is known for its importance and studied extensively by researchers. The lithology of Sarmord Formation is limestone and also contains marly limestone and marl. It has a thickness range of 109-286 m. To determine the fauna present in the formation, authors studied 170 thin sections under a microscope. They identified fourteen benthic foraminifera and algae species belonging to sixteen genera, based on the benthic foraminifera. After studying the paleontological data from the investigated area, it was determined that two distinct biozones exist within Sarmord Formation. These biozones were identified as the *Choffatella decipiens* range zone, which spans the Hauterivian to Early Aptian period, and the *Palorbitolina lenticularis* range zone, which spans the Late Barremian to Late Aptian period. This information provides insight to the age of Sarmord Formation, which is thought to deposit during the Hauterivian to Aptian period.

Keyword: Sarmord Formation, biozone, Hauterivian, Aptian, benthic foraminifera, calcareous algae.



الطباقية الحياتية للكريتاسي الاسفل من آبار مختاره في وسط العراق

لؤي سميرشاكور و انوار كاظم موسى

قسم علوم الارض, كلية العلوم, جامعة بغداد

الخلاصة

تكوين السارمورد من التكوينات المهمة والتي ترسبت شمال العراق ووسطه في العصر الطباشيري الاسفل، تم دراسة الطباقية الحياتية لتكوين السارمورد في حقل تكريت النفطي في محافظة صلاح الدين . تمت عملية النمذجة للمقاطع التحت سطحية للتكوين في اثنين من الابار النفطية (5.T.K.3,T.K) ويتراوح سمك التكوين (286,109) متر وتم تحضير 170 شريحة صخرية تمت دراستها تحت المجهر واطهرت الدراسة البتروغرافية لصخور تكوين السارمورد انه يتالف من حجر جيرى وحجر جيرى مارلي ومارل تشكل الحبيبات الهيكلية (الفورامنيفرا القاعية والطحالب الكلسية وبعض المتحجرات الاخرى) وتم تمييز (14) نوعا والتي تنتمي ل(16) جنسا من المنخربات القاعية والطحالب الكلسية، وهي تمثل الجزء الاكبر من المحتويات الكربونية وبالاعتماد على المنخربات القاعية تم تحديد نطاقين حياتيين هما من الاسفل النطاق الأول *Choffatella* *decipiens range zone* ذو العمر هو تريفيان ابئين المبكر والنطاق الثاني *Palorbitolina lenticularis range* zone ذو العمر بريميان متأخر الى الابئين المتأخر وبالاعتماد على عمر الانطقة الحياتية تم تحديد عمر تكوين السارمورد بالكريتاس الاسفل (هو تريفيان – ابئين متأخر) كلمات مفتاحية: تكوين سارمورد، نطاق حياتي، هو تريفيان ، أبئين، المنخربات القاعية، طحالب كلسية.

Introduction

Sarmord Formation is a significant formation that represents the Early Cretaceous period and reflects the deposition of the sedimentary cycle. The formation is dominated by thick, Lower Cretaceous carbonate and Siliciclastic sediment [1]. It is one of the most widely exposed Cretaceous formations Northern Iraq region, particularly in Shiranish, Saramadiyah, and Raina [2]. Sarmord Formation is a significant geological formation that extends from the Iraq-Iran border to the west of Rawanduse area, with frequent inter-fingering with Balambo and Qamchuqa Formation [3]. After the late Kimmerian orogeny, Neotethys progressively developed, and deep marine sediments of the Early Cretaceous (Berriasian - Aptian) was deposited, in which Sarmord Formation became a part of this subcycle, it is represented from shore to deep basin by Lower Sarmord, Lower Qamchuqa , Garagu, Yamama Ratawi, Zubair, and Lower Balambo formations [4]. Surdash anticline of the high Folded Zone in Sulaymaniyah



region of northeastern Iraq was the site of the first description of Sarmord Formation by Wetzel in [2]. According to its types section, the Sarmord Formation comprises brown and bluish Marls, with alteration of marly neritic limestone. The formation has a total thickness of 455-m. The formation age was given as Hautevivan - Barremian [2]. It is also characterized in the subsurface section, as seen in the wells Ainzala (12 and, 19), Kirkuk (109), Sasan (1), Najma (29), and Butmah (2), as well as the formation's appearance in the subsurface section. Sarmord Formation is distinguished from other formations in the same Sedimentary cycle by the rhythmic alternation between its marly lithofacies throughout the outcropped and subsurface regions [4]. Sarmord Formation is a Lower Cretaceous diachronous and synonymous stratigraphy that correlates chronostratigraphically with several formations in the central and western parts of Iraq [5]. Sarmord Formation is underlined by Balambo or Chia Gara formations with unconformable contact and is overlain by the Qamchuqa, Balambo, Garagu, and Yamama formations. The upper boundaries are a gradational and conformable exception to the small area of the Foothill Zone [4]. Zubair Formation and the upper portion of Ratawi Formation are the lateral equivalents of Sarmord Formation in the southern part of Iraq, where the basal bed of Zubair Formation in the Awasil area passes laterally towards Basrah districts [2]. In the lower part of Sarmord Formation, the typical section recorded the following abundance of fossils: *Heteraster coulou*, *H. oblongus*, *Postamides phillips*, *Choffatella decipiens*, *phaldomya cf- esemark*, *Orbitolina discoidea*, *Cyclammina cf grgriegi*, *Pseudocyclamming sp. P. cf. kelleri*, *Cuneolina Pavonia*, *Permocalculus inopinatus*, *Salpingo porell cf. muehlberg* and stated at the age of Sarmord Formation is Valanginian -Aptian [2]. The following fossils were investigated by [6] using data from the middle part of Sarmord Formation in Khabas-1: *Orbitolina kardica*, *Orbitolina cf. discoidea*, *Choffatella decipiens*, *Trocholina elongata*, *Cuneoling afaffonia*, *Pseudocyclammina lituus*, *Nautiloculina sp.*, and *Hensonella cylindrical*, and Miliolid. It was determined that the age was Hauterivian - Early Barremian. [7] studied the palynology of Sarmord Formation in Ajeel oil field and suggested the age of the formation is Berriasian-Albian. In their study of Sarmord Formation's biostratigraphy and facies analysis in northern Iraq, [8] identified two biozones: the Everticyclammina kelleri assemblage zone and the Pseudocyclamming lituus Assemblage



zone, which provide the formation's age range of Late Valanginian - Late Hauterivian and depositional environment range from tidal to shallow open marine. The Lower Cretaceous Sarmord Formation in North Iraq was studied by [9], and it was found that the formation was deposited at a rimmed carbonate platform with gradual shallowing of the basin from basinal sediments at the lower part overlain by deep shelf in the uppermost part. This study aims to define biostratigraphy of the Sarmord Formation to determine the benthic foraminifera zonation and age of this formation in the studied section based on the microfossils assemblages.

Geological Setting

According to [4], Sarmord Formation, which represents the Early Cretaceous part of the Late Berriasian-Aptian subcycle, is split into three zones, with various Sedimentary stages representing various portions of the stable shelf. The Second Zone, as it was named by [2], where Sarmord Formation is located. According to [5], the lower Sarmord Formation is a part of the Thamama Group, while the upper Sarmord Formation is a part of the Was'a Group.

Tikrit oil field is situated in two geological regions, the Mesopotamian zone (Tigris subzone) and the Foothill zone (Himreen-Makhul subzone), both of which are regarded to be a component of the foreland basin of the Zagros fold and thrust belt [10]. According to [11], the Mesopotamian zone, which is the easternmost unit of the stable shelf, was likely raised during the Hercynian deformation. Tigris subzone is the largest and most mobile section in the Mesopotamian zone. It has a long normal fault and broad syncline and small anticline that trend northwest to southeast [12]. The age of Sarmord Formation is equivalent to various stratigraphic units in the neighboring nations. These include Yamama and Buwaib formations in Saudi Arabia, Salila and Habshan formations in the United Arab Emirates, and Ratawi and Zubair formations that are correlated to the Sarmord Formation in Kuwait [1], Govanda Formation in Iran and Cudi Group in Turkey are equivalent units too [3]. In the north and south parts of Iraq, [13] studied various surface- and subsurface-level rock units of the Tithonian - Albian age, dividing the formation into the Lower, Middle, and Upper parts. Sarmord Formation was split into three parts by [14]: the Lower Sarmord Formation (Tithonian-Berriasian era), the Middle Sarmord Formation (Valanginian-Aptian age), and the Upper Sarmord Formation (Albian age).



Sarmord Formation was separated into two subcycles by [10] the upper Sarmord refers to the Albian subcycle and the lower Sarmord refers to the Berriasian-Aptian subcycle). In their study of Sarmord Formation's facies analysis in its type locality, [15] noted an alternation between argillaceous limestone and marl as dominant facies, with homogeneous facies predominating in other surface areas. The Milankovitch cyclicity, according to [16], was an important role in the development of the rhythmic alternation style in the Sarmord successions. Additionally, he concluded that the open sea shelf constituted the depositional environment. [17] Investigated the micropaleontology and depositional environment of an outcropping of the Lower Sarmord Formation, which is equal to Zubair Formation and dates to the Valanginian-Early Aptian. [18] mainly focused on this study formation when they examined the petrography of Sarmord Formation in northwest Iraq which is composed of bituminous dolostone, and the formation's deposition is deep marine in origin Normal salinity is present along the shelf margin. [19] examined the Lower Sarmord biostratigraphy in well kirkuk-109 and identified the biostratigraphic zones. In the study of [20] found that the petrophysical characteristics of Sarmord Formation in northern Iraq are made up of limestone and dolomitic limestone and have a long history of good porosity. [21] Examined the stratigraphy and nannofossil biozonation of Sarmord Formation in northern Iraq and conclude that it dates from the Late Valanginian - Barremian. Petrography and Mineralogy of Sarmord Formation (Valanginian-Aptian) were examined by [22] in three areas of northeastern Iraq consisting primarily of alternated yellowish to bluish gray bedded marly limestone with yellowish to gray soft marl beds and gives the main diagenetic processes affecting the studied formation. These belong to three stages early (Shallow burial, middle, and late deep burial, and give the environment the formation in shallowing basin from basinal to deep shelf.

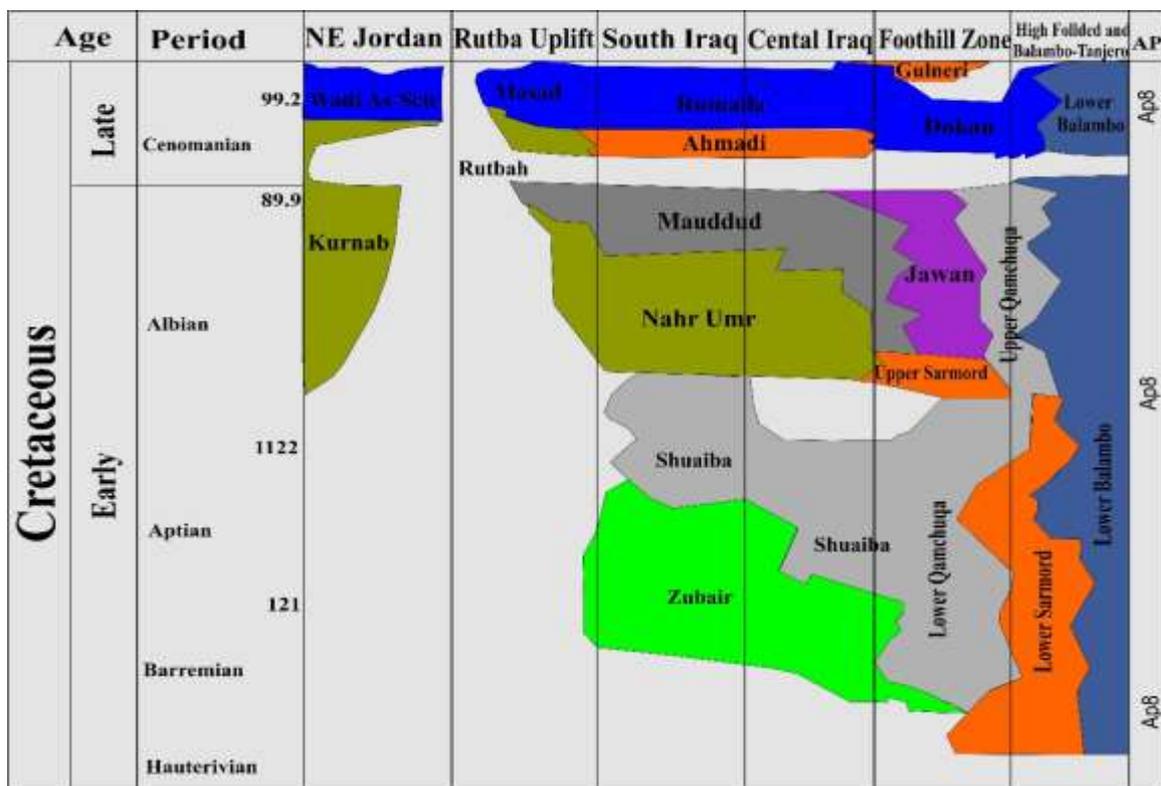


Figure 1: Lithostratigraphy correlation of the Early Cretaceous succession in Iraq, after [5] with some modifications.

Material and Methods

The research region is found in Tikrit oil field, which was drilled by the Iraq National Oil Company (INOC), and is situated in the Mesopotamian Zone in northern Iraq (Fig. 2). The average elevation of the field area along Tigris River in Salah Aldeen Governorate is 150–160 m above sea level. In Table 1, the Thickness of the chosen formation in the study region and geographic coordinates are shown for two boreholes in this study's subsurface section of Sarmord Formation. 190 samples were collected from the study area, with sampling intervals of typically 2- 4 m. 170 samples (110 core and 80 cutting) of hard carbonate rock were studied by making thin sections from each sample, and fossils such as benthic foraminifera, calcareous algae, and other fossils were identified, as well as the creation of a biozone based on the Standard Taxonomic.

Table 1: Coordinates of two selected sections of the research region and thickness with the top and bottom of the formation

Well no.	Longitude	Latitude	Thickness of Fm.	Top of Fm.	Bottom of Fm.
TK3	365°147'4" E	3827° 541'5"N	286m	2493m	2779m
TK5	300°327'2" E	38529° 716'5"N	109m	2762m	2835m

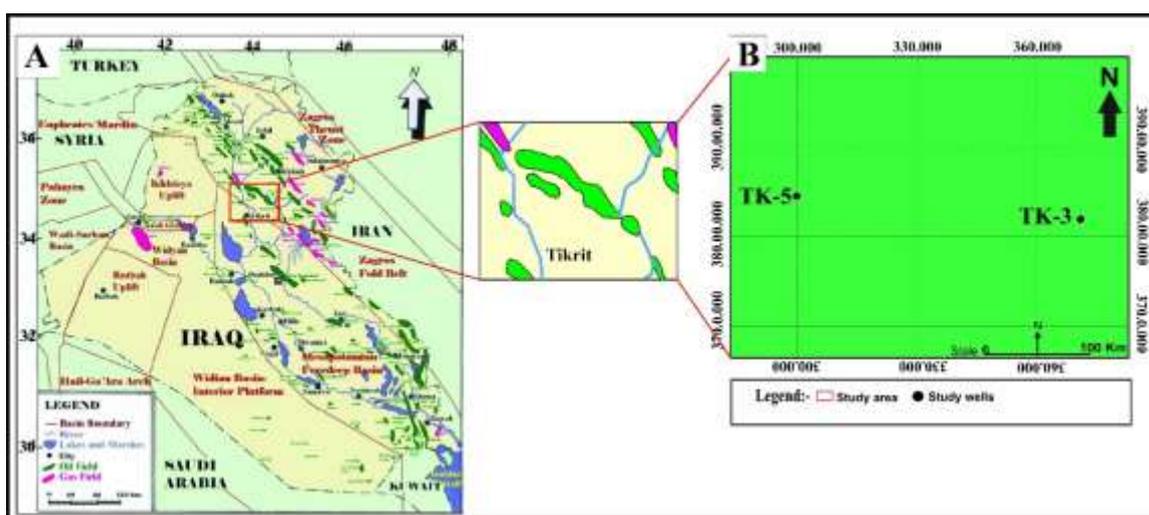


Figure 2: Map of Iraq showing Oil and Gas fields; B. Location map of studied wells

Biostratigraphy and Biozone

Descriptive biostratigraphy is employed in determination zone for regional or local stratigraphic correlation. Biostratigraphy uses fossils to provide geological time and the balances of biology with geology. Sarmord Formation, whose thickness ranged from (109-286) m and is composed of limestone, marl and marly limestone with dolomitic limestone in some intervals. It's biostratigraphy according to the distribution of benthic foraminifera, calcareous algae, and other fossils, the formation of two subsurface wells has been studied. Two biozones were determined as a result, and they produced a foraminifera and algal fauna consisting of 14 species belonging to 16 taxons. The sediments of this formation contain the following microfauna.

Foraminifera

Pseudocyclammina lituus Yokyama (Pl.2, Figs. A. B), *Pseudocyclammina* sp., *Everticyclammina* sp., *Praechrysalidina* sp., *Choffatella decipiens* Schlumberger (Pl.1, Fig G,



H), *Choffatella* sp., Miliolids (Pl.2, Fig. H), *Orbitolinopsis capuensis* Decastro, *Cuneolina* sp., *Cuneolina camposauri* Sartori (Pl.2.Fig.C), *Trocholina* sp., *Trocholina elongata* Leupold, *Trocholina alpina* Leupold (Pl.2.Fig.D), *Orbitolina* sp., (Pl.1.Fig.F), *Orbitolina discoidea* Blumenbach (Pl.1. Fig. C, E), *Palorbitolina lenticularis* Blumenbach (Pl.1, A, B, and D) *Nodosaria* sp., *Ammobaculites* sp., *Pseudochrysidina* sp. (Pl.2, Fig E), *Valvulinidae* sp., *Nautiloculina oolithical* Mohle (Pl.2, Fig G), *Textularia* sp. (Pl.2, Fig. F), *Globigerina* sp., *Bolivina* sp, *Nautiloculina* sp., *Actinoporella* sp. (Pl.2.Fig.Q), *Actinoporella podolica* Alth (Pl.2, Fig. L), *Bacinella irregularis* Radoicic (Pl.2.Fig.O) *Bacinella* sp., *Salpingoporella* sp., *Salpingoporella dinarica* Radoicic (Pl.2, Fig I, J, K), *Acicalaria* sp. (Pl.2.Fig.N), *Permocalculus* sp., *Permocalculus ampullaceous* Elliot (Pl.2, Fig. P), *Cylinidroporella* sp., *Permocalculus irenia* Elliot (Pl.2.Fig.M), Alage Inde. In addition to other fossils such as echinoid fragment, gastropoda shell (Pl.2.Fig. R), pelecypoda shell (Pl.2.Fig. 9), Ostracoda, sponge spicules, and Fossils Inde. Biostratigraphy zone of this current study depends on benthic foraminifera, the definitions of these biozones determined according to stratigraphic distribution of these foraminifera. The taxonomy followed here was adopted by [23]; [24]; [25]; [26; [27]; [28; [29]; [30]; [19]; [31]; [8]; [32];[33] [34];[35]. Two biozones are distinguished (figs 3,4).

1- *Choffatella decipiens* Rang Zone

Definition: From first appearance of *Choffatella decipiens* to first appearance of *Palorbitolina lenticularis*.

Age: Hauterivian-Early Aptian.

Occurrence: This zone is located in Sarmord Formation's bottom portion and measures approximately 158 m thickness in TK-3 and 53 m thickness in TK-5 (Figs. 3,4)

Remark and correlation: Index fossils identify in this zone as *Choffatella decipiens*. The taxonomic genus related to this taxon includes: *Pseudocyclamina lituus*, *Pseudocyclamina* sp., *Everticyclammina* sp., *Choffatella* sp., *Trocholina elongata*, *Cuneolina* sp., *Cuneolina Camposauri*, *Orbitolina* sp. *Textularia* sp., *Orbitolina discoidea*, *Pseudochrysidina* sp., Miliolids sp., *Trocholina alpinal*, *Actinoporella podolica*, *Actinoporella* sp, *Permocalculus* sp. *Bacinella irregularis*, *Salpingoporella* sp. gastropoda, pelecypoda, ostracoda, spong spicules.



According to several researchers, some of these occurrences have been reported by [36] described this species from Hauterivian-Aptian in Iran, [27] recoded this species in the Valanginian-Aptian in Iran, [23] described Barremian -Early Aptian in South Iraq, [37] describe it form early Aptian in Lebanon, [36] described from the Hauterivian - Aptian in Itali, [38] described from the Aptian in northwestern Iraq, [39] described Barremian- Aptian in north Iraq, , [40] recorded from Barremian – Aptian in Honduras, [41] studied Hauterivian - Aptian in Iran, [26] studied this species from Late Barremian- - Early Aptian in Yemen, [43] descibed Late Barremian-early Aptian in Saudi Arabia, [17] [44] identified this species Lower Aptian in North Iraq, [19] described Haterivian-Barremian in North Iraq. The age of this *Choffatell decipence* zone was determined to be that Hauterivan- early Aptian in this study.

2- *Palorbitolina lenticularis* Rang Zone

Definion: This is identified depending on the first appearance of *Palorbitolina lenticularis*, the upper limit of the zone was determined by the disappearance of this species.

Age: Late Barrerian -Late Aptian.

Occurrence: This zone is situated the upper portion of Sarmord Formation and ranges in thickness from 53 m in TK- 3 and 56 m TK-5 (Fig. 3,4).

Remark and correlation: Index fossils identify this zone is a *Palorbitolina lenticularis*. the taxonomic genus related to this taxon includes:- *Everticyclammina* sp., *Trocholina elongata*, *Cuneolina* sp., *Orbitolina* sp., *Textularia* sp., *Orbitolina discoidea*, *Praechrysalidina* sp., *Orbitolinopsis capuensis*, *Valvalinidae* sp., *Ammobaculites* sp., *Nautiloculina oolithical*, *Pseudochrysidina* sp., *Nodosaria* sp., *Globigerina* sp., *Salpingoporella* sp., *Salpingoporella dinarica*, *Cylindroporella* sp., *Acicularia* sp., gastropoda shell, pelecypoda shell, calcispheres, sponge spicule. According to several researchers, some of these occurrences have reported: [45] in Algerial, [46] in Balkan, [47] in South France, [48][49][50] in south south Iraq, [27] South Afraca, [17] [51] in Iraq and [31] in Iraq all studied identified the age of the zone for (Late Barremian – Aptian) and [52] in Italy, [53] in Yemen, [54] in Iraq, [55] in Iraq, [56] in Italy, [43] in Saudi Arabia and [57] in Japan, all studied identified the age of the zone for (Early Aptian - Late Aptian). The age of this *palorbitolina lenticularis* zone was determined to be

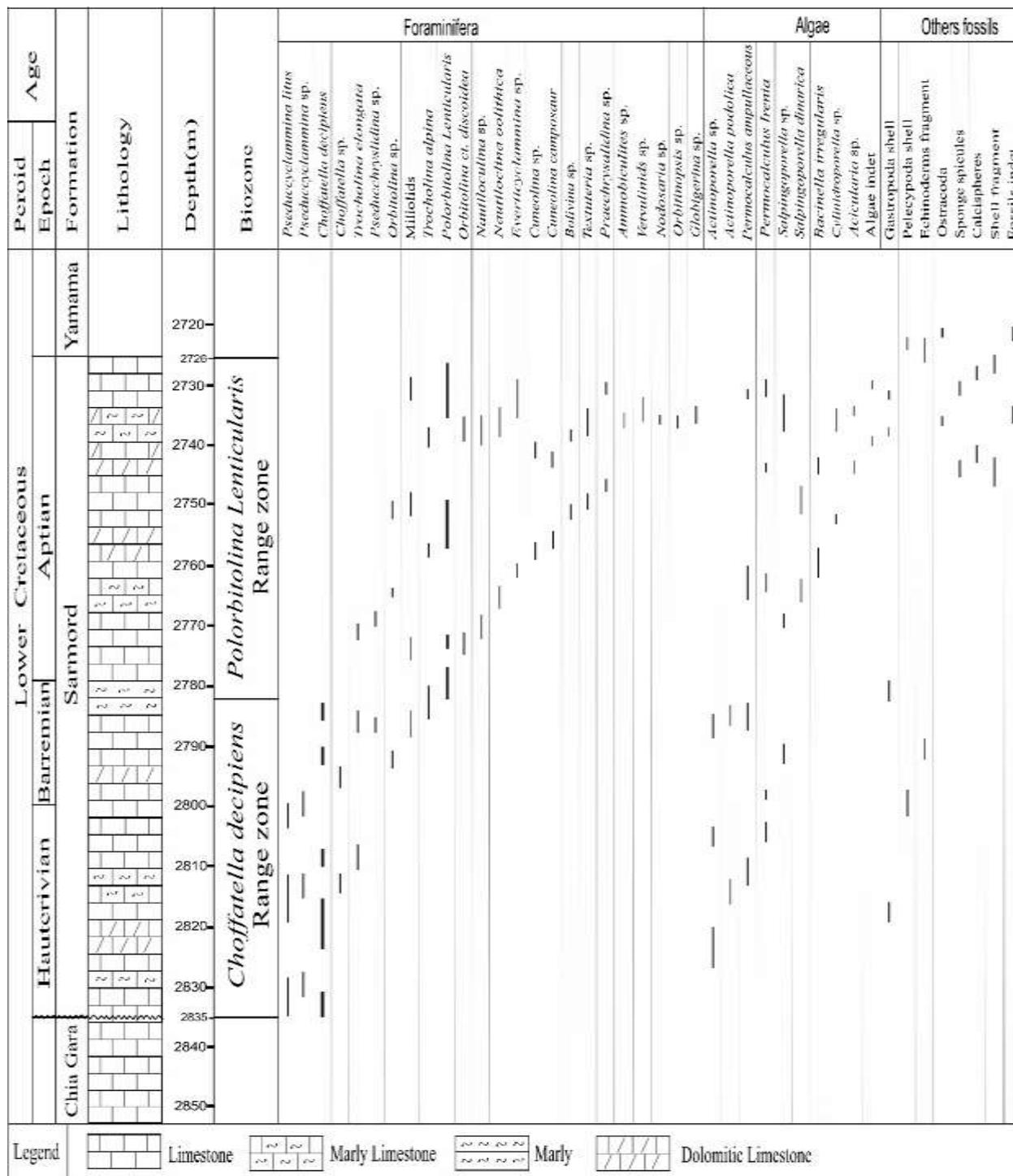


Figure 4: Biozone and Biostratigraphic distribution of benthic Foraminifera and algae within Sarmord Formation in TK-5.

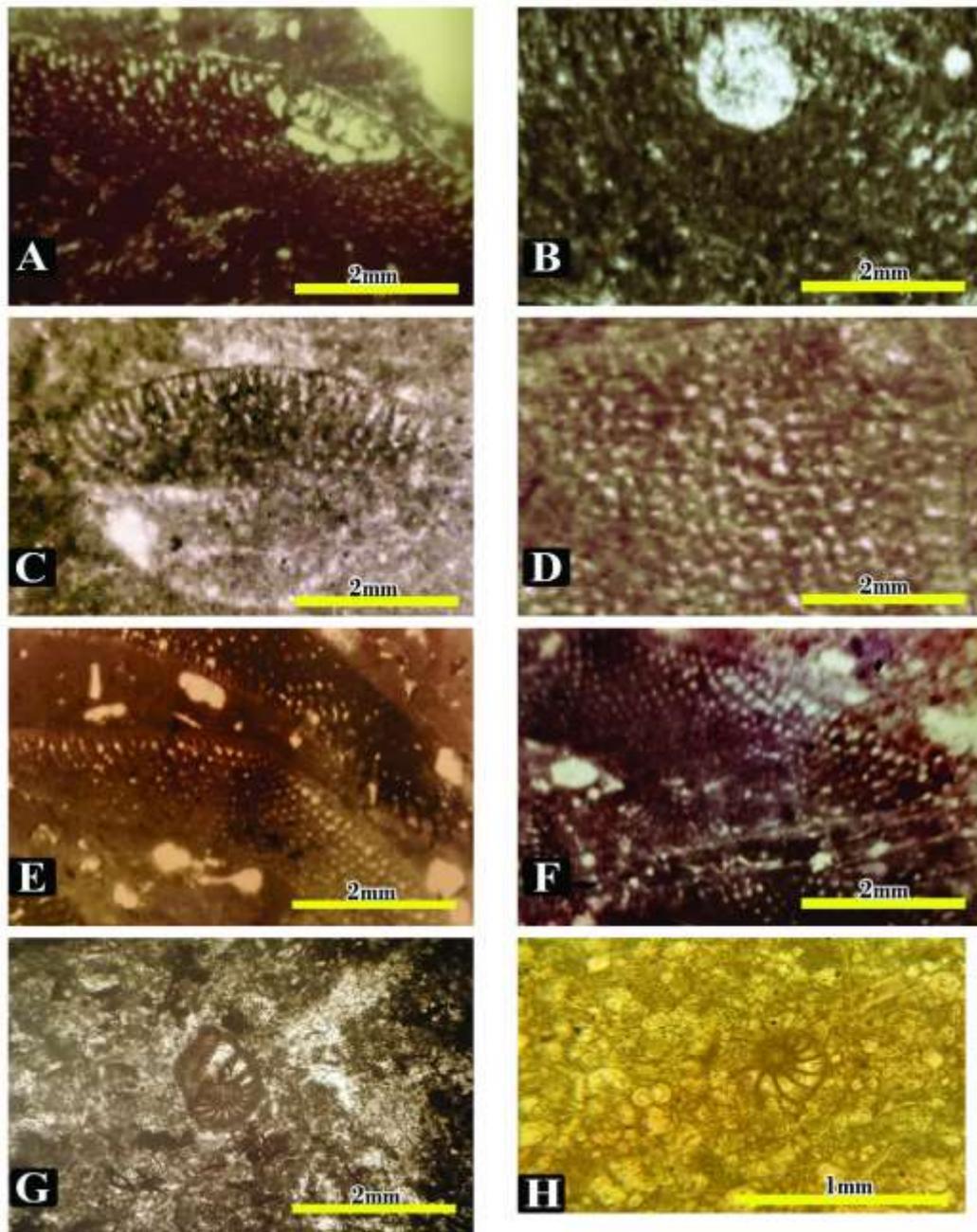


Plate 1: All figure from Sarmord Formation (Hatevian-Late Aptian A - *Palorbitolina lenticularis*, depth 2585 m well Tk- 3; B. *Palorbitolina lenticularis* , depth 2780 m well T. K 5; C. *Orbitolina discoid*, depth 2740m, well-T.K.5; D. *Palorbitolina lenticularis*, depth 2615 m well. T. K3; E. *Orbitolina discoidea*. depth 2600 m well T.K.3; F. *Orbitolina* sp, depth 2520m well.TK.3; G. *Choffatella decipiens*. depth 2792 m, well. T.K. 5; H. *Choffatella decipiens*, depth 2640m, well. TK.3.

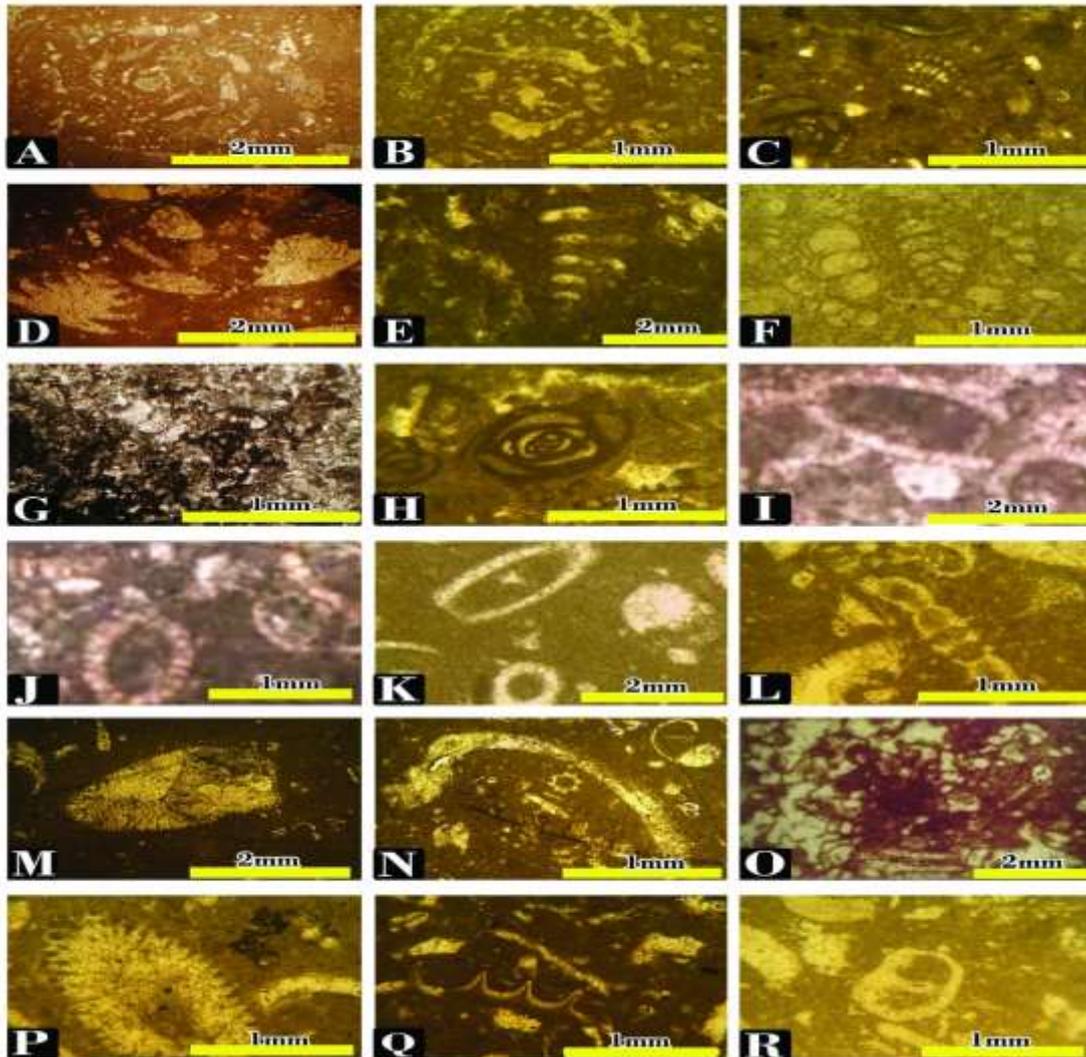


Plate 2 : All Figure Sarmord Formation (Hauterivian – Late Aptian) A. *Pseudocyclammina lituus*, depth 2720 m, well TK3; B: *Pseudocyclammina lituus*, depth 2815 m, well-Tk. 5; C: *Cuneolina camposauri*, depth 2560 , well. TK.3; D: *Trocholina arabica*, depth 2590 m, well. TK.3; E: *Pseudochryslidina* sp. depth 2770 m, well- TK.5; F:*Textularia* sp., depth 2520m, well TK.3; G.*Nautiloculina oolithica*, depth: 2738m, well. TK.5;H. Miliolids sp. , depth 2550m, well, TK. 3; I :*Salpingoporella dinarica*, depth. 2510 m, well. TK. 3 ;J.*Salpingoporella dinarica*, depth 2540m, well TK.3; K: *Salpingoporella dinarica*, depth 2750m, well TK. 5; L.*Actinoporela podolica*, depth. 2645m, well. TK. 3; M.*Permocalculus irenia*, depth 2562m, well TK. 3; N.Pelecypoda Shell, depth 2740m, well. TK. 5; O.*Bacinella irregularis*, depth 2564m well. TK. 3; P: *Permocalculus ampullaceous*, depth. 2762 m. well. TK. 5; Q. *Actinoporella* sp. ,depth. 2824m, well. TK. 5; R. Gastropoda shell, depth .2530m, well.TK.3.



Conclusion

The current study deals with Biostratigraphy of the Lower Cretaceous Sarmord Formation at selected wells in Tikrit oil field at Salah Aldeen Government is composed limestone marly limestone and marl, the formation's thickness ranged 109-286 m. The lower contact of formation is unconformable with Chia Gara Formation and upper contact of formation is conformable with Yamama Formation. There are fourteen species and sixteen genera identified based on the distribution of foraminifera and algae from Sarmord Formation, all of which have been previously described within Sarmord Formation. Two biozones were identified within Sarmord Formation that it is represented by large benthic foraminiferal assemblage biozone *Choffatella decipiens* rang zone (Hauterivian-Early Aptian) and *Palorbitolina lenticularis* rang zone (Late Barremian to Late Aptian). The age of Sarmord Formation is determinate to be (Hauterivian - Late Aptian) according to these biozone of foraminifera at studied wells.

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