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The Sedimentology and Facies Analysis of the Cretaceous Oceanic Red Beds (CORBs) in the Shiranish Formation, Northern of Iraq

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Abstract

Upper Cretaceous Oceanic Red Beds **(CORBs)** are pelagic sediment deposits that deposited in the Upper Cretaceous basin, with widespread in part of the world as well as in Iraq. This research investigates the deposition of cyclic marl and marly limestone **CORBs** of six selected sections at the active southern margin of the Tethys during the Late Campanian - Maastrichtian with petrography, microfacies, and depositional environment.

As this study was not a consideration in the past, so decided to visit and identify all exposure areas of the Upper Cretaceous period rocks are visited. This study involved two fields touring reconnaissance extended from Darbandikhan city in the east south to Shiranish Village in the west north. Six lithological sections covering the studied area, four sections represent Cretaceous Oceanic Red Beds **(CORBs)** and two sections without **(CORBs)** for the purpose of comparison between them. The sections are described in detail and 250 samples were collected from all studied sections.

For the petrography and microfacies analysis 149 thin sections were studied. The microfacies analysis showing two major successions with Red Bed and Non-Red Bed marl and marly limestone, occasionally interbedded with thinly beds of shale, sandstone and siltstone. These comprised of five microfacies are Oligostegina Marly Limestone, Globotruncana Marly Limestone, Marlstone with Microfossils, Red Marlstone, and Red to Variegated Calcareous Sandstone with Radiolarian (Debrise Flow) Making 20 thin sections from Gendilly section(GS) (the typical section of this study) for microscopic study of minute fossils (nannofossils) examination, for this study proved that the Cretaceous Oceanic Red Beds **(CORBs)** dating is Mastrichtian age. The Microfossils and nannofossils tests proved the presence of Danian Age in studied area.

This study has proved that the carbonate content in red limestone beds ranged between 53.5-100.0 %, while this percentage ranged in red marly rocks between 20.5-50.0 %, But in the rocks that do not contain red beds, Carbonate content in limestone rocks ranged between 52.0-100.0 %, and in marl rocks this ratio ranged between 27.5-49.5 %**.**

Keywords: Sedimentology, Facies Analysis, Cretaceous Oceanic Red Beds and Shiranish Formation.

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رسوبية و تحليل سحنات الطبقات المحيطية الحمراء للطباشيري في تكوين الشيرانش، شمال العراق

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الخلاصة

تعد الطبقات المحيطية الحمراء للعصر الطباشيري الأعلى (CORBs) ذات انتشار عالمي واسع النطاق في شمال بحر التيثيس، ومحدودية انتشاره في شمال العراق رواسب عميقة ترسبت في حوض الطباشيري ألأعلى. تركز هذا البحث في دراسة هذا النوع من الرسوبيات (CORBs) وتتابعاته الدورية في طبقات المارل والحجر الجيري المارلي ضمن تكوين الشيرانش (الكامباني المتأخر− الماسترختيتي المبكر) من ناحية الخصائص الرسوبية والمكونات المعدنية والدراسة الجيوكيميائية والظروف البيئية الترسيبية. وشملت هذه الدراسة تحديد ودراسة ستة مقاطع جيولوجية، اربعة مقاطع تحتوي على الطبقات الحمراء ومقطعان آخران يخلوان منها، لغرض المقارنة فيما بينهما والتي تغطي منطقة الدراسة. 250 عينة صخرية جمعت من جميع المقاطع الجيولوجية موضوعة البحث، بواقع 140، 41، 28، 17، 14، 10 للمقاطع GS, Ch, Sm, D, Dr, Q على التوالي. أجريت معظم الفحوصات المعدنية والكيميائية على 352 عينة (180 عينة من الصخور المطحونة 172 عينة من القطع الصخرية) في مختبرات جامعة فيينا − مركز علوم الأرض − قسم الجيوداināميك بموجب البعثة البحثية الممنوحة لي.

لدراسة صخارية هذه الرسوبيات والتحليل السحني لها، تم عمل 149 شريحة صخرية (125 شريحة انجزت في مختبرات الهيأة العامة للمسح الجيولوجي والتعدين و24 شريحة في مختبرات جامعة فيينا)، بواقع 64، 30، 19، 10، 20، 6 للمقاطع الجيولوجية GS, Ch, Sm, D, Dr, Q على التوالي. كما تم عمل 20 شريحة صخرية من المقطع الجيولوجي النموذجي GS لدراسة الأحافير الدقيقة والمجهرية، ولقد اثبتت دراسة الاحافير الدقيقة والمجهرية لهذه الترسبات (CORBs) عن وجود عينات تعود الى عصر الدانيان والذي كان يعد مفقوداَ في منطقة الدراسة.

وقد اثبتت هذه الدراسة ان صخور الحجر الجيري المارلي وصخور المارل مختلفة في محتواها من الكاربونيت، كما يختلف محتواها في الصخور الحاوية على الطبقات الحمراء عن محتواها في الصخور الخالية من الطبقات الحمراء. أذ تراوحت بين 53,5 − 100 % في صخور الحجر الجيري المارلي، وبين 20,5 − 50,0 % في صخور المارل. من جانب آخر تراوحت هذه النسبة بين 52 − 100 % في الصخور الحاوية على الطبقات الحمراء، وبين 27,5 − 49,5 % في الصخور الخالية من الطبقات الحمراء.

Introduction

Upper Cretaceous Oceanic Red Beds **(CORBs)** are pelagic sediments deposited in the Upper Cretaceous basin. They are widespread in the northern Tethys and have deployment in Iraq too. In this paper the Upper Cretaceous Oceanic Red Beds will be examined and studied. In Iraq, the **(CORBs)** are represented by part of the Shiranish Formation. They were deposited during the Late Cretaceous Period, and they are found in limited outcrops.

The first reddish or pinkish CORBs were began deposited about 670 Myr following the OAE2 [1]. The onset of red oxic sedimentation, both in deep ocean basins (North Atlantic) and in the basinal and slope environments above the CCD (of the Tethys), probably was linked to this global environment change [2]. The geochemical results and stable element isotopes evidence suggested a gradual condition changes from anoxic (latest Cenomanian) to oxic (Early to Middle Turonian) OAE2 environments [3]. In Santonian-Campanian especially characterized by low productivity and highly oxygenated bottom waters basis on the low organic-matter contents, cerium contents, and benthic foraminiferal assemblages [4, 5]. During the Turonian period the tendency to oligotrophic conditions was dominated, this can be inferred from decreasing carbon isotope values. Subsequent small-sized positive peaks of the carbon isotope curve [6- 8], and may be of a special case of anoxic equatorial Atlantic Ocean during worldwide oxic oceans condition [9].

The studied area is situated in the northeastern part of Iraq. It is bounded by longitudes (45° 03´- 45° 45´E) and latitudes (34° 55´ -35° 37´ N), and it is extending from Zakho area in the northwestern towards the southeastern near the Darbandikhan Lake. It falls within three governorates; Sulaimaniya, Erbil and Duhok. The study area is located on Sulaimaniya-Erbil road, 70 km West of Sulaimaniya city (Figure- 1).

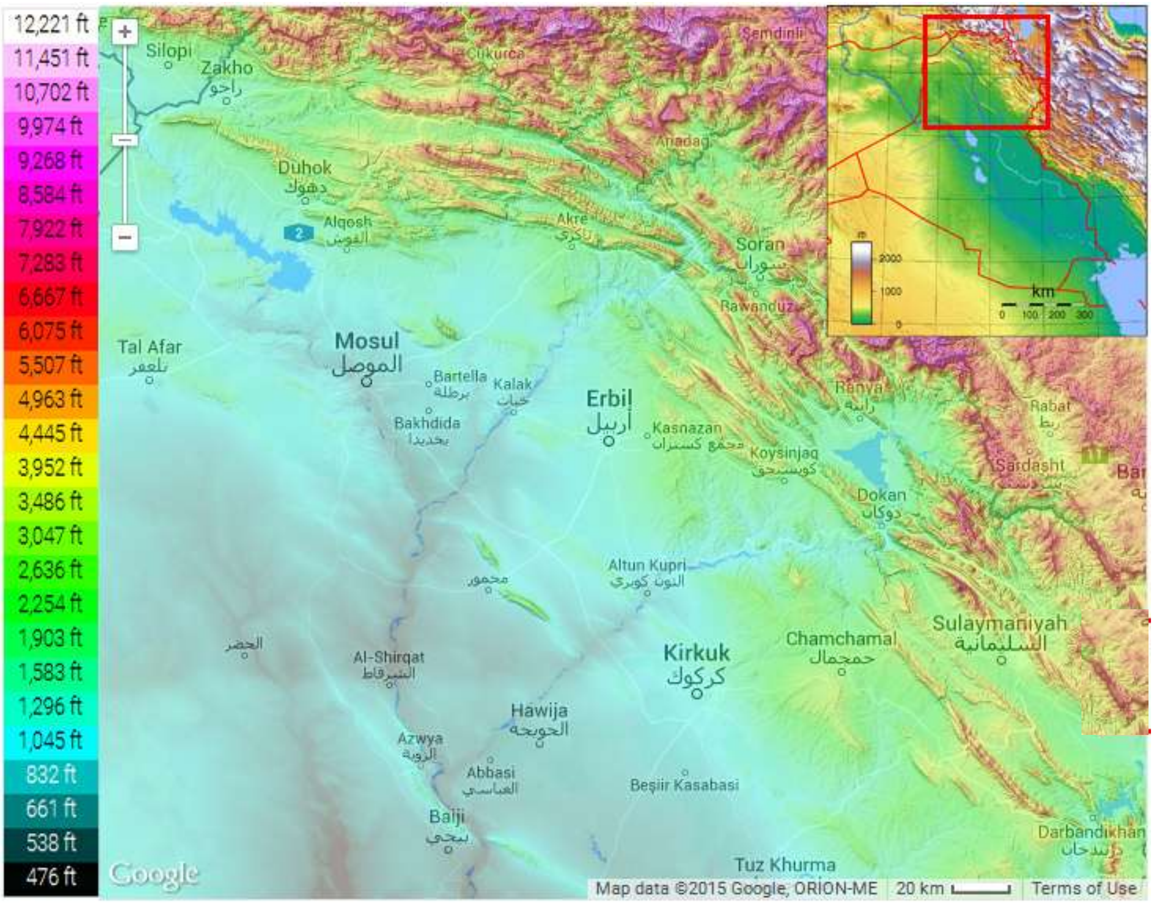


Figure 1- Geographical location map of the studied area.

Geological Framework

The exposed geological formations in the study area, they are mostly ranging in age from the Late Campanian age (Bekhme Formation) to the Middle Eocene age (Pila Spi Formation). It is exposed at the Unstable Shelf and is characterized by High Folded Zone and Zagros Structure Zone [10]. They constituted by long and narrow anticlines; some of them exhibit different types of faulting. The lithologies of these formations include limestones, dolostones, shale, marl, claystone, siltstone and sandstone. The Zagros Suture Zone consist of different igneous and metamorphic rocks; limestone, shale and mudstone. The Quaternary deposits include river terrace, alluvial fan, slope, valley fill, floodplain, and polygenetic deposits [11] and [12] (Figure- 2). Cretaceous period is divided into groups and subgroups (sequences) **(**Jassim and Goff, 2006). In this research the formations that spread in the project area shown in (Table- 1).

The Shiranish Formation is first defined by [13], from the High Folded Zone of north Iraq near the village of Shiranish Islam. In the type area, the Shiranish Formation is about 225m thick [14]. It is composed of thinly bedded marly limestone at the lower part, blue marl at the upper part with beds of marly limestone. Shiranish Formation is rich in fossils especially Planktonic Foraminifera, and it contains limestone conglomerate in some areas such as Sinjar Area [14].

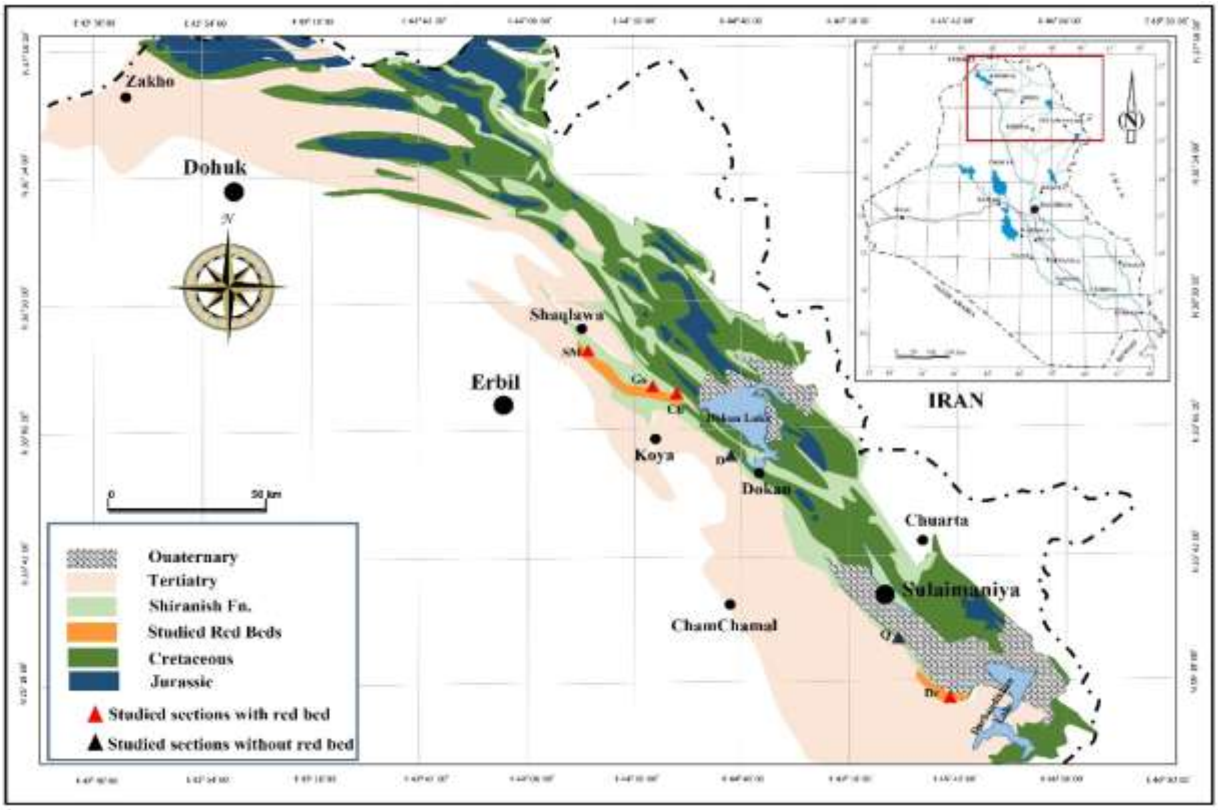


Figure 2- Geological map of the studied area showing the six studied sections [11 and 12].

According to geological divisions into groups and sequences the study area lies within the following divisions (Table- 1):

Table 1- Formations spread in the studied or research area.

Sequence	Formation	Period	Age	Main Lithology
Middle – Early Eocene Mid. Palaeocene – Early Eocene	PilaSpi	Tertiary	Late Eocene	Chalky Limestone
	Avanah		Middle Eocene	Limestone
	Gercus		Middle Eocene	Clastic and Limestone
	Kolosh		Palaeocene	Shale & Sandstone
Late Campanian – Mastrichtian	Tanjero	Cretaceous	Late Campanian-Maastrichtian	Marl &Marly Limestone
	Shiranish		Late Campanian-Maastrichtian	Marl &Marly Limestone
	Bekhme		Mastrichtian	Limestone
	Aqra		Late Campanian	Limestone
	Kometan		Santonian	Limestone

Materials and Methods

Because of the fact that there is no Iraqi previous suitable for this proposal **(CORBs)** for the area under consideration, a detailed touring reconnaissance and geological survey was carried out for each studied section, and learning of the many global literatures, researches and reports pertaining to this study. This study includes three main steps:-

The field checking step includes; Two fields touring reconnaissance, then making many traverse sections, described 6 selected sections of them, and collected 250 samples that covered all sections (Table- 2), take some pictures.

Section	Total thickness (m.)	Shiranish Formation		Tanjero Formation		Number of Samples
		Thickness (m.)	No. of Samples	Thickness (m.)	No. of Samples	
Gendilly (GS)	246	96	128	150	7	**140**
Chinarook (Ch)	104	104	41	-	-	**41**
Smaqully (Sm)	56	56	28	-	-	**28**
Dukan (D)	126	126	17	-	-	**17**
Darbandikhan (Dr)	56	56	14	-	-	**14**
Qaradagh (Q)	122	122	10			**10**
Total collection samples						**250**

Table 2- Thickness and number of studied samples from selected sections.

And the second is the laboratory work; which including make 125 thin sections (slides) in the Iraqi Geological Survey other tests are conducted and performed in the Vienna University Laboratories in Austria, which includes making 24 thin sections (slides) for petrology study, 180 samples for carbonate content ($CaCO_3$ %) examinations, making 20 thin sections (slides) from GS section for nannofossils study, 75 samples for Total Organic Content (TOC%) checking and 17 samples for stable isotopes C^{13} and O^{18}.

Petrography and Microfacies Analysis

The lithological study is emphasis on field description of the Shiranish Formation with red beds in the studied sections; Gendilly (GS), Chinarook (Ch), Smaqully (Sm), Darbandikhan (Dr), Dukan (D) and Qaradagh (Q).

The microfacies comprise five types of lithological composition (marl, marly limestone, shale, sandstone, and siltstone), all studied sections include many cycles succession of marl and marly limestone with each other, occasionally interbedded with thinly beds of shale, sandstone and siltstone, below description of each type of lithology:

First: Red Bed Member

1- Oligostegina Marly Limestone

They up to 90% of foraminifera (Plate 1-1), bright violet-red color, but if it is less calcareous, then the color is light violet. The planktonic foraminifera are redeposited and transported from nearby shallower slope/shelf area. Angular quartz and crinoid debris occasionally occur with high iron oxide.

2- Globotruncana Marly Limestone

There are two types according to different microfossils. One is foraminifera wackestone having 30% - 50% planktonic foraminifera tests with mainly planktonic, few benthic foraminifers and radiolarians with common of bioturbation. Few rounded carbonate intraclasts occur. Another variety is radiolarian wackestone with 30% radiolarian. Radiolarians are mainly replaced by calcite. Quartz grains are rare about 3%. The matrix is highly oxygenated reddish-brown carbonate mud (Plate 1-2).

3- Marlstone with Microfossils

Microfossils are mainly foraminifers (15% - 25%). Foraminifera appear in laminated layers. Recrystallization is common (Plate 1-3).

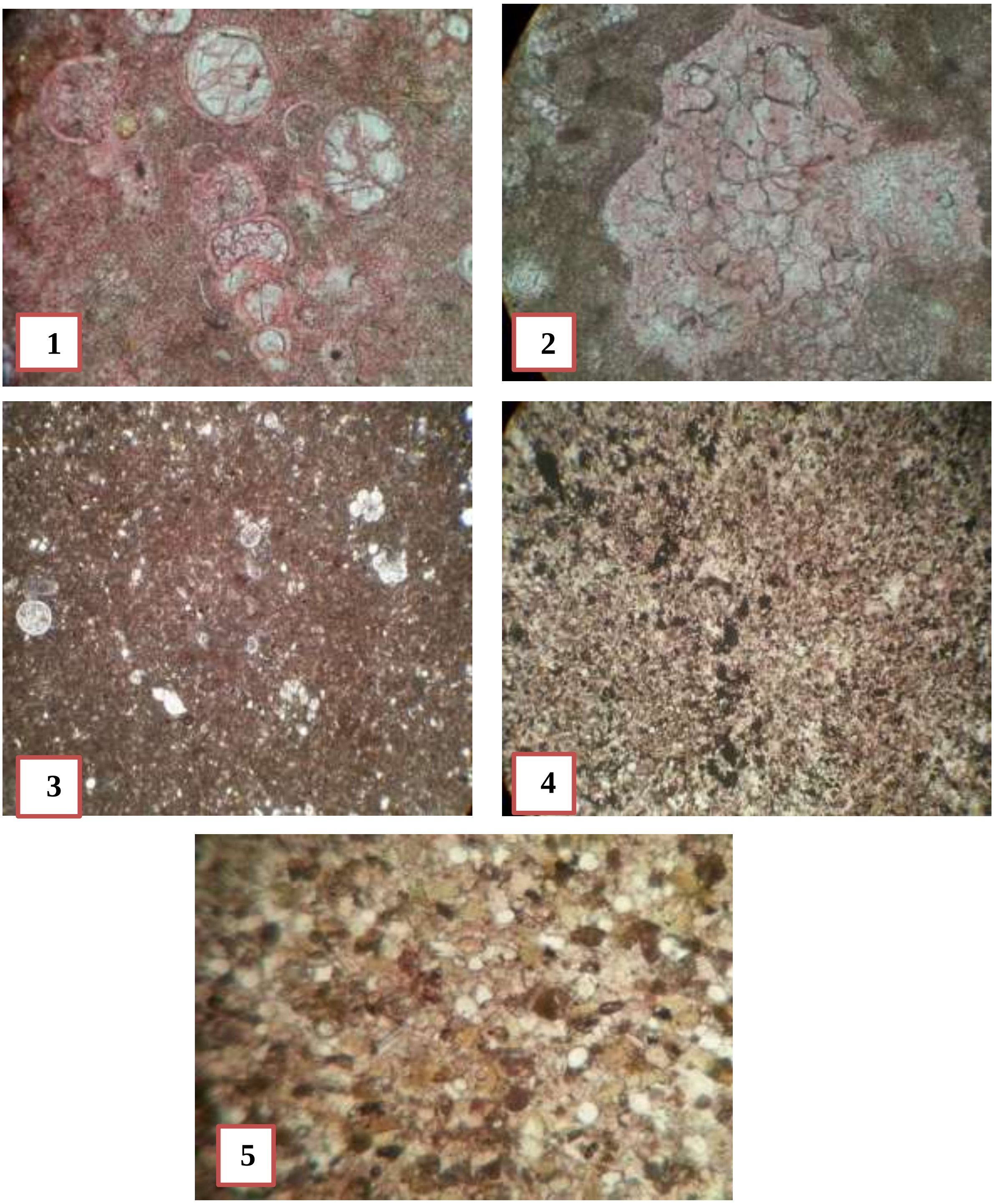
4- Red Marlstone

It is composed of a micrite mixed with argillaceous component. Very few foraminifers occur. Bioturbation and silty-size quartz are common with high iron oxide and organic materials (Plate 1-1).

5- Red to Variegated Calcareous Sandstone with Radiolarian (Debrise Flow)

They are intraclasts mostly larger than 2 mm, up to 8 mm, poorly sorted, subangular to subrounded (Plate 1-5). They are composed of calcareous ground with radiolarian and glauconitic-bearing sandstone, and red gray wacke.

Plate 1



1. Oligostegina marly limestone microfacies
2. Globotruncana marly limestone microfacies.
3. Fossiliferous marly limestone microfacies.
4. Red marlstone microfacies.
5. Brecciated calcareous sandstone with radiolarian microfacies.

Second: Non-Red Bed Member

1- Oligostegina Marly Limestone

This composed of 40% of foraminifera (Plate 2-1) light gray color, but if it is less calcareous, then the color is dark gray.

2- Foraminiferal Marly Limestone

This facies is composed of globigerina as a main grain compound. The mass ground is mainly marl to marly limestone (Plate 2-2).

3- Marlstone with Microfossils

Microfossils are mainly foraminifers (15% - 25%). Foraminifera appear in laminated layers. Recrystallization is common (Plate 2-3), with organic material and very less of oxides.

4- Marlstone

The marlstone facies is composed of an equal percentage of clay and calcareous material with less of very fine quartz (Plate 2-4).

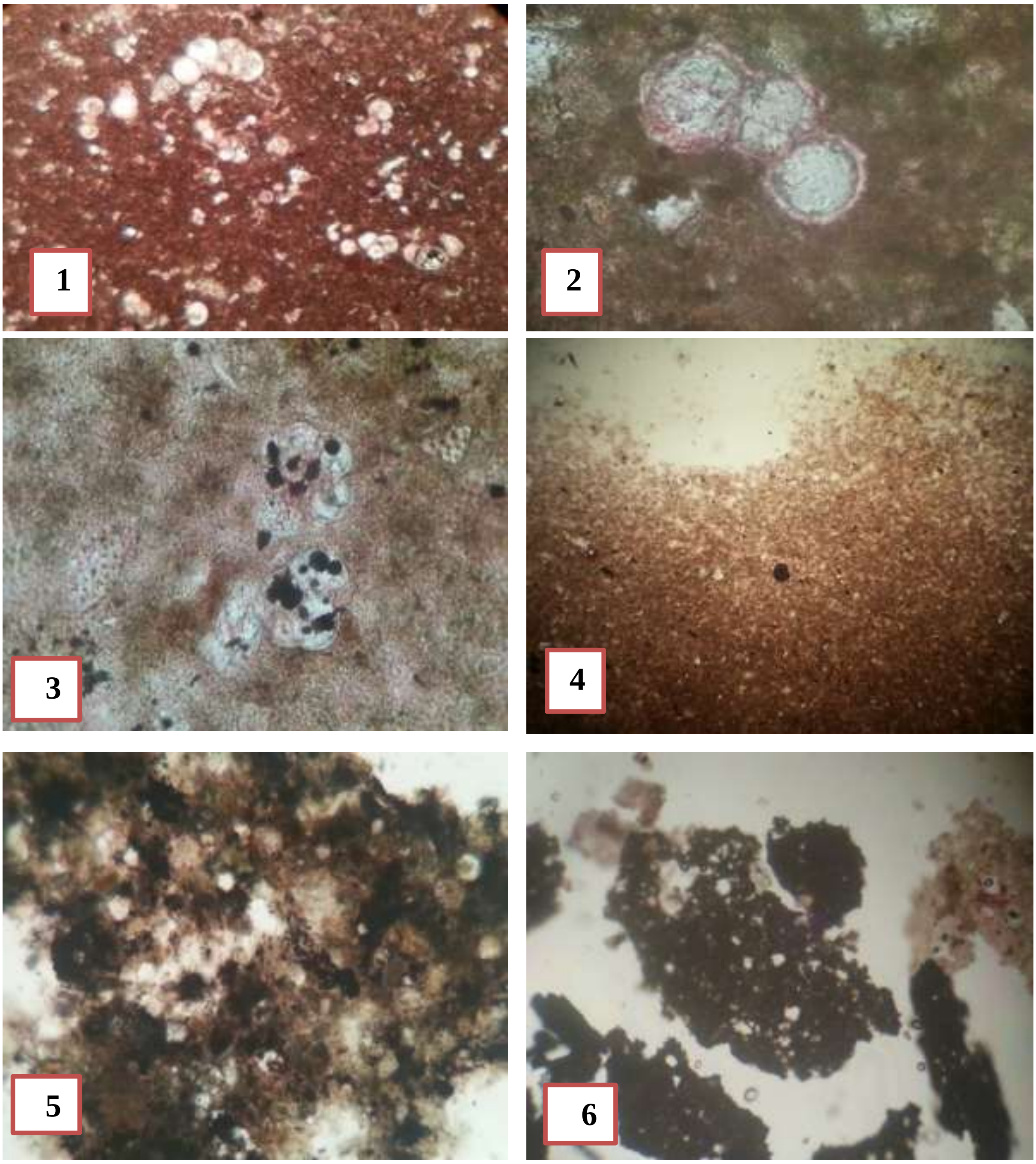
5- Shales

They are dark-brown reddish, paper-sheet- like shale (Plate 2-5) variably siliceous and completely devoid of any carbonate. Micro fracture and silt-size quartz (5%) are common.

6- Yellow-Gray Volcanoclastic and Bioclastic Floastone and Rudstone (Debrise Flow)

This lithofacies is embedded within the red facies. The bioclastic grains (60%-90%) are angular or subangular, poorly sorted, with size up to 10 mm. The bioclasts are mainly sponges and echinoderms, with less frequently occurring nullipore, bivalve debris. The volcanoclastic grains (10%—30%) are mainly basaltic composition (Plate 2-6). The latter are well-sorted, rounded, with average size 0.2 mm. This lithofacies is interpreted as debris flow deposits generated from a shallower carbonate environment sitting on a volcanic basement.

Plate 2



1- Oligostegina marly limestone microfacies.
2- Globigerina marly limestone microfacies.
3- Fossiliferous marlstone microfacies.
4- Marlstone microfacies.
5- Shale microfacies.
6- Volcanoclastic bioclastic microfacies.

Nannofossils Analysis

Nannofossils were checked from the GS-section. 19 smear slides of the section were prepared using a small piece of sediment and a drop of distilled water. The sediment was smeared onto a glass slide and fixed with Canada balsam. The samples were examined qualitatively under the light microscope for nannofossil biostratigraphy (magnification 1000x) without detailed quantitative evaluation. We refer to Burnett (1998) [15] for nannofossil taxonomy and to [16] and [15] for Cretaceous nannofossil zonations used in this study Figure-3

Most of the samples show a poor preservation with strong diagenetic overgrowth on nannofossils up to the point where certain nannofossils taxa could not be determined accordingly. Only a few samples showed a medium to poor preservation where most of the taxa could be identified reliably Nannofossil abundance range from rare to abundant, with most of the samples containing a few nannofossils per field a view.

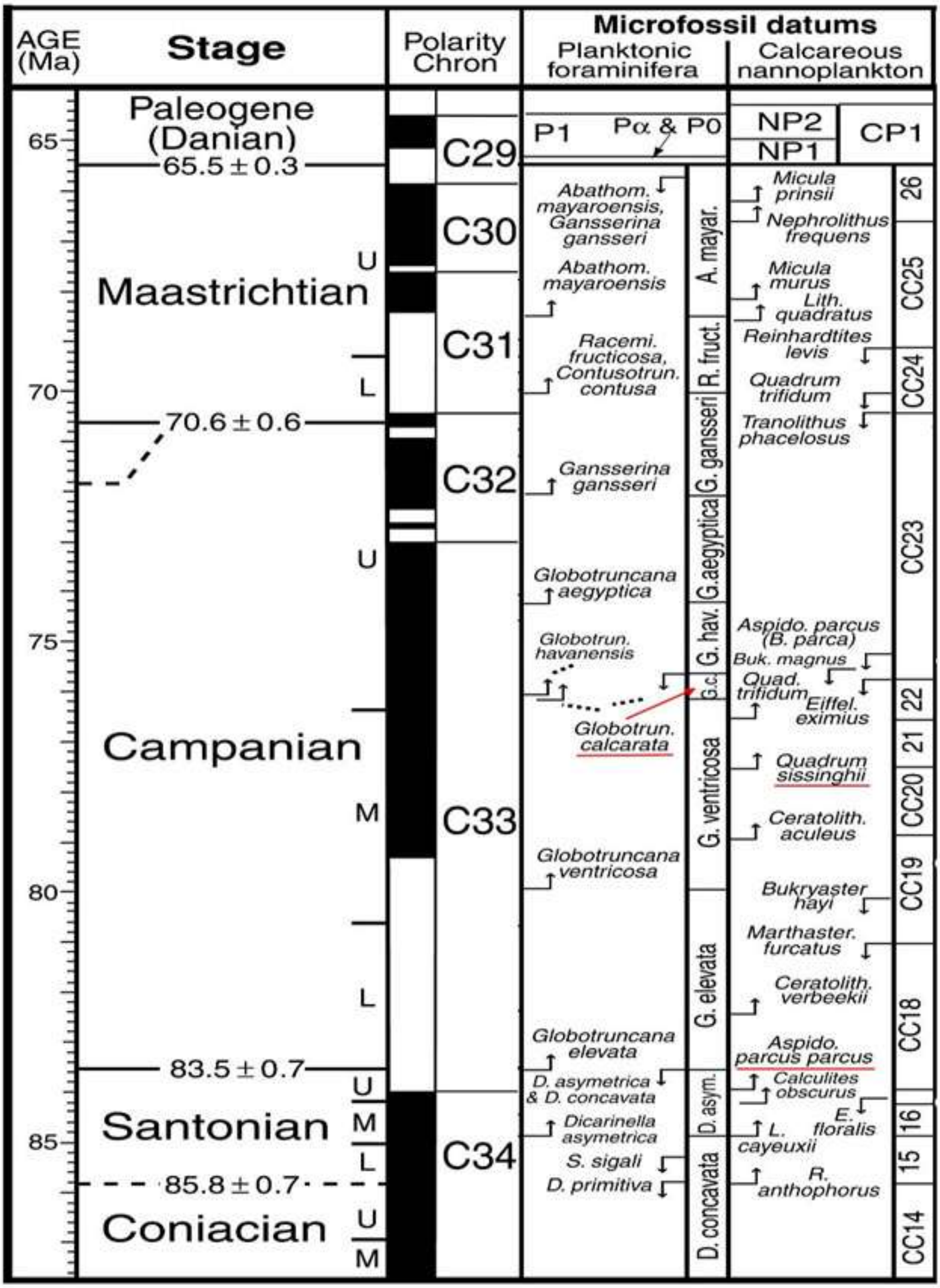
The lowermost samples from sample GS5 to GS40 define an interval that can be attributed to standard nannofossil zones UC16/17 [15] and CC23a/b [16]. The main marker taxa of calcareous nannoplankton present are *Broinsonia parca parca* (Last occurrence = LO in sample GS40) and *Broinsonia parca constricta*, *Ceratolithoides aculeus, Lithraphidites praequadratus, Micula praemurus, Tranolithus orionatu*s (LO in sample GS40) and *Uniplanarius gothicus*. The LO of *Broinsonia parca constricta* defines the top of standard zone UC16 and the top of CC23a. The LO of *Tranolithus orionatus* and *Uniplanarius* species defines the top of UC17 after [15] and CC23b after [16]. This interval includes probably the Campanian-Maastrichtian boundary [17]. Therefore, the lower part of this section is still as Campanian, whereas the uppermost part can be considered as Early Maastrichtian in age.

The interval from sample GS44 to GS52 can be attributed to standard nannofossils zones UC19/20. Here, no *Broinsonia parca parca* or *Broinsonia parca constricta* or *Tranolithus orionatus* or *Uniplanarius* species were found, although the assemblages do not change and no new taxa come in. According to the zonation of [16] this corresponds to standard nannofossil zone CC24 and CC25a. An Early Maastrichtian age is therefore indicated for this interval [15].

At sample GS64 the first *Lithraphidites* cf. *quadratus* was found, indicating the base of nannofossil zone UC20 (Subzone UC20a) and CC25b, respectively. At sample GS74, also *Arkhangelskiella mastrichtiana* has its first occurrence (FO) in the section, which is also an indicator for a Late Maastrichtian age [15]. Also, *Operculodinella operculata* appears for the first time in significant amounts in sample GS74, a species that later on characterizes the Cretaceous/Paleogene boundary [18]. A Late Maastrichtian age is indicated for this section interval.

Starting at sample GS102, *Micula* (cf.) *murus* occurs rarely. The FO of *Micula murus* defines the base of subzones UC20b and CC25c [16] which is of later Late Maastrichtian age. This is the highest nannofossils marker recorded in the section, UC20c/d and CC26 could not be identified, possibly due to bad preservation and low abundances in this part of the section up to sample GS130.

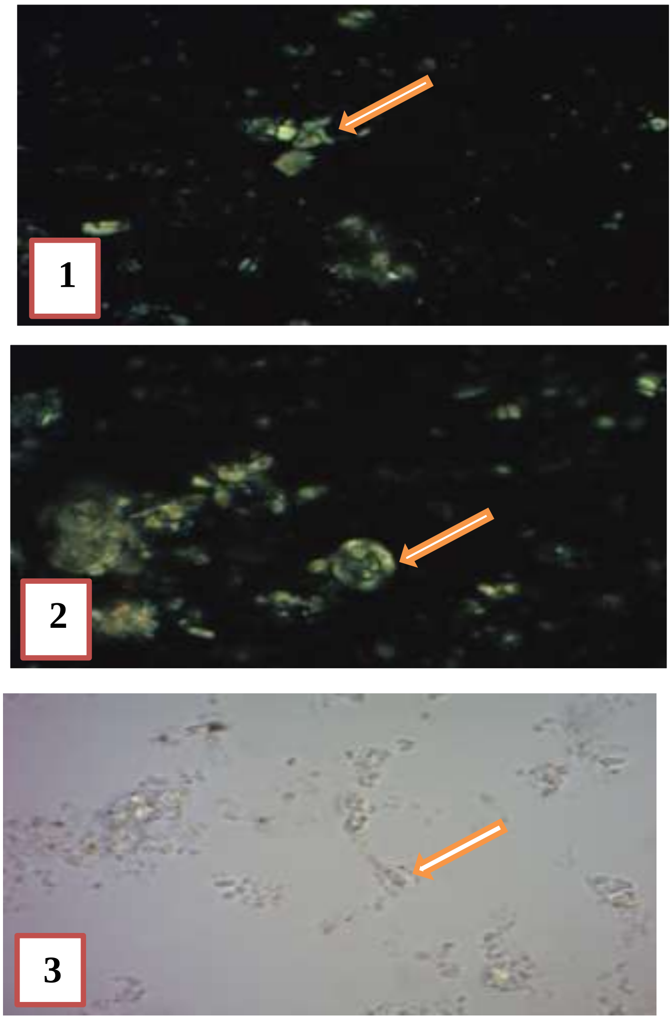
The two uppermost samples (GS132, GS134) have high clastic silt content and no identifiable nannofossils. However, some remains may already indicate a Cenozoic (Paleocene-Danian) age for this interval, and no typical Cretaceous nannofossils could be found anymore[19].


AGE (Ma)
Stage
Polarity Chron
Microfossil datums
Planktonic foraminifera
Calcareous nannoplankton
Paleogene (Danian)
65.5 ± 0.3
Maastrichtian
70.6 ± 0.6
Campanian
83.5 ± 0.7
Santonian
85.8 ± 0.7
Coniacian
U
L
M
65
70
75
80
85
C29
C30
C31
C32
C33
C34
P1
Pα & P0
NP2
NP1
CP1
Abathom. mayaroensis, Gansserina gansseri
Abathom. mayaroensis
Racemi. fructicosa, Contusotrun. contusa
Gansserina gansseri
Globotruncana aegyptica
Globotrun. havanensis
Globotrun. calcarata
Globotruncana ventricosa
Globotruncana elevata
D. asymetrica & D. concavata
Dicarinella asymetrica
S. sigali
D. primitiva
A. mayar.
R. fruct.
G. gansseri
G.aegyptica
G. hav.
G.c.
G. ventricosa
G. elevata
D. asym.
D. concavata
Micula prinsii
Nephrolithus frequens
Micula murus
Lith. quadratus
Reinhardtites levis
Quadrum trifidum
Tranolithus phacelosus
Aspido. parcus (B. parca)
Buk. magnus
Quad. trifidum
Eiffel. eximius
Quadrum sissinghii
Ceratolith. aculeus
Bukryaster hayi
Marthaster. furcatus
Ceratolith. verbeekii
Aspido. parcus parcus
Calculites obscurus
E. floralis
L. cayeuxii
R. anthophorus
26
CC25
CC24
CC23
22
21
CC20
CC19
CC18
16
15
CC14

AGE																						AGE
SAMPLE			Gs134	Gs132	Gs130	Gs128	Gs120	Gs112	Gs106	Gs102	Gs96	Gs90	Gs72	Gs64	Gs52	Gs44	Gs40	Gs31	Gs25	Gs13	Gs5	SAMPLE
Arkhangelskiella cymbiformis						R		R	R	R	R	R		R	R		R	R				*Arkhangelskiella cymbiformis*
Arkhangelskiella maastrichtiana						R	R	R		R		R	R									*Arkhangelskiella maastrichtiana*
Biscutum constans										R												*Biscutum constans*
Broinsonia parca parca																	R					*Broinsonia parca parca*
Broinsonia parca constricta																					R	*Broinsonia parca constricta*
Calculites obscurus						R					R											*Calculites obscurus*
Ceratolithoides aculeus					R	R	R	R	R	R					R		R					*Ceratolithoides aculeus*
Ceratolithoides cf. verbeekii																						*Ceratolithoides cf. verbeekii*
Ceratolithoides sp.						R				R	R	R										*Ceratolithoides sp.*
Chiastozygus litterarius									R	R												*Chiastozygus litterarius*
Cribrosphaerella ehrenbergii					R	R	R	R	R	R	R	R	R	R			R					*Cribrosphaerella ehrenbergii*
Eiffellithus gorkae																		R				*Eiffellithus gorkae*
Eiffellithus turriseiffelii						R	R	R	R				R	R	R	R	R				R	*Eiffellithus turriseiffelii*
Lithastrinus cf. Septenarius											R						R					*Lithastrinus cf. Septenarius*
Lithraphidites carniolensis								R	R	R				R	R							*Lithraphidites carniolensis*
Lithraphidites quadratus									cf	cf				cf								*Lithraphidites quadratus*
Lucianorhabdus cayeuxii										R	R						R					*Lucianorhabdus cayeuxii*
Manivitella pemmatoidea							R			R					R							*Manivitella pemmatoidea*
Microrhabdulus decoratus					R	R	F			F		R			R							*Microrhabdulus decoratus*
Micula quadrata					R	R	F	R		R	R		R		R		R	R			R	*Micula quadrata*
Micula cf. praemurus										R	R			R			R					*Micula cf. praemurus*
Micula staurophora					F	C	C	C	C	C	F	C	C	C	C	R	C	F	F	R	R	*Micula staurophora*
Operculodinella operculata						cf			cf			cf	cf									*Operculodinella operculata*
Petrarhabdus copulatus														R								*Petrarhabdus copulatus*
Prediscosphaera arkhangelskyi					F	F		F	F	R	R	R	F	R	F		R			R		*Prediscosphaera arkhangelskyi*
Prediscosphaera spinosa										R												*Prediscosphaera spinosa*
Quadrum sp. small						R																*Quadrum sp. small*
Reinhardtites levis					F	F	R	F	F	R	F	R	R	R	R		R	R		R	R	*Reinhardtites levis*
Retecapsa crenulata									R													*Retecapsa crenulata*
Rhagodiscus angustus										R												*Rhagodiscus angustus*
Tranolithus minimus																	R					*Tranolithus minimus*
Veshinella crux					F	C	F	C	F	C	F	F	C	C	F	R	F	F	F	R	F	*Veshinella crux*
Zeugrhabdotus erectus															R					R		*Zeugrhabdotus erectus*
Zeugrhabdotus diplogrammus						R				R	R		R	R								*Zeugrhabdotus diplogrammus*
Zeugrhabdotus embergeri					R		R			R							R					*Zeugrhabdotus embergeri*
Zeugrhabdotus spiralis									R													*Zeugrhabdotus spiralis*
									R													
Abundance																						*Abundance*
Preservation																						*Preservation*

Figure 4-A (abundant): >30 species for view; C (common): 10 to 30 spec.s for view; F (few): 1 to 10spec.s for view; R (rare) 1 -0.1:spec.s for view; P (presence):< 0.1spec.s for view; B (barren): no specimens. The abundance classes for the single species and the reworking are as follows: A (abundant): >30%; C (common): 10 to 30%; F (few): 1 to 10%; R (rare): 0.1 ؛% 1-P (presence): < 0.1%.

Plate 3



1. *Broin. p. constricta* 1210B - 36H -1
2. *Broin. p. constricta* 1210B - 37H - CC
3. *C. cf. C. longissimus* 1210B - 36H - 7, 60

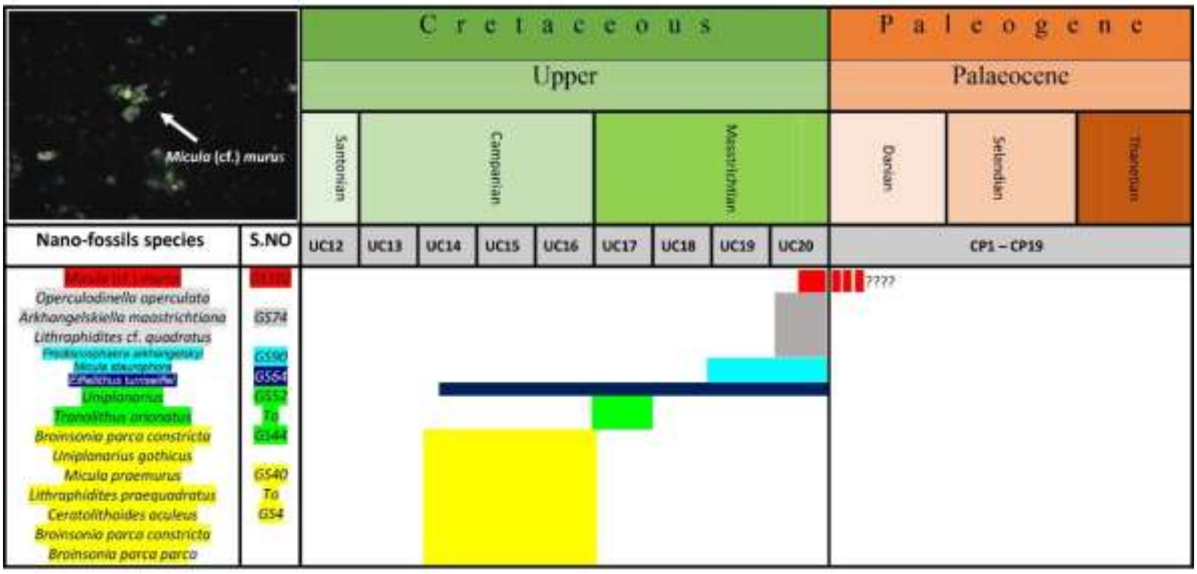


Figure 5- Nannofossils distribution chart for GS section.

Facies Association

There are three main association facies which distinguished within the Shiranish Formation in the studied area: -

1- Facies Association I

This facies association occurred at the middle part of the formation in the D and Q sections with 20% of the total thickness. It contains planktonic foraminifera, *Globotruncana sp*., which consider index fossil of Upper Cretaceous age [20] and turbidity deep marine environment with brecciated calcareous sandstone with radiolarian and also contains cubic pyrite. Availability of micrite refers to the absence of high energy current and lack of pores, which allow to the carbonate solution to pass through it and deposited as sparite [21]. Iron oxides were deposited at the pores of matrix. This facies similar to the slope facies (SMF4) within zone FZ according to [22]. The association of this environment is characterized by distinctly inclined sea floor (commonly 5˚to nearly vertical) seaward of platform margins. Very narrow facies belt which represented the slope benthos and some deep-water benthos and Plankton.

2- Facies Association II

This facies association occurred at the upper part of the formation, and have 82% of total thickness, and recognized by available of the planktonic foraminifera such as *Ecoglobogerina sp.* and *Globotruncana sp*., and fossil chamber filled by spary cement which are coincided with [23], pyrite also recognized at the chamber of some planktonic foraminifera (Figuer- 6) and at fossil's pores which consider ideal condition to the pyrite precipitation due to availability of organic matter that makes alkali reducing environment promote crystallization of pyrite . Micrite change upward to microsparite which is reflects the change from quite deep marine environment to the less depth marine environment. This facies similar to the standard facies Toe-of-slope apron (deep shelf margin) (SMF3) within the zone (FZ3) [22].

The Setting of this facies summarized by moderately inclined sea floor (over 1.5˚) basin ward of steeper slopes. Water depths similar to FZ 2 and perhaps 200 to 300 m. Narrow facies belt.

3- Facies Association III

This facies association occurred at the upper part of the formation and have 20% of the total thickness. Its matrix contains micrite that partly or completely transformed to microspare, and less than 20% planktonic foraminifera. Fossils chamber filled by cement or micrite and sometimes by pyrite. Carbonate mudstone characterized by the fossils due to the high amount of clay materials which prevents production of organic carbonate. This facies similar to the standard facies cratonic deep-water basin (SMF3) within the zone (FZ1) [22]. This association facies referred to the paleobathymetry below the wave base, below the euphotic zone and water depth about 30 m to several 100s m.

Conclusions

The present study has confirmed in the previous studies that describe the deep planktons foraminifera are the most abundant in the studied rocks. They include *Globotruncana, hitrohilex and textularia*, in addition to abundance species of *Globotruncana Heterohelix sp.*, *Hedbergella sp.*, as well as few of echinoderms, *sponge spicules* and *pelecypod*.

The microfossils have proved a clear presence of *Palaeoglobigerina sp*, *Eoglobigerina sp*, *Parvularugoglobigerina sp*, *Ecoglobo* and *Paleoglob* fossils of the Phanerozoic Eon - Cenozoic Era - Paleocene Epoch - Paleogene Period - Danian Age, which absent from the previous studies. This result is supported by nannofossils study, which follows later.

The nannofossils checking suggested, the lowermost part can be attributed to standard nannofossil zones UC16/17 [15] and CC23a/b [16]. The main marker taxa of calcareous nannoplankton present in sample GS40 are recorded the Last Occurrence (LO) of these nannoplankton species. Therefore, the lower part of this section may still be Campanian, followed by the interval from sample GS44 to GS52 can be attributed to standard nannofossil zones UC19/20.

According to the zonation of [16] this corresponds to standard nannofossil zone CC24 and CC25a. This interval includes probably the Campanian-Maastrichtian boundary [17]. An Early Maastrichtian age is therefore indicated for this interval [15]. At sample GS74, also *Arkhangelskiella maastrichtiana* has its first occurrence (FO) in the section, which is also an indicator for a Late Maastrichtian age [15], and a species that found in sample GS74 characterizes by Cretaceous/Paleogene boundary [18]. Up to sample GS130, the nannofossil marker recorded and suggested the Late Maastrichtian age for this section interval. Whereas the uppermost part of this section can be considered to be Early Maastrichtian in age. Finally the two uppermost samples (GS132, GS134) have high clastic silt content and no identifiable nannofossils. However, some remains (*Micula cf. murus*) may already indicate a Cenozoic-Paleogene-Paleocene-Danian age for this interval, which suggested the boundary between shiranish formation and the overlying formation. This result confirms what has proven by microscopic fossils study that mentioned above.

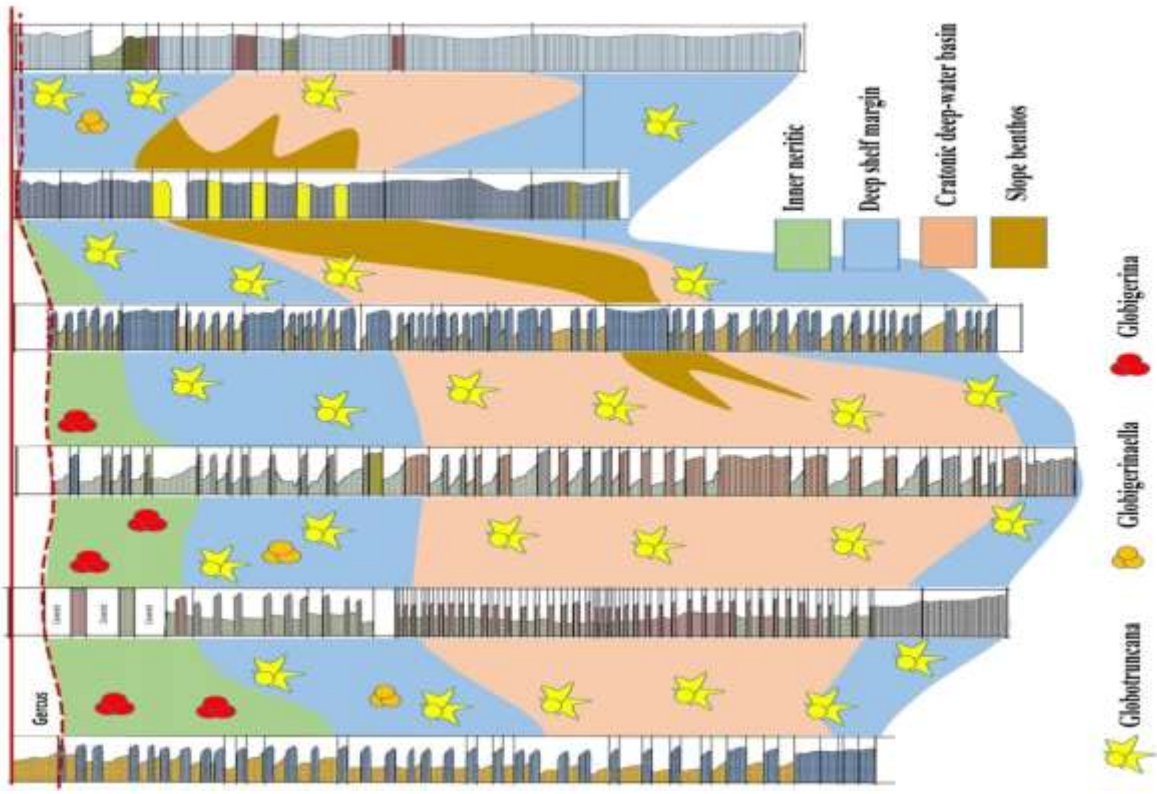


Figure 6- Cros the facies association distribution with the microfossils contains in the studied area

The main sequence of the Shiranish **CORBs** from the Northern Iraq (Late Maastrichtian-Early Maastrichtian age) is marl with low carbonate content, and marly limestone of high carbonate content. Under the influence of the global climate change and rotated from greenhouse to cold conditions (Milankovitch theory), this caused the deposition of rock sequences (marly limestone and marl) and repeat for more than one session.

Shiranish **CORBs** generally abundant in deep-sea planktic foraminifers and calcareous nannofossils. The presence of these agglutinated foraminiferal assemblages indicates that the **CORBs** were deposited in an abyssal environment.

All **CORBs** of the Shiranish Formation in all studied sections are yielded high Fe_2O_3 values around 3%. This study can assume that the enrichment in Fe_2O_3 occurs in an oxic environment.

References

1. Scott, R. W., Hu, X. M., Malata, E., Melinte, M., Sanders, D., Shcherbinina, E. A., Skupien, P., and Wagreich, M., **2004**. *Timing and rates of deposition of Cretaceous oceanic red beds (abstract): 32nd International Geological Congress, Abstracts, Part 1, p. 573.*
2. Leckie, R. M., Bralower, T.J., and Cashman, R. **2002**. *Oceanic anoxic events and plankton evolution: Biotic response to tectonic forcing during the mid-Cretaceous. Paleoceanography,* **17**, 1041, *doi: 10.1029/2001 PA000623.*
3. Neuhuber, S., Wagreich, M., Wendler, I., and Spötl, C. **2007**. *Turonian oceanic red beds in the Eastern Alps: concepts for paleoceanographic changes in the*

Mediterranean Tethys. Palaeogeography, Palaeoclimatology, Palaeoecology 251, 222-238.

4. Kaiho, K. **1994**. *Planktonic and benthic foraminiferal extinction events during the last 100 m.y.: Palaeogeography, Palaeoclimatology, Palaeoecology,* **111:** *45–71.*
5. Wang, C. and Hu, X. **2005**. *Cretaceous world and oceanic red beds: Earth Science Frontiers,***12:** 11–21 (in Chinese with English abstract).
6. Stoll, H. M. and Schrag, D. P. **2000**. *High-Resolution Stable Isotope Records From The Upper Cretaceous Rocks of Italy and Spain: Glacial Episodes in a Greenhouse Planet: Geological Society of America, Bulletin*, **112**: 308–319.
7. Erba, E. and Tremolada, F. **2004**. *Nannofossil carbonate fluxes during the Early Cretaceous: phytoplankton response to nitrification episodes, atmospheric CO2, and anoxia. Paleoceanography 19 (10.1029/2003PA000884).*
8. Jarvis, I., Gale, A.S., Jenkyns, H.C. and Pearce, M.A. **2006**. *Secular variation in Late Cretaceous carbon isotopes: a new 13C carbonate reference curve for the Cenomanian-Campanian (99.6–70.6 Ma): Geological Magazine,* 1**43**: 561–608.
9. Wagreich, M., Bojar, A.-V., Sachsenhofer, R. F., Neuhuber, S. and Egger, H. **2008**. *Calcareous nannoplankton, planktonic foraminiferal and carbonate carbon isotope stratigraphy of the Cenomanian–Turonian boundary section in the Ultrahelvetic Zone (Eastern Alps, Upper Austria): Cretaceous Research,* **29**: 965–975.
10. Jassim, S. Z. and Goff, J. C. **2006**. *Geology of Iraq. Published by Dolin, Prague and Moravian Museum, Srno. 341p.*
11. Ma'ala K. A. **2008**. *Geological map of the Sulaimaniya Quadrangle, sheet N1-38-3, scale 1:20000, GEOSURV.*
12. Sissakian, V., K. **1998.** *Geological map of Iraq, sheet No.1- 3-307 rd edition, Geol. Surv. Min., Invest. Baghdad, Iraq.*
13. Henson, F. R. S. **I951**. *Oil occurrences in relation to regional geology of the Middle East. Geol. Soc. Tulsa, Digest,* **19:** 72-81.
14. Bellen, R. C. Van, Dunnington, H. V., Wetzel, R. and Morton, D. **1959**. *Lexique Stratigraphique Internal Asie. Iraq. Intern. Geol. Conger. Comm. Stratigr, 3, Fasc. lOa, 333p.*
15. Burnett, J. A. **1998**. *Upper Cretaceous. In: Brown, P.R. (Ed.), Calcareous Nannofossil Biostratigraphy, Chapman & Hall, Cambridge.* pp. 132-199.
16. Perch-Nielsen, K. **1985**. *Mesozoic Calcareous Nannofossils. In: Plankton Stratigraphy.*
17. Wagreich, M., Küchler, Th. and Summesberger, H. **2003**. *Correlation of calcareous nannofossil zones to the local first occurrence of Pachydiscusneubergicus (von Hauer, 1858) (Ammonoidea) in European Upper Cretaceous sections. Netherlands Journal of Geosciences,* **82**: 283-288.
18. Egger, H. **2003**. *Upper Campanian variegated shales of the Rhenodanubian Flysch basin (Austria), in Tüysüz, O., and Yikilmaz, B., eds., Upper Cretaceous Oceanic Red Beds: Response to Ocean/Climate Global Change (abstract): Abstracts IGCP463 Meeting, Bartin, Turkey,* p. 20–21.
19. Cushman, J. A. **1922**. Shallow water Foraminifera of the Torugas region. Papers, Tortugas Laboratory, 17: 1-85. Folk, R. L. 1974. Petrology of Sedimentary Rock, Hemphill Publishing Company, Austin, TX.
20. Flugel, E. **2010**. *Microfacies of Carbonate Rocks, 2nd ed. Springer-Verlag Berlin, Germany.* 976 pp.
21. Scholle P. A. **2003**. *A Color Guide to the Petrography of Carbonate Rocks: Grains, textures, porosity, diagenesis. AAPG Memoir 77, Published by The American Association of Petroleum Geologists Tulsa, Oklahoma, U.S.A.,* 459p.
22. Siesser, W.G., Ward, D.J. and Lord, A.R. **1987**. Calcareous nannoplankton biozonation of the Thanetian stage (Palaeocene) in the type area. *Journal of Micropalaeontology,* **6**: 85-102.
23. Wilson, P. A., Norris, R. D. and Cooper, M. J. **2002**. *Testing the mid-Cretaceous greenhouse hypothesis using ''glassy'' foraminiferal calcite from the core of the Turonian tropics on Demerara Rise: Geology,* **30**: 607–610.