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Calcareous nannobiostratigraphy of the Hartha Formation, East Baghdad well No.6, Central Iraq

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Abstract

Fifteen samples of Limestone from the Hartha Formation were obtained from East Baghdad well No.6, Central Iraq, from the depth (2247-2261 meter) about 14 meters thickness. Detail investigation was carried out, from which fifteen species of calcareous nannofossils identified; eleven were descried from other regions and four were left under an open name because of lack of material or rare of samples.

The recorded calcareous nannofossil assemblages recognized two biozones these from the lower to the upper part of the section :

1 - *Eiffellithus eximius* Interval Zone (CC19) part
2- *Ceratolithoides aculeus* Interval Zone (CC20) part

These biozones are correlated with other calcareous nannofossils biozones from both local and regional sections that lead to conclude the age of the Middle Campanian.

Introduction

The Hartha Formation was first described By P.M.V. Rabanit(1952 unpublished report),Owen and Nasr (1958) described formation at the type section in Zubair-3 well between depths 1704.3-1833.2 m. about (129 m. in thickness), it is consisted of organic detrital glauconitic limestone with grey marl and green shale and the limestone are strongly dolomitized in places.

The studied section is located in central Iraq (Fig.1), it lies at an unstable shelf from Iraqi tectonic units (Buday and Jassim,1987). The Hartha Formation was obtained from East Baghdad well No.6, Central Iraq, between (2247-2261 m in depth) about 14 m thick. It consists completely of organic detrital limestone.

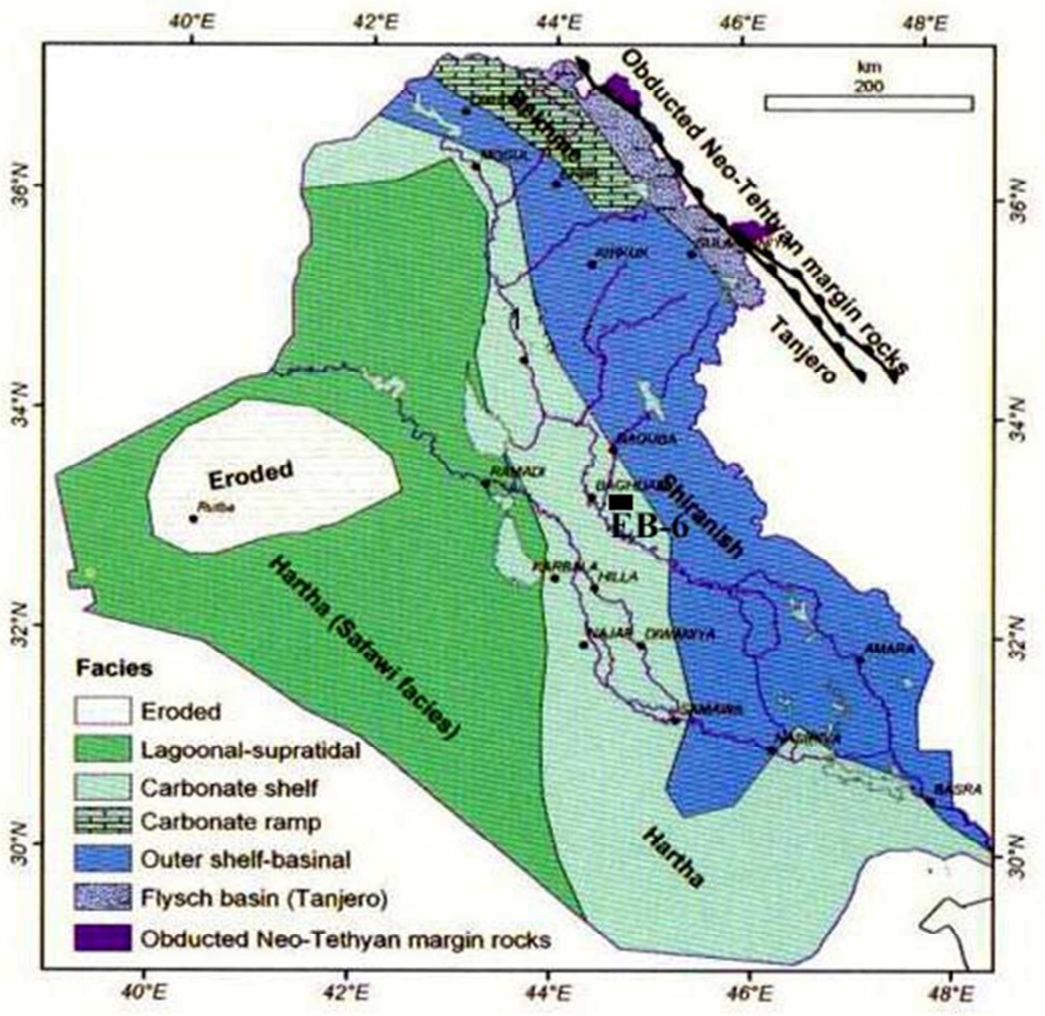


Fig. 1: Location map of the studied section

Methodology

15 cutting samples were obtained from the East Baghdad well No.6, central Iraq from Hartha Formation, they represent 14 m of marl and marly limestone succession . Thin sections are prepared for the polarized microscope examination. The extraction of the calcareous nannofossils is carried out using the method of Armstrong and Brasier, (2005) as follow:

1. About 5 grams of each rock sample is crushed to pass through a sieve of 45 μm and then soaked in distilled water. A drop of small size is added to act as a dispersant.
2. The cover slip is left to dry on a warm hotplate. To make permanent mounts the slide and residue are allowed to dry at a low temperature away from possible sources of contamination.
3. A drop of mounting medium (Canada Balsam) is placed on a clean cover slip and this cover is then dropped on the residue and allowed to dry before examining with transmitted light microscope.

Result and Discussions

1 - Systematics paleontology

Kingdom Protista
Division Chrysophyta Rothmaler, 1949
Class Coccolithophyceae Rothmaler, 1949
Family Arkhangelskiellacea Bukry,1969
Genus *Aspidolithus* Noel,1969
Type species: *Aspidolithus angustus* Noel,1969
Aspidolithus parcus Stradner,1963
Pl.1, Fig.1

Description: Heterococcoliths tired placolith, 2-3 cycles from the distal shield, the inner cycle is broadest, indistinct bicyclic LM image, broad, bright inner cycle and narrow, darker outer cycle central area perforate plane with axial sutures, with no boss or spine.
Occurrences:

Authors	Age	Location
Stradner, 1963	Upper Cretaceous	Germany
Perch-Nielsen, 1985	Early Campanian	General
Al-Badrani *et al*., 2012	Campanian	Iraq
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

Aspidolithus sp.
Pl.1, Fig.2
Description: Heterococcoliths tired placolith, 2-3 cycles from the distal shield, the inner cycle is broadest, indistinct bicyclic LM image, broad, bright inner cycle, and narrow, darker outer cycle.
Remarks: The central area is not well clear, therefore, left under an open name.

Family Braarudosphaeraceae Deflandre, 1947
Genus *Braarudosphaera* Deflandre, 1947
Type species: *Braarudosphaera bigelowi* (Gran and Braarud) Deflandre, 1947
Braarudosphaera bigelowi Deflandre, 1947
Pl.1, Fig.3
Description: Discoidal Nannoliths consisting of several crystal units and showing radial symmetry, constructed from five segments which from pentalith, elements trapezoidal, sutures go to edges of the pentagon having inequilaterally elements.
Occurrences:

Authors	Age	Location
Gran and Braarud, 1935	Recent	Atlantic ocean
Deflandre, 1947	Recent	Atlantic ocean
Bukry, 1069	Upper Cretaceous	U.S.A.
Perch-Nielsen, 1985	Turonian to Recent	General
Al-Badrani, 2007	Eocene to Miocene	Iraq
Lees and Bown, 2005	Upper Cretaceous	Pacific
Melinte and Bojar, 2008	Cenomanian to Turonian	Romanian
Al-Badrani and Al-Khashab, 2013	Coniacian	Iraq

Genus *Bukryaster* Prins,1971
Type species : *Bukryaster hayi* Prins and Sissingh, 1971
Bukryaster hayi Bukry,1969
Pl.1, Fig.4
Description: Discoidal Nannoliths consisting of several crystal units and showing radial symmetry, constructed from five segments which from pentalith, stellate, suture go to edges of a pentagon ornament of five ridges and depressions.
Occurrences

Authors	Age	Location
Bukry, 1969	Upper Cretaceous	U.S.A.
Perch-Nielsen, 1985	Turonian to Maastrichtian	General

Family Chiastozygaceae Rood,Hay and Brnard(1973)
Genus *Chiastozygus* Gartner,1968
Type species : *Zygodiscus amphipons* Bramlette and Martini,1964
Chiastozygus cf. platyrhethum Hill,1976
Pl.1, Fig.6
Description: Heterococcoliths, Loxoliths with variably-developed proximal/inner-cycles and a central-area spanned by diagonal crossbars. LM image includes unicyclic type, the specimens elliptical but broken in part.

Occurrences :

Authors	Age	Location
Hill, 1976	Early Cretaceous	U.S.A.
Perch-Nielsen, 1985	Aptian to Maastrichtian	General
Watkins *et al*., 1998	Late Albian	Ghana
Lees and Bown, 2005	Upper Cretaceous	Pacific
Al-Badrani *et al*., 2012	Campanian	Iraq

Family Eiffellithaceae Reinhardt ,1965
Genus *Eiffelithus* Reinhardt,1965
Type species: *Eiffellithus gorkae* Reinhardt,1965
Eiffellithus eximius Stover,1966
Pl.1, Fig.7
Description: Heterococcoliths, Loxoliths with crossbars generally fibrous and spine-bearing, the central area is perforated.
Occurrences

Authors	Age	Location
Stover,1966	Upper Cretaceous	France
Perch-Nielsen, 1985	Turonian to Campanian	General
Watkins *et al*.,1998	Late Albian	Ghana
Lees and Bown, 2005	Upper Cretaceous	Pacific
Al-Badrani, 2012	Campanian	Iraq
Al-Badrani *et al*., 2012	Campanian	Iraq
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

Family Nannoconceae Deflandre,1959
Genus *Nannoconus* Kamptner,1931
Type species : *Nannoconus steinmanni* Kamptner,1931
Nannoconus elengatus Bronnemann, 1955
Pl.1, Fig.9
Description: Cylindrical nannolith composed entirely of spirally- arranged plates enclosing an axial canal, C-axis arranged tangentially to a central axis. U-shaped in axial section, longer than wide, the diameter of the cavity 1.5-2.5 micron.
Occurrences:

Authors	Age	Location
Bronnemann, 1955	Aptian-Albian	Cuba
Perch-Nielsen, 1985	World wide	General

Family Polycyclolithaceae Forchheimer,1972
Genus *Micula* Vekshina,1959
Type species: *Micula decussata* Vekshina,1959
Micula decussata Vekshina,1959
Pl.1, Fig.8
Description: Nannoliths, four blocky, strongly twisted, wall-cycle elements, joined along sutures which go out to the points of the cube.
Occurrences :

Authors	Age	Location
Vekshina, 1959	Upper Cretaceous	Russia
Gartner, 1968	Upper Cretaceous	U.S.A.
Bukry, 1969	Upper Cretaceous	U.S.A.
Perch-Nielsen, 1985	Coniacian to Maastrichtian	General
Watkins et al., 1998	Late Albian	Ghana
Chira, 2004	Upper Cretaceous	Romania
Lees and Bown, 2005	Upper Cretaceous	Pacific
Al-Badrani, 2012	Campanian	Iraq
Al-Badrani et al., 2012	Campanian	Iraq
Al-Badrani and Mahmood, 2014	Campanian to Maastrichtian	Iraq
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

Family Polycyclolithaceae Forchheimer,1972
Genus *Quadrum* Princ and Perch-Nielsen,1977
Type species: *Quadrum gartneri* Princ and Perch-Nielsen,1977
Quadrum gartneri Princ and Perch-Nielsen,1977
Pl.1, Fig.12
Description: Nannoliths, Elements have tangential *c*-axis orientation, 3-5 ray-like wall-cycle elements, the elements are joined along sutures which go out to the mid-point of the cube edges, distinct by closing central area.

Occurrences

Authors	Age	Location
Princ and Perch-Nielsen, 1977	Middle Cretaceous	General
Perch-Nielsen, 1985	Turonian to Early Campanian	General
Watkins et al., 1998	Late Albian	Ghana
Lees and Bown, 2005	Upper Cretaceous	Pacific
Milinte and Bojar, 2008	Cenomanian to Turonian	Romania
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

Quadrum sp.
Pl.1, Fig.13
Description: Nannoliths, Elements have tangential *c*-axis orientation, 3-5 ray-like wall-cycle elements, the elements are joined along sutures which go out to the mid-point of the cube edges, no central opening or diaphragm.
Remarks: It is arms very wide, therefore, left under an open name.
Family Prediscosphaeraceae Rood,Hay and Barnard,1971
Genus *Prediscosphaera* Vekshina,1959
Type species: *Prediscosphaera decorate* Vekshina,1959
Prediscosphaera grandis Perch-Nielsen 1979

Pl.1, Fig.10
Description: Heterococcoliths, Elliptical to circular placoliths with two shields and a central-area spanned by crossbars which support tall. The distal shield is typically bicyclical, with a broad outer cycle, The LM image is bicyclical, with the outer cycle dark, and inner cycle bright. The specimens are small and more cyclic.
Occurrences :

Authors	Age	Location
Perch-Nielsen, 1979	Maastrichtian	Italy
Perch-Nielsen, 1985	Maastrichtian	General
Lees and Bown, 2005	Upper Cretaceous	Pacific
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

Prediscosphaera sp.
Pl.1, Fig.11
Description: Heterococcoliths, Elliptical to circular placoliths with two shields and a central-area spanned by crossbars which support tall. The distal shield is typically bicyclic, with a broad outer cycle, The LM image is bicyclic, with the outer cycle dark, and inner cycle bright.
Remarks: The rim is wide, therefore, left under an open name.

Family Zydodiscaceae Hay and Mohler,1967
Genus *Tranolithus* Stover,1966
Type species: *Tranolithus gablus* Stover,1966
Tranolithus phacelosus Stover,1966
Pl.1, Fig.14
Description: Heterococcoliths, Loxoliths with variably-developed proximal/inner-cycles and a central-area spanned by a single transverse bar. LM image includes both unicyclic and bicyclic types. Central-area spanned by 2-4 broad, disjunctive platelets constitutes a transverse bar, and there is a proximal net of lateral bars.
Occurrences :

Authors	Age	Location
Stover, 1966	Upper Cretaceous	France
Perch-Nielsen, 1985	Albian to Early Maastrichtian	General
Watkins et al., 1998	Late Albian	Ghana
Al-Badrani and Al-Assaf, 2011	Maastrichtian	Iraq
Al-Badrani, 2012	Campanian	Iraq
Al-Badrani and Al-Khashab, 2013	Coniacian	Iraq
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

Tranolithus sp.
Pl.1, Fig.15
Description: Heterococcoliths, Loxoliths with variably-developed proximal/inner-cycles and a central-area spanned by a single transverse bar. LM image includes both unicyclic and bicyclic types. Central-area spanned by 2-4 broad, disjunct platelets .
Remarks: The rim is narrow ,therefore, left under an open name.

Incertae sedis
Genus *Ceratolithoides* Bramlette and Martini,1964
Type species : *Ceratolithoides kampantri* Bramlette and Martini,1964
Ceratolithoides aculeus Stradner,1961

Pl.1, Fig.5
Description: Conical, arrowhead- or horseshoe-shaped nannoliths.

Occurrences

Authors	Age	Location
Stradner, 1961	Albian	Mexico
Perch-Nielsen, 1985	Campanian to Maastrichtian	General
Lees and Bown, 2005	Upper Cretaceous	Pacific
Al-Badrani et al., 2012	Campanian	Iraq
Al-Badrani and Mahmood, 2014	Campanian to Maastrichtian	Iraq
Al-Mamari and Al-Badrani 2019	Campanian to Maastrichtian	Iraq

2 - Nannobiostratigraphy

Depending on the stratigraphic distribution of the recorded species, two biozones are identified:

1- *Eiffellithus eximius* Interval Zone (CC19) part

Definition: Interval from the last occurrence of *Marthasterites furcatus* (Deflandre and Fert, 1954) Deflandre, 1959 to the first occurrence of *Ceratolithoides aculeus* Stradner,1961.

Thickness: 9 meters

Discussion: The lower boundary of this biozone is not exposed in the studied section, Sissingh (1977) suggested a subdivision for this biozone by the last occurrence of *Bukryaster hayi* Bukry,1969, which recorded in this section. The upper boundary determinates by the first occurrence of *Ceratolithoides aculeus* Stradner,1961, who aged by late Middle Campanian the event used by Sissingh to define the top of this zone (CC19) *Calculites ovalis* zone , therefore, the present succession have Middle Campanian.

2- *Ceratolithoides aculeus* Interval Zone (CC20) part

Definition: Interval from the first occurrence of *Ceratolithoides aculeus* Stradner,1961 to the first occurrence *Quadrum sissinghi* Perch-Nielsen,1984.

Thickness: 5 meters.

Discussion: The lower boundary explained above, but an upper boundary that marked by the first occurrence of *Quadrum sissinghi* Perch-Nielsen,1984 which not recorded recently, therefore, the present succession has Early Campanian.

Conclusions

This study has the following conclusions:

1 - 15 species belonging to 11 genera of calcareous nannofossil assemblage were recorded from the sampled sequence of the Hartha Formation.

2 - The studied depth interval is subdivided into two biozones which are from the lower to the upper part of the section:

1 - *Eiffellithus eximius* Interval zone (CC19) part

2- *Ceratolithoides aculeus* Interval zone (CC20) part

3 - Based on the recorded biozones, the age of the Hartha Formation in the sampled interval is the Middle Campanian.

4 - The studied biozones can be correlated with other regional studies.

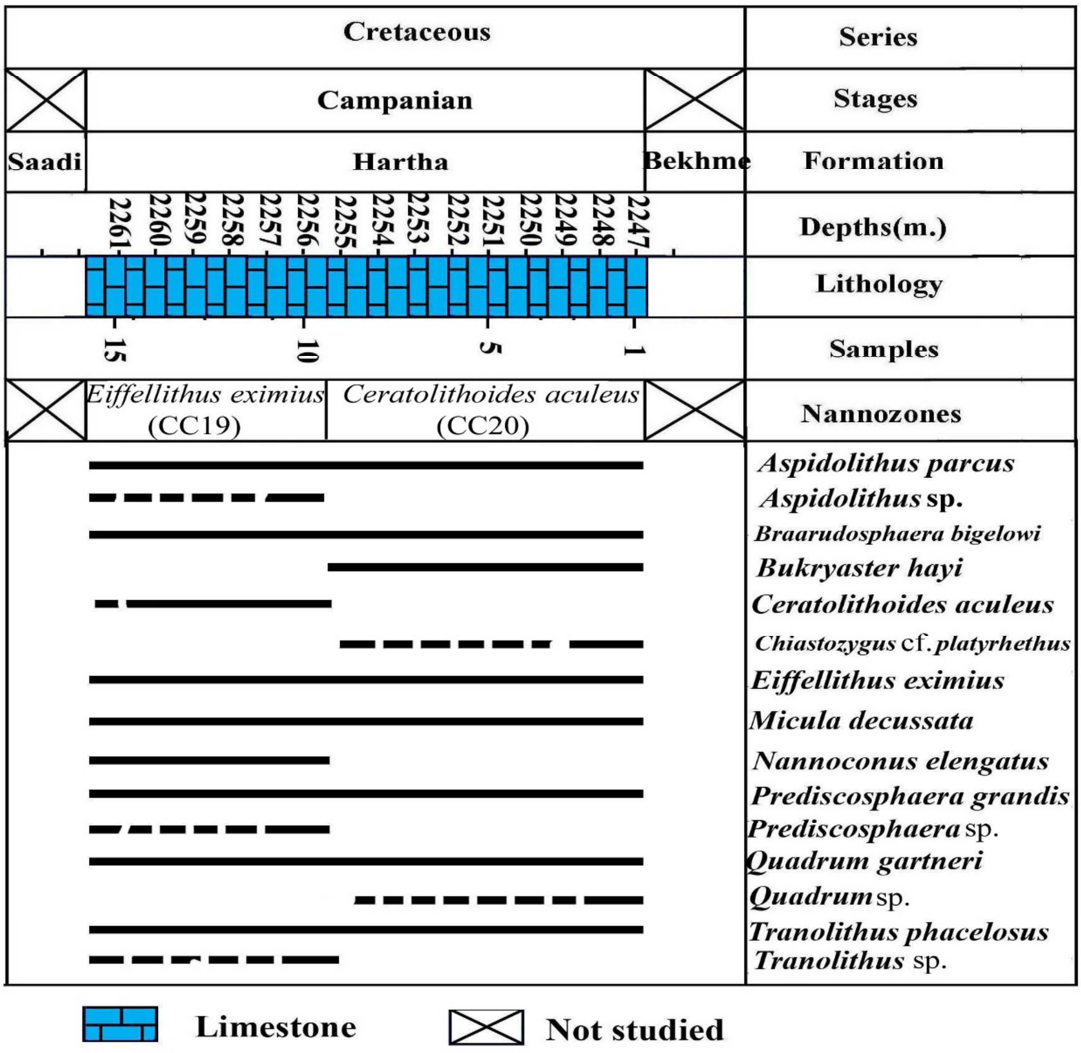


Fig.2: Calcareous Nannofossils biostratigraphic zonation chart of the studied section

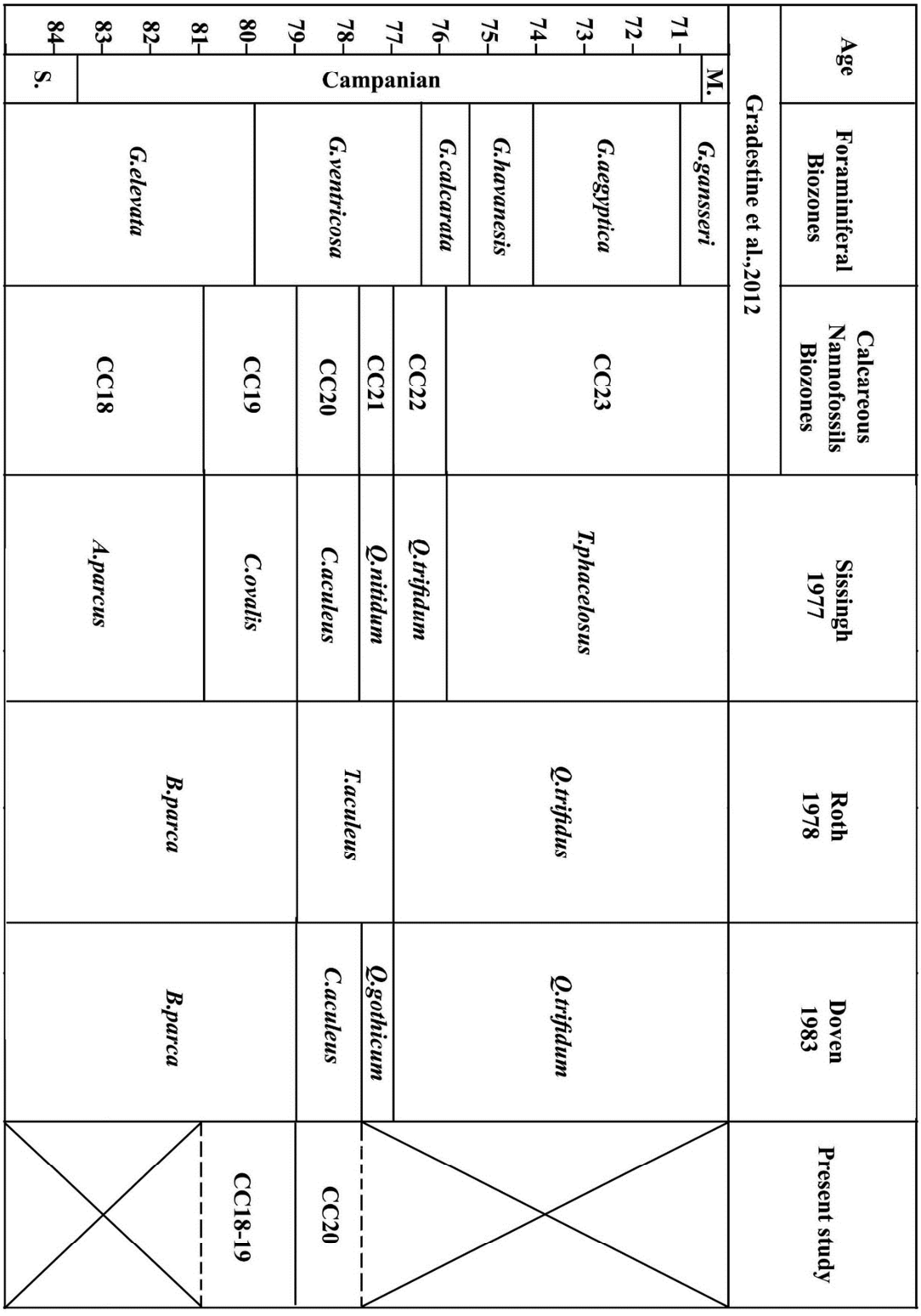


Fig.3: Compared schemes for the studied section

References

[1] Al-Badrani, O.A. *"Biostratigraphy and paleoecology of Upper Cretaceous Ammonites for the Lower part of Shiranish Formation Northwest Iraq*. Unpublished M.Sc.Thesis, University of Mosul 104p. (In Arabic). (2001).

[2] Al-Badrani, O. A. *"Nannobiostratiraphy of the Lower part of Shiranish Formation, Sinjar Anticline, NW Iraq*". Iraqi National Journal of Earth Sciences. Vol. 12, No. 1, pp. 1-16. (2012).

[3] Al-Badrani, O. A., and Al-Assaf, E. N. *"Nannobiostratigraphy of Shiranish Formation in Balad Well No. 8, Northern Baghdad, Iraq*". Iraqi National Journal of Earth Sciences. Vol. 11, No. 2, pp. 65-80. (2011).

[4] AL-Badrani, O. A., and AL-Kashab, S. A. *"Biostratigraphy and Paleoecology by calcareous nannofossils and Ostracoda of Tanuma Formation, Central Iraq*". Iraqi National Journal of Earth Sciences. Vol. 13, No. 2, pp. 33-46. (2013).

[5] Al-Badrani, O. A. and Al-Maamari, M. A. *"Calcareous Nannofossils Biostratigraphy of Shiranish Formation (K-306) well, Northern Iraq*". Iraqi National Journal of Earth Sciences. Vol. 19, No. 2, pp. 1-10. (2019).

[6] AL-Badrani, O. A., and Mahmood, R. M. *"Study of nannolith from Upper Cretaceous Shiranish Formation, Higran area, Northern Iraq*". Arbian Journal of Geosciences. Vol. 7, No. 12, pp. 5571-5578. (2014).

[7] Al-Badrani, O. A.; Karim, K. H. and Ismail, K. M. *"Nannofossils' biozones of the contact Between kometan and shiranish formations, Chaqchaq valley, Sulaimaniyah, NE Iraq*". Iraqi Bulletin of Geology and Mining. Vol.8, No.1, p. 19-29. (2012).

[8] Armstrong, H. and Brasier, M. *"Microfossils Black well publishing*". 296p. (2005).

[9] Bronnimann, P. *"Microfossils incertae sedis rrom the Upper Jurassic and Lower Cretaceous of Cuba*". Micropaleontology J. pp 28-51. (1955).

[10] Buday , R.T., and Jassim, S.Z. *"The Regional Geology of Iraq. 2, Tectonism, Magmatism and Metamorphism, Baghdad*". 352p. (1987).

[11] Bukry, D. *"Upper Cretaceous coccoliths from Texas and Europe*". The University Kansas Paleontology Contribution, Article 51, (Protista 2), pp. 1-79. (1969).

[12] Chira,C.,Blac,R. and Vulc,A. *"Cretaceous calcareous nannofossils from ceru Bacainiti area,Apuseni Mountains*". Romania. Acta Paleontologica Romaniae. Vol.4, pp. 89-96. (2004).

[13] Deflandre,G. *"Braarudosphaera nov.gen.,type d'une famille nouvelle de Coccolithophorides actuels a elements composites.C.r*". Seasnces Acad.Sci.Paris. Vol. 225, pp. 439-41. (1947).

[14] Gartner,S. *"Coccoliths and related calcareous nannofossils from upper cretaceous deposits of Texas and Arkansas*".Univ. Kans. Paleont. Contrib. Protista, art.1, pp.1-56. (1968).

[15] Gran, H.H. and Braarud, T. *"A quantitative study of the phytoplankton in the Bay of Fundy and the Gulf of Maine (including observations on hydrography, chemistry and turbidity)".* Journal of the Biological Board of Canada. Vol. 1, pp. 279-467. (1935).

[16] Hill, M.E. *"Lower Cretaceous calcareous nannofossils from Texas and Oklahoma*". Palaeontologica B. Vol. 156, pp. 103-79. (1976).

[17] Milinte, M.C. and Bojar, A.V. *"Biostratigraphic and isotopic record of the Cenomanian- Turonain deposits in the Ohaba-Ponor Section (SW Hateag, Romania)*". Cretaceous Research Vol. 29, pp.1024-1034. (2008).

[18] Owen, R.M.S. and Nasr, S.N. *"The stratigraphy of Kuwait-Basrah area*". American Association of Petroleum Geologists special publication, Habitat of oil symposium, p.1252-1278. (1958).

[19] Perch-Nielsen, K. *"Albian to Pleistocene calcareous nannofossils from the western South Atlantic*". Initial Rep. Deep Sea drill. Proj. Vol.39, pp.699- 823. (1977).

[20] Perch-Nielsen,K. *"Calcareous nannofossils from the Cretaceous between the North sea and the Mediterranean*". In Bolli, H. M., Saundes, J. B., & Perch-Nielsen, K. (eds.), 1985, Plankton stratigraphy. Cambridge University Press, Cambridge, pp.329-426. (1979).

[21] Perch-Nielsen, K. *"Mesozoic calcareous nannofossils*". In Bolli, H. M., Saundes, J. B., & Perch-Nielsen, K. (eds.), Plankton stratigraphy. Cambridge University Press,Cambridge. pp. 427-554. (1985).
[22] Sissigh, W. *"Biostratigraphy of Cretaceous calcareous nannoplankton*". Geol. Mjnb. Vol. 56, pp. 37-65. (1977).
[23] Stover, E. *"Cretaceous coccoliths and associated nannofossils from France and Netherlands*". Micropaleontology. Vol. 12, No. 2, pp. 133-167. (1966).
[24] Stradner, H. *"Vorkommen von Nannofossilien im Mesozoikum und Alttertiär*". Erdöl-Zeitschrift. Vol. 77, No. 3, pp. 77-88. (1961).
[25] Stradner, H. *"New contributions to Mesozoic stratigraphy by means of nannofossils*". Proceedings of the Sixth World Petroleum Congress, Section 1 Paper 4, pp. 167-183. (1963).
[26]Vekshina, V. N. *"Coccolithophoridae of the Maastrichtian deposits of the West Sberian lowland*". Trudy Sibir. Nauch-Issled. Inst. Geol. Geofiz. Min. Syrya. Vol. 2, pp. 56-81. (1959).
[27] Watkins, D. K., Shfik, S., Shin, I. C. *"Calcareous nannofossils from the Cretaceous of the deep Ivorian basin*". Proceeding of the ocean drilling program scientific results. Vol. 159, pp. 319-333. (1998).

Plate 1

1- *Aspidolithus parcus* Stradner, 1963

2- *Aspidolithus* sp.

3- *Braarudosphaera bigelowi* Deflandre, 1947

4- *Bukryaster hayi* Bukry, 1969

5- *Ceratolithoides aculeus* Stradner, 1961

6- *Chiastozygus cf. platyrhethus* Hill, 1976

7- *Eiffellithus eximius* Stover, 1966

8- *Micula* decussate Vekshina, 1959

9- *Nannoconus elengatus* Bronnemann, 1955

10- *Prediscosphaera grandis* Perch-Nielsen,1979

11- *Prediscosphaera* sp.

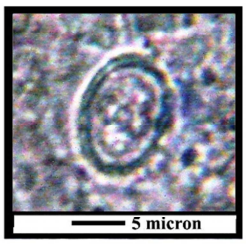
12- *Quadrum gartneri*Princ and Perch-Nielsen, 1977

13- *Quadrum* sp.

14- *Tranolithus phacelosus* Stover,1966

15- *Tranolithus* sp.

Plate 1



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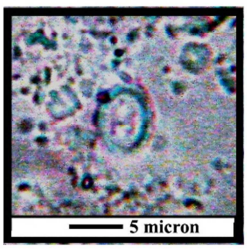

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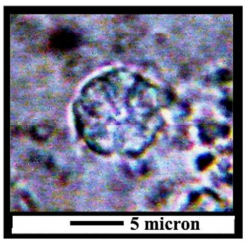

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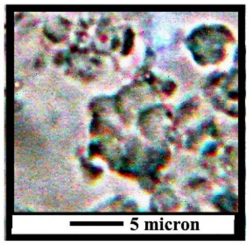

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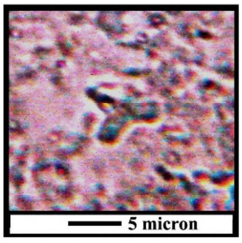

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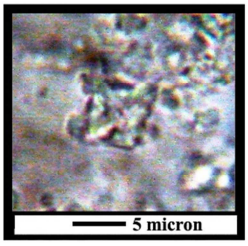

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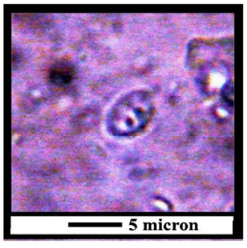

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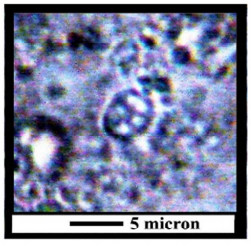

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