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High Resolution Planktic Foraminiferal Biostratigraphic Study of Cretaceous /Paleogene Boundary in Kurdistan Region, Northern Iraq

Majid M. Al-Mutwali [*1], Salim M. Aldabbagh [2], Muhammad Saleem Y. Al-Bakkal [3]

[1,3] *Petroleum and Mining Engineering College, University of Mosul, Iraq*
[2]*Department of geology- Science College, University of Mosul, Iraq*

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Correspondence:
Name : **Majid M. Al-Mutwali**
majidmutwaly@uomosul.edu.iq

ABSTRACT

The high-resolution planktic foraminiferal biostratigraphic study for Cretaceous/ Paleogene (K/Pg) boundary successions of three exposed sections (Duhok Dam, Sandour & Shaqlawa) in Kurdistan region, northern Iraq confirmed the existence of a complete section for K/Pg boundary. The studied sections located in areas that experienced deep marine sedimentation within the foreland basin during the transition from Cretaceous to Paleogene, therefore it is highly required for an integrated and high accuracy study to be done to record this event. Each section includes the boundary between Shiranish Formation (late Campanian–Maastrichtian) and Kolosh Formation (Paleocene–Early Eocene). Sampling was carried out across the boundary with a sample distance of (0.1-0.2 m). Forty-eight planktic foraminiferal species belonging to eighteen genera were noted from the examined Shiranish Formation, and sixteen species belonging to eight genera are recognized from the studied Kolosh Formation. Depending on the identified planktic foraminiferal assemblages, three biozones (CF3, CF2 & CF1) are recorded from the studied uppermost Cretaceous and three biozones (P0, Pα, P1) with three subzones (P1a, P1b & P1c) are recorded from lower Paleocene for each section. This study confirms the existence of Danian sequences in Iraq; evidence suggests that these sections can be regarded as hitherto the most perfect K/Pg boundary sections in Iraq, and the Duhok Dam section is the more distinctive section between them.

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دراسة طباقية حياتية عالية الدقة لأنواع الفورامنيفرا الطافية لحد الكريتاسي / الباليوجين في اقليم كردستان شمال العراق

ماجد مجدي المتولي [1] , سالم محمود الدباغ [2] , محمد سليم البقال [3]

[1,3] كلية هندسة النفط والتعدين ، جامعة الموصل، نينوى، العراق

[2] كلية العلوم ، قسم علوم الارض ، جامعة الموصل، نينوى، العراق

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المراسلة:

الاسم: **ماجد مجدي المتولي**

majidmutwaly@uomosul.edu.iq

الملخص

اكدت الدراسة عالية الدقة للطباقية الحياتية لأنواع الفورامنيفرا الطافية ضمن تتابعات حد الكريتاسي / الباليوجين في ثلاثة مقاطع سطحية (مقطع سد دهوك , صندور وشقلاوة) ضمن اقليم كردستان شمالي العراق وجود مقطع متكامل لهذا الحد. لقد شهدت مناطق المقاطع المدروسة ترسيب بحري عميق خلال ضمن حوض الفورلاند خلال الفترة الأنتقالية بين الكريتاسي والباليوجين, لذلك فقد احتاجت تلك المقاطع الى دراسة متكاملة ودقيقة لتسجيل الأحداث عبر هذا الحد. كل مقطع من هذه المقاطع الثلاثة تضمنت دراسة هذا الحد الواقع بين تكوين شرانش (الكامبانيان المتأخر – الماسترختيان) وتكوين كولوش (الباليوسين – الأيوسين المبكر). النمذجة عبر حد الكريتاسي / الباليوجين ضمن المقاطع المدروسة اخذت بأبعاد تتراوح بين (10–20) سنتمتر بين كل نموذج وآخر. تم تشخيص (48) نوع من انواع الفورامنيفرا الطافية تعود الى (18) جنس ضمن تتابعات تكوين شرانش, كما تم تشخيص (16) نوع من انواع الفرامنيفرا الطافية تعود الى (8) اجناس ضمن تكوين كولوش في المقاطع الثلاثة قيد الدرس. اعتمادا على هذه الحشود المصنفة من الفورامنيفرا الطافية تم تحديد ثلاثة انطقة حياتية(CF3, CF2 & CF1) ضمن تتابعات الكريتاسي الأعلى وثلاثة انطقة حياتية (P0, Pα, P1) اضافة الى ثلاثة تحت انطقة (P1a, P1b & P1c) ضمن تتابعات الباليوسين الأسفل في كل مقطع. ان الدراسة الحالية قد اثبتت وجود تتابعات الدانيان في العراق, واستنادا الى النتائج المستحصلة فأن هذه المقاطع تعتبر حالياً من افضل المقاطع المتكاملة لحد الكريتاسي/ الباليوجين في العراق , ويمثل مقطع سد دهوك المقطع الأكثر تميز بينهم.

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Introduction

The best way to assess and identify the boundary between the Cretaceous and Paleogene is to study in high resolution the planktic foraminiferal assemblages and observe how and when they disappear at the top of the Cretaceous deposits and then the gradual appearance of those in the Early Paleogene deposits, in addition to accurately identifying the biostratigraphic zones and subzones of these indicative species of planktic foraminifera and correlate them with other regional and global biostratigraphic systems. This article is concerned primarily with Cretaceous/Paleogene boundary sequences in Iraq, where revisions of related previous studies were made, as well as the achievements of our latest study on this boundary in northern Iraq. The current study attempts to answer many intriguing questions about the Cretaceous / Paleogene boundary sequences in Iraq raised through various researches and studies conducted by national and international authors concerning biostratigraphy, correlation similarities, age determination, and nature of the contact. The present study is fully convinced that in northern Iraq there is a complete section for K/Pg boundary, especially in areas that experienced deep marine sedimentation within the foreland basin during the transition from Cretaceous to Paleogene and therefore it is highly required for an integrated and high accuracy study to be done to record this event. In order to elucidate the biostratigraphy at the K/Pg boundary, we have studied three surface sections. The most completed section of the Cretaceous/Paleogene in Iraq was determined and detailed, where the results of the current study were based on many field trips and a high-resolution study of the planktic foraminifera (backed by other data). Lithologically, it is related to the Shiranish and Kolosh Formations. The purpose of the current study is to provide basic and important information within the stratigraphic framework of Iraq with the aim of establishing the existence of the Danian sequences in Iraq, as well as determining the ideal location for the complete section of the Cretaceous /Paleogene boundary section in Northern Iraq. Foraminiferal biostratigraphic analysis validated the occurrence of complete uppermost Maastrichtian sediments (Sharbazheri et al., 2009 and 2011; Salih et al., 2013; Mousa et al., 2020; Al-Nuaimy et al., 2020). The present investigation of planktic foraminiferal assemblages and its biozonations for the upper part of the Shiranish Formation and lower part of Kolosh Formation in Duhok area, North of Iraq point towards corroborate the occurrence of complete uppermost Maastrichtian deposits and Early Danian, and to offering our contribution to the general debates on the standard biozonation of the uppermost Maastrichtian and Danian stratigraphic interval in addition to correlation with standard biozones and subzones.

Location of Studied sections

The studied Cretaceous-Paleogene (K/Pg) boundary between the Maastrichtian (Shiranish Formation) and Paleocene (Kolosh Formation) is located within the High Folded zone. Three exposed sections (Duhok Dam , Sandour & Shaqlawa sections) are selected in northern Iraq for a high-resolution planktic foraminiferal biostratigraphic study (backed by other investigations) of Cretaceous/ Paleogene (K/Pg) boundary successions .The first Duhok dam section is located 5 km north of Duhok city near Duhok Dam lake in the Karmawa Valley at longitude (42º 59' 44") east and latitude (36º 54' 30") north; the second section is located on a longitude (43º 03' 02") east and latitude (36º 54' 16") north 12 km northeast of the city of Duhok near the village of Sundour; and the third is the Shaqlawa section, which is located 55 km north of the city of Erbil at longitude (44º 19' 28) east and latitude (36º 24' 09) north as shown in Figure (1).

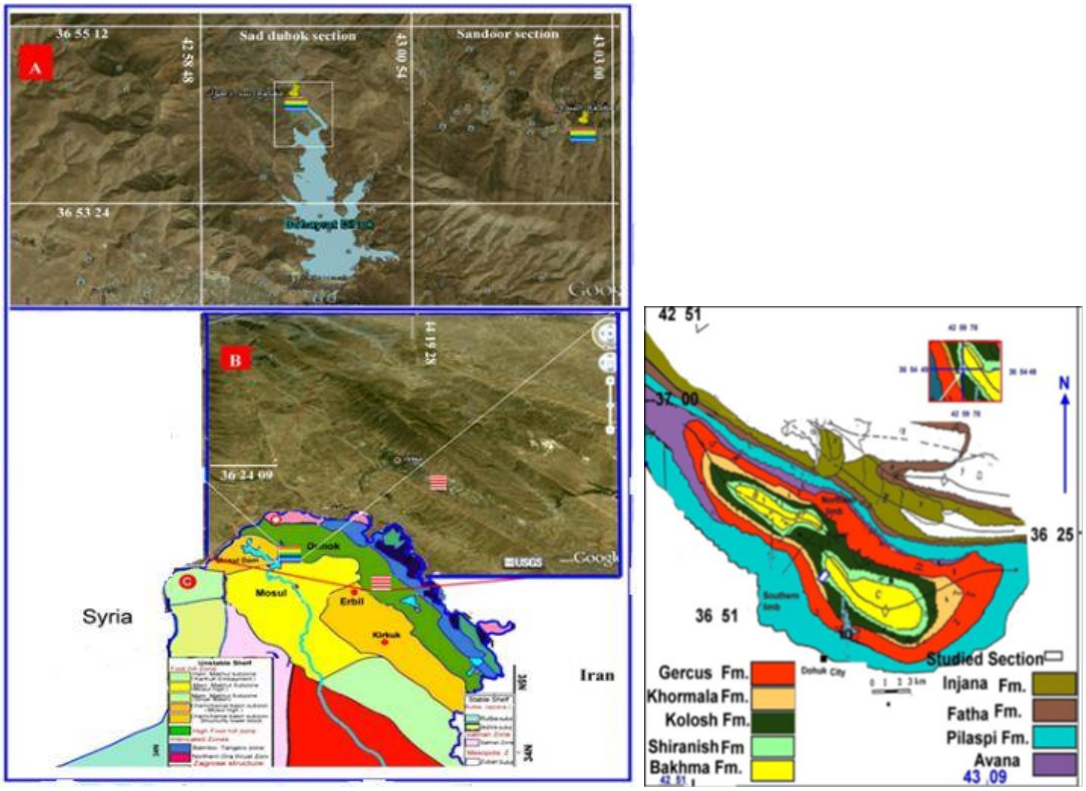

Fig. 1: Location of the stdied sections on the tectonic map of Northern Iraq (Jassim & Goff, 2006). A: Satellite image for Duhok Dam & Sandour sections; B: Satellite image for Shaqlawa section; C: Geological map of the Bekhair anticline showing location of Duhok Dam section.

Revaluation of Cretaceous-Paleogene boundary in Iraq

Many researchers in Iraq have studied the Upper Cretaceous and the Lower Paleogene formations in different regions, and their studies include rock characteristics and stratigraphy. All these researchers recorded a period of no sedimentation or erosion in the upper part of the upper Cretaceous and the lower Paleogene within the K/pg boundary in the studied sections in Iraq. Kassab (1972, 1974, 1975, 1976) and Kassab et al (1986) through their biostratigraphic investigation at the type localities of the Shiranish and Tanjero formations and six other sections in north and northeast Iraq recognized two planktic foraminiferal zones and five subzones. They assigned Late Campanian-Maastrichtian age for both formations. Abdel-Kireem (1986a &b) and Abawi et al. (1982) recognized five planktic foraminiferal zones and two subzones. Al-Mutwali and Al-Jubouri (2005) assigned the Shiranish Formation in the Sinjar area to Late Campanian-Late Maastrichtian age. Kassab (1974, 1975, 1976, and 1978) and Kassab et al. (1986) studied the biostratigraphy of Kolosh Formations at their type section and additional locations in the north and northeast of Iraq. They distinguished the biostratigraphic zones of planktic foraminifera of Lowermost Middle Paleocene, represented by Globorotalia uncinata Zone. The Late Lower Paleocene at Sandour village near Duhok is verified by Munim (1976) and Jacob (1978) by recognition of Globorotalia trinidadensis Zone in Kolosh Formation. The biostratigraphy of planktic foraminefera in Kolosh Formation at Shaqlawa area have been studied by Al-Mutwali (1983), recognizing Globorotalia trinidadensis Zone which indicates the Late Early Paleocene age. Raffo (1989) recorded some Danian species during his study about the biostratigraphy of planktic foraminifera of Aaliji Formation, and describe the contact nature with the underlying upper Cretaceous Shiranish Formation at Mushorah well (No.1), northwest Iraq.

All studies failed to present a complete K/PG section in any part of Iraq compared to the known global boundary in the El-Kif section, north of Tunisia. With the exception of Sharbazheri (2008), Sharbazheri et al. (2009), Al-Bakkal (2013), and Salih et al. (2013). Hammoudi, 2011 in her study about the K/Pg contact line within the Hijran section in the Shaqlawa region - northern Iraq recorded the presence of the biostratigraphic zones of the Late Cretaceous and the Early Paleocene, but not to the degree of the complete section, due to the presence of sedimentary interruption and loss of CF1 (Plummerita hantkeninoides Zone). Bamerni,2021 completely imitated the study of Al-Bakkal, 2013 and named the same planktic foraminiferal biostratigraphic zones for the K/Pg boundary in the Duhok area.In paleontological standards, the K / Pg contact line either occurs immediately after the mass extinction of the planktic foraminiferous groups of the Cretaceous period, or occurs with the beginning of the emergence of Paleocene species of planktic foraminifera. For the purpose of evaluating the extent of the integration of the K/Pg stratigraphic boundary, the stratigraphy must first be studied in details and with high accuracy, in addition to the sedimentary study and the study of stable isotopes. These joint analyses reveal the simplest unusual changes that occur during sediment accumulation, or the possibilities of non-sedimentation or the presence of time gaps within the sedimentary succession.

Despite the high accuracy of the sampling, it is sometimes not possible to obtain some important and rare index fossils, like (Plummerita hantekeninoides, Guembelitria cretacea & Parvularugoglobigerina eugubina), and some of them may have special and limited environments (Koutsoukos, 2005) so it cannot exist, or it may be lost due to lack of sedimentation or the presence of hard ground. The most confusing is the occurrence of erosion and the transfer of some fossils from the upper Cretaceous sediments and their redeposition above the contact line within the lower Danian sediments, which leads to confusion and difficulty in determining the exact line of contact. In northern Tunisia, an official international stratigraphic surface section has been chosen for the K/Pg boundary in the El-Kef region by the ICS (International Commission on Stratigraphy). In the El-Keif section of Tunisia, the location of the boundary line, which is a few millimeters thick, has been located at the bottom of the 50 cm thick clay layer, which is called the K/Pg boundary clay layer (Keller, 1993). This section has been selected because it represents a complete section consisting of continuous sedimentary successions of shale rocks without the presence of unconformity, hard ground or stratigraphic gaps, and the micro fossils appear with a good degree of preservation. The global section in Tunisia is characterized by ideal transitional boundaries so that it can be compared and contrasted with contact lines around the world (Keller, 1993; Koutsoukos, 2005).

The complete K-Pg boundary section in Northern Iraq

The three studied sections include K/Pg boundary between Shiranish and Kolosh formations, whereas the best and complete section is at Duhok Dam. In this section Shiranish Formation consist of alternate layers of marly limestone and marl and the Kolosh Formation consist of alternate thick dark gray calcareous shale and thin sandstones. The K- Pg boundary in the area is characterized by continued bluish grey marl for 30 m from the uppermost part of Shiranish Formation into the lower part of the Kolosh Formation, a lithological constancy of bluish grey marlstone is noticed in the field through the K- Pg boundary with no indications of break or gap in the sedimentary record, e.g., basal conglomerate or breccia, hardground surface, or condensed section, except the presence of dentritic celestite which found 0.10–0.20 m underneath the K-Pg boundary and the plenty of micro trace fossils (*Skolithes* and *Ophiomorpha*) at the K- Pg boundary. A rapid decrease of planktic foraminiferal assemblages and increasing of benthic species and ornamented ostracods have

been noticed at the K- Pg boundary. These evidences insinuate a marine regression episode near the K- Pg boundary. The biostratigraphy of the K- Pg boundary section is shown in Fig.2.

Across the boundary between Shiranish and Kolosh formations field traverses were carried out in the Duhok Dam area with sample collection from the marl sediments, the collected samples were equipped for identification of the planktic foraminiferal species of the uppermost Maastrichtian and lowermost Danian. On reiterated field visits, sample collection at closer distances was made, and their faunal investigation steered to restricting the section across the K-Pg boundary. After a number of field trips, we were capable of ending up with a section of about 1-m thickness through the K-Pg boundary, from which we carried out exhaustive sampling. Underneath the boundary, six samples were gathered: biozone CF2 samples 108 and 109 at remoteness of 0.60 and 0.50 m, respectively, and biozone CF1 samples 110, 111, 112, and 113 at 0.40, 0.30, 0.20, and 0.10 m, respectively. Over the boundary, four samples were gathered: biozone Po one sample 114 at 0.10 m and biozone Pα three samples 115, 116, and 117 at 0.20, 0.30, and 0.40 m, respectively. samples are grayish marl with blocky subconchoidal fracture fewer fissile than shale (Fig. 2).

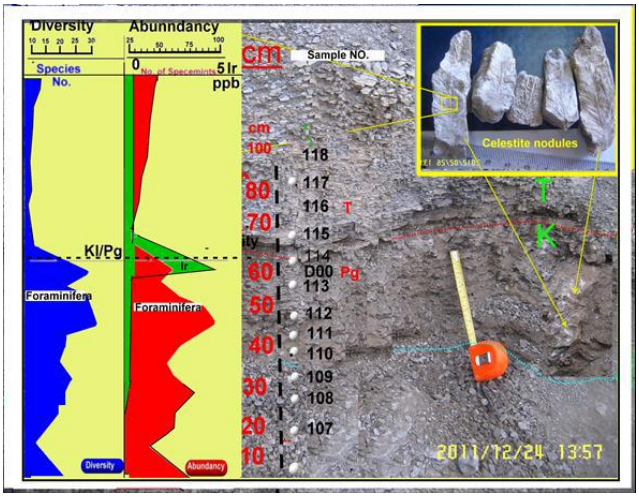

Fig.2: Photograph of the K/Pg boundary in Sad-Duhok section showin the sample locations and graphs of abundance, diversity and extinction of the planktic foraminifera and the anomalous element iridium Ir.

Biostratigraphy

Forty-eight planktic foraminiferal species belonging to eighteen genera were recorded from the studied Upper Cretaceous samples of Shiranish Formation and sixteen species belonging to eight genera are identified from studied Lower Paleogene samples of Kolosh Formation (Figs.3,4&5). Using high-resolution sampling and depending on the basis of recognized planktic foraminiferal species three biozone (CF3,CF2,CF1) are recorded from the studied Late Mastrichtian of each section, It is significant to mention that the zonal scheme of Cretaceous foraminifers (CF) proposed by Li & Keller (1998a,b), which substitutes the Abathomphalus mayaroensis Zone with four zones (R. fructicosa Zone, P. hariaensis Zone, P. palpebra Zone, P. hantkeninoides Zone) supports a much better age assessment for the Late Maastrichtian . During the Early Paleocene three biozone (P0, Pα, P1) are recorded from each section, the (P1) zone is subdivided into three subzones (P1a, P1b & P1c) (Fig.6), these zones are correlated with similar zonal schemes inside and outside Iraq (Figs.7,8). Determining these zones indicates a comprehensive stratigraphic record through the Cretaceous-Paleogene transition; these zones are:

1- Pseudoguemblina hariaensis Interval Zone (Part) (CF3): It is the part of the interval zone that is determinant between the first appearance of the nominate taxon Pseudoguemblina hariaensis and the last appearance of Gansserina ganssari. This zone represents the first distinguished zone in Shiranish Formation where it is taped in all the studied sections; in the Duhok Dam section it is 6 m thick, in the Sandour section it is 9 m thick, and in Shaqlawa it is 5 m thick. The age of this zone is middle Late Maastrichtian, with the time extended between 66.83 Ma and 65.45 Ma (Li and Keller, 1998).

2- Pseudoguemblina palpebra Partial Range Zone (CF2): This zone signifies the partial range of the nominate taxon Pseudoguembelina palpebra among the last appearance of the Gansserina ganssari and the first appearance of Plummerita hantkeninoide. It is recorded in all studied sections; in the Duhok Dam section, it is 10 m thick, in the Sandour section, it is 6.5 m thick, and in Shaqlawa, it is 11 m thick. The age of this zone is late Maastrichtian, spanning time between 65.45 Ma and 65.30 Ma.

3- Plummerita hantkeninoides Taxon Range Zone (CF1): This zone is defined by the total range of the proposed tax on Plummerita hantkeninoides. The Late Maastrichtian in low latitude regions as well as the Tethyan paleogeographic realm is characterized by the total range of the A. mayaroensis Zone (Canudo et al., 1991, Molina et al., 1996; Pardo et al., 1996; Sharbazheri et al., 2009). In the studied sections it demonstrates the uppermost Cretaceous biozone within Shiranish Formation, and its top denotes the K/Pg boundary. The recorded planktic foraminiferal assemblage of this zone shows a steady decrease in both species and individual numbers, where the mass extinction of large tropical-subtropical taxa coincides with the upper limit of this zone. The study has shown that about three quarters of species gradually and selectively disappeared at or close to the K/Pg boundary. Survived just ecologic opportunists which has the ability to adapt to wide variation in temperature (Biserial &triserial morphotypes). The thickness of this zone is 45cm in Duhok Dam section and Sandour sections while it is 2m thick in Shaqlawa section. The age of this zone is Latest Maastrichtian spanning between 65.30 Ma and 65 Ma.

4- Guembelitria cretacea Partial Range Zone (P0): This zone has a biostratigraphic interval represented by the partial range of the nominate taxon Pseudoguembelina palpebral, which confines between the last appearance of the Late Cretaceous genera denoted by the top of Plummerita hantkeninoides Zone to the first Appearance of Parvularugoglobigerina eugubina. This zone is recorded in all the studied sections of 30 cm thickness in Duhok Dam and Sandour sections while it is 35cm thick in Shaqlawa section. This zone represents the age of Earliest Paleocene (Earliest Danian) with the time span between 65.0 Ma and 64.97Ma. (Olsson et al., 2000).

5- Parvulargoglobigerina eugubina Total Range Zone (pα): The biostratigraphic interval of this zone corresponds to the total range of the nominated taxon Parvularugoglobigerina eugubina. It is documented in all the studied sections; in the Duhok Dam section, it is 100 cm thick, in the Sandour section, it is 60 cm thick, and in Shaqlawa, it is 160 cm thick. The age of this zone is the Earliest Paleocene (earliest Danian), spanning time between 64.97 Ma and 64.90 Ma.

6- Parasubbotina pseudobulloides Partial Range Zone (P1): This zone represents the partial range of the biostratigraphic interval of nominate taxon Parasubbotina pseudobulloides , which confines between the last appearance of Parvularugoglobigerina eugubina to the first appearance of Praemurica uncinata. This zone is subdivided into three subzones:

a-Parvulargoglobigerina eugubina – Subbotina triloculinoides Interval Subzone (P1a):

it is represented by the biostratigraphic interval which confines between the last appearance of *Parvularugoglobigerina eugubina* and first appearance of *Subbotina triloculinoides.* The thickness of this zone is 3.25m in Duhok Dam section and 0.3m in Sandour section while it is 2m thick in Shaqlawa section. The age of this subzone is Early Danian with the time span between 64.90 Ma and 64.50 Ma.

b- Subbotina triloculinoides Interval Subzone (p1b):

Represented the biostratigraphic interval which confines between the first appearance of *Subbotina triloculinoides* and the first appearance of *Globanomalina compress.* The thickness of this zone is 2 m in Duhok Dam section and 1.7m in Sandour section while it is 5m thick in Shaqlawa section. The age of this subzone is Early Paleocene (Danian) with the time span between 64.50 Ma and 63Ma.

c. Globanomalina compressa Interval Subzone (P1c):

This subzone is represented by the biostratigraphic interval, which is confined between the first appearance of Globanomalina compressa and the first appearance of Praemurica uncinata Bolli. The age of this subzone is Early Paleocene (Danian).

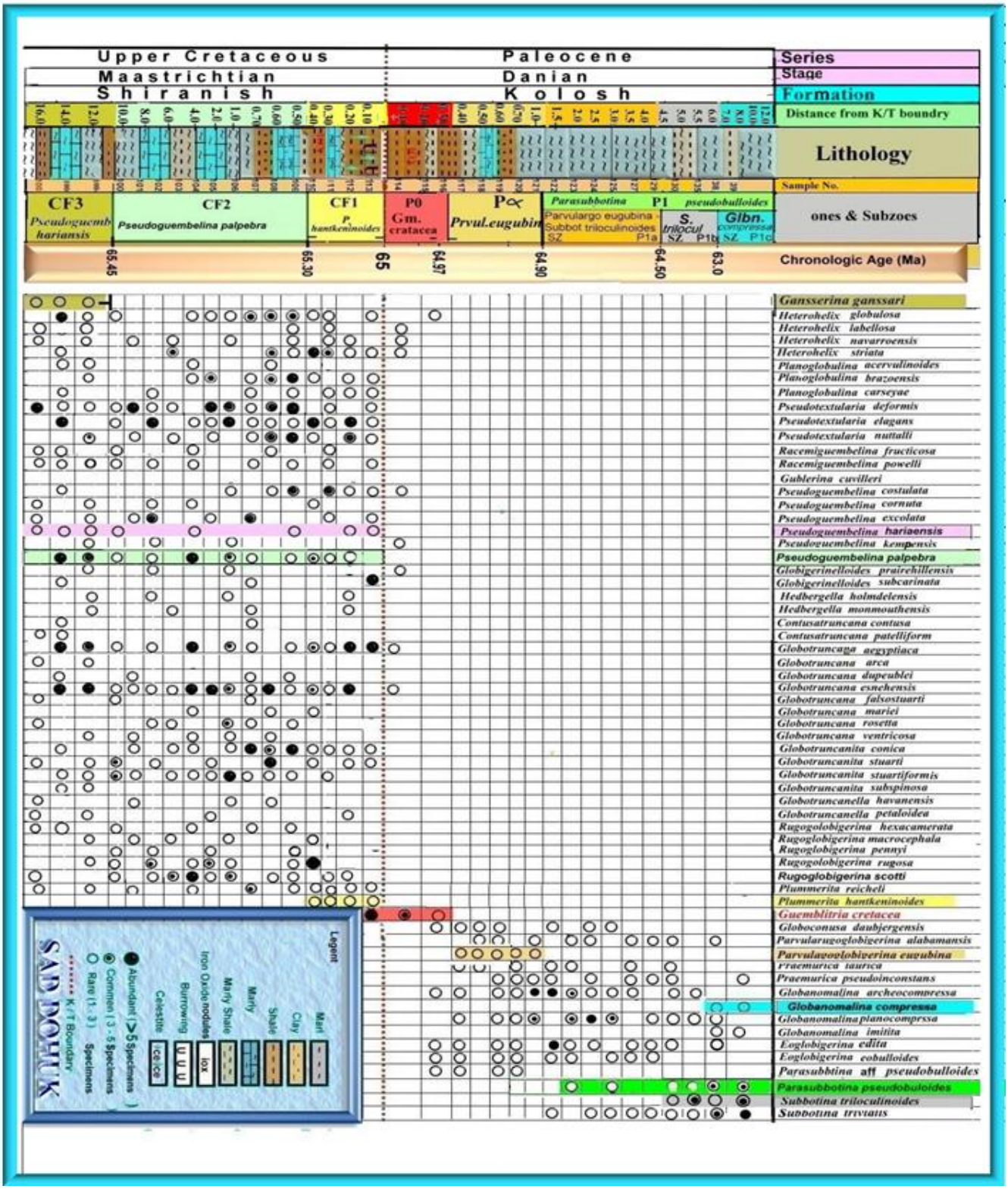

Fig. 3. Biostratigraphic range chart of planktic foraminifera at Cretaceous/Paleogene boundary, Duhok Dam section.

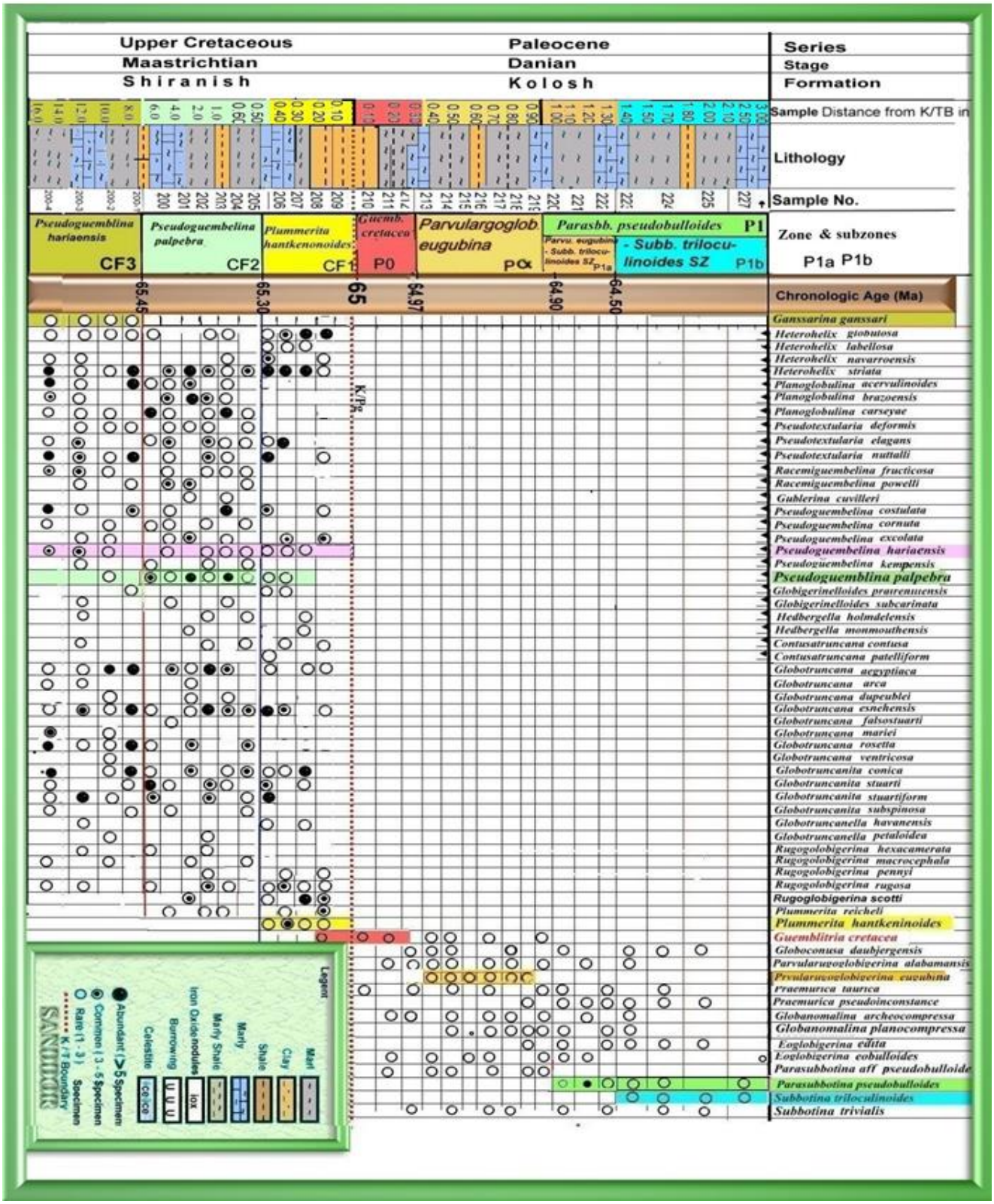

Fig. 4. Biostratigraphic range chart of planktic foraminifera at Cretaceous/Paleogene boundary, Sandour section.

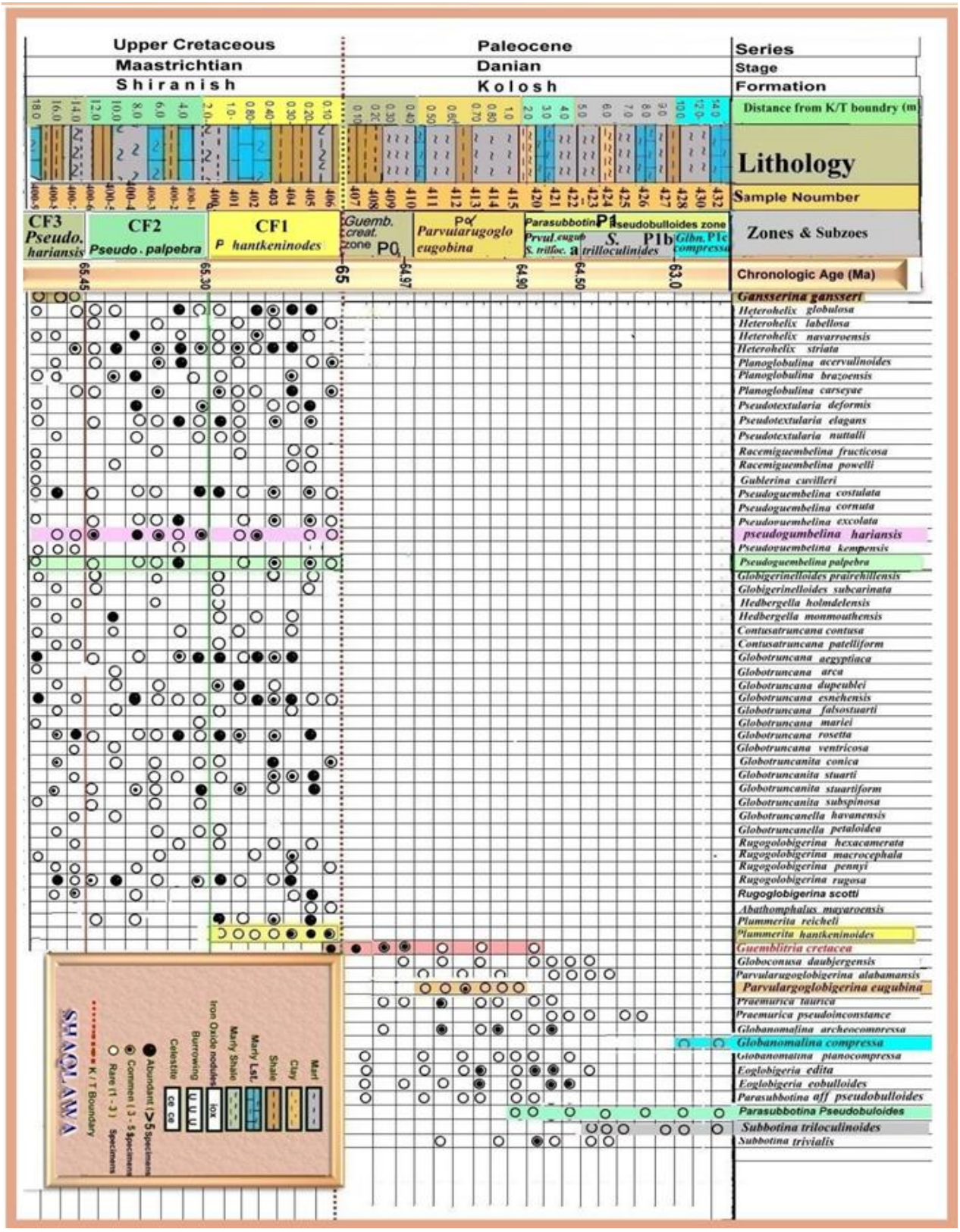

Fig. 5. Biostratigraphic range chart of planktic foraminifera at Cretaceous/Paleogene boundary, Shaqlawa section.

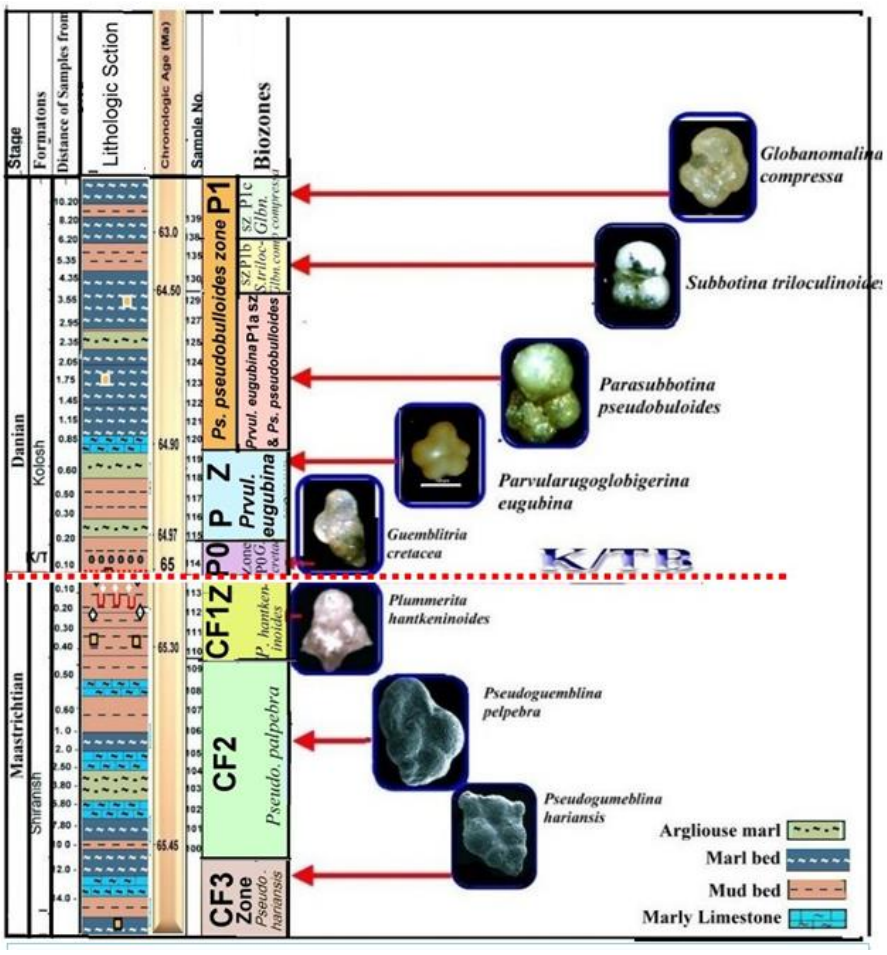

Fig.6: Biostratigraphy of K- Pg of Duhok Dam section, North Iraq

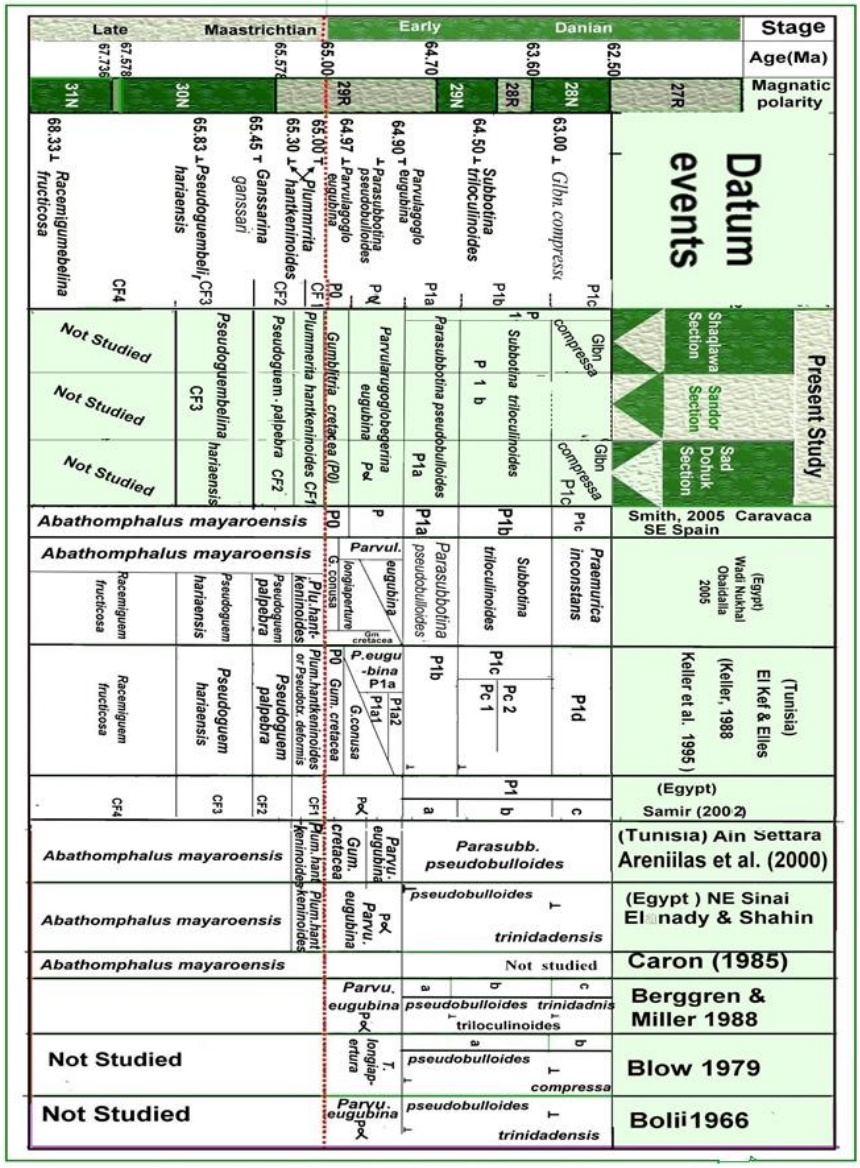

Fig.7: Correlation of the present biostratigraphic zonation with the zonal schemes outside Iraq.

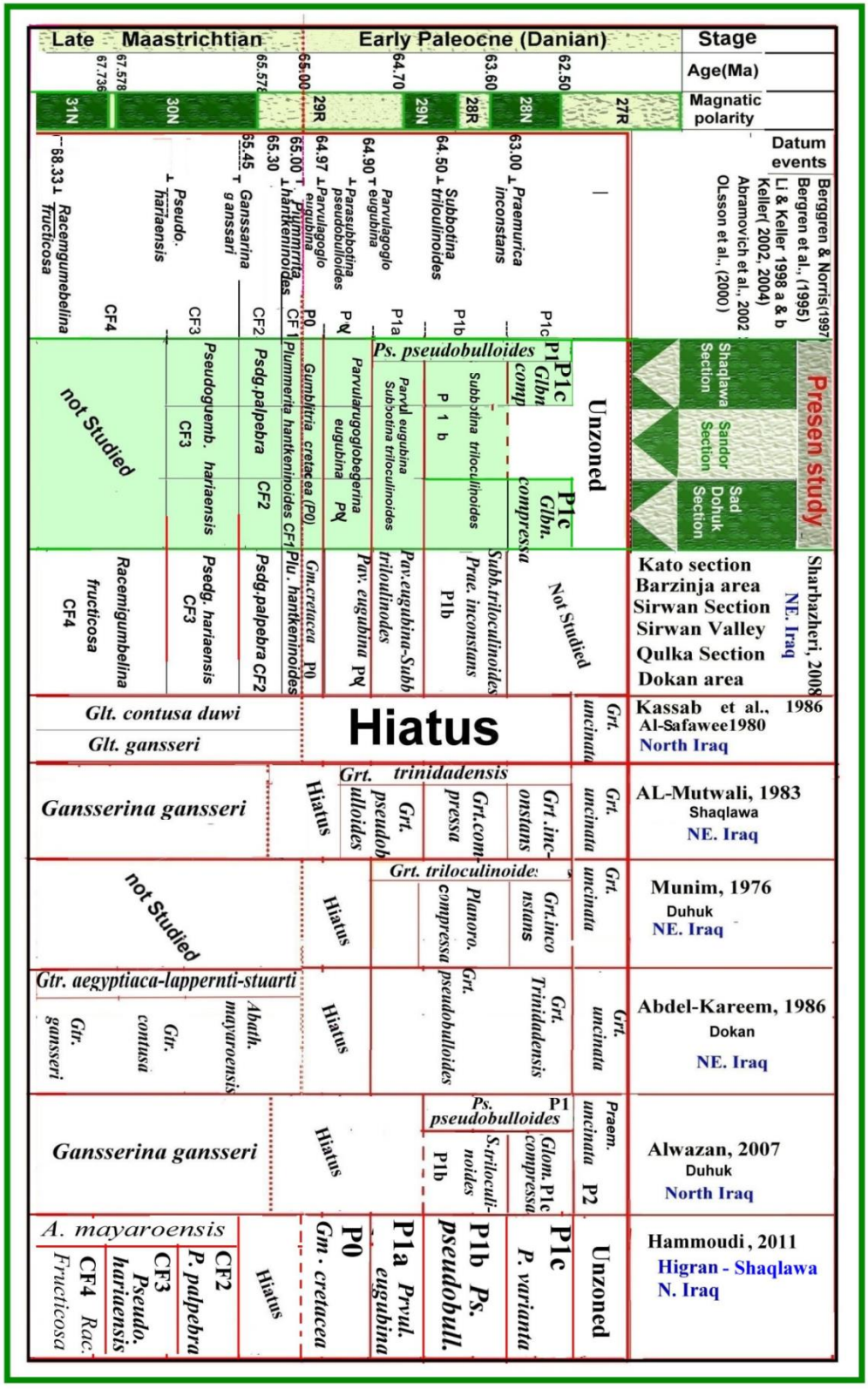

Fig.8: Correlation of the present biostratigraphic zonation with the zonal schemes inside Iraq

Conclusion

1- The present study is concerned with high-resolution biostratigraphy of Cretaceous/ Paleogene (K/Pg) boundary successions exposed at three selected sections (Duhok Dam , Sandour & Shaqlawa sections) in Kurdistan region, northern Iraq. Each section includes the boundary between two widely exposed formations, namely Shiranish (Campanian–Maastrichtian) and Kolosh (Paleocene).

2- Forty-eight planktic foraminiferal species belonging to eighteen genera were recorded from the studied part of the Shiranish Formation, and sixteen species belonging to eight genera are identified from the studied part of the Kolosh Formation.

3-Depending on the geological ranges and relative abundance of identified planktic foraminiferal assemblages, the studied sections along the K/Pg boundary has been precisely divided into into a number of biostratigraphic zones, three biozone (CF3, CF2 & CF1) from the upper Cretaceous and three biozone (P0, Pα, P1) with three subzones (P1a, P1b & P1c)from the lower Paleocene of every section, these zones are (from the older at the base):

6- Parasubbotina pseudobulloides Partial Range Zone (P1).

c-Globanomalina compressa Interval Subzone (P1c).

b-Subbotina triloculinoides Interval Subzone (p1b).

a-Parvulargoglobigerina eugubina—Subbotina triloculinoides Interval Subzone (P1a).

5- Parvulargoglobigerina eugubina Tota Range Zone (pα).

4-Guembelitria cretacea Partial Range Zone (P0).

3-Plummerita hantkeninoides Taxon Range Zone (CF1).

2- Pseudoguemblina palpebra Partial Range Zone (CF2).

1- Pseudoguemblina hariaensis Interval Zone (Part) (CF3).

4- Planktic foraminiferal biostratigraphic evidence suggests that these sections can be regarded as hitherto the most complete K/Pg boundary sections in Iraq, and the Duhok Dam section is the more distinctive section among them.

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Plate -1-

Figs.1,2,3: Guembelitria cretacea Cushman. Figs.4,5,6,7: Globoconusa daubjergensis, (Bröennimann). Figs. 8,9: Parvulagoruglobigerina alabamensis Liu & Olsson.

Figs.10,11,12: *Parvulagoruglobigerina eugubina* (Luterbacher & Premoli- Silva).

Plate-2-

Figs.1,2: *Racemiguembelina powelli* Smith & Pessagno. Figs. 3,4: *Gublerina cuvillieri* Kikoine. Figs.5,6: *Pseudoguembelina costulata* Cushman.Figs.7,8: *Pseudoguembelina cornuta* Seiglie. Figs.9,10: *Pseudoguembelina excolata* (Cushman). Figs.11,12: *Pseudoguembelina hariaensis* Nederbragt.

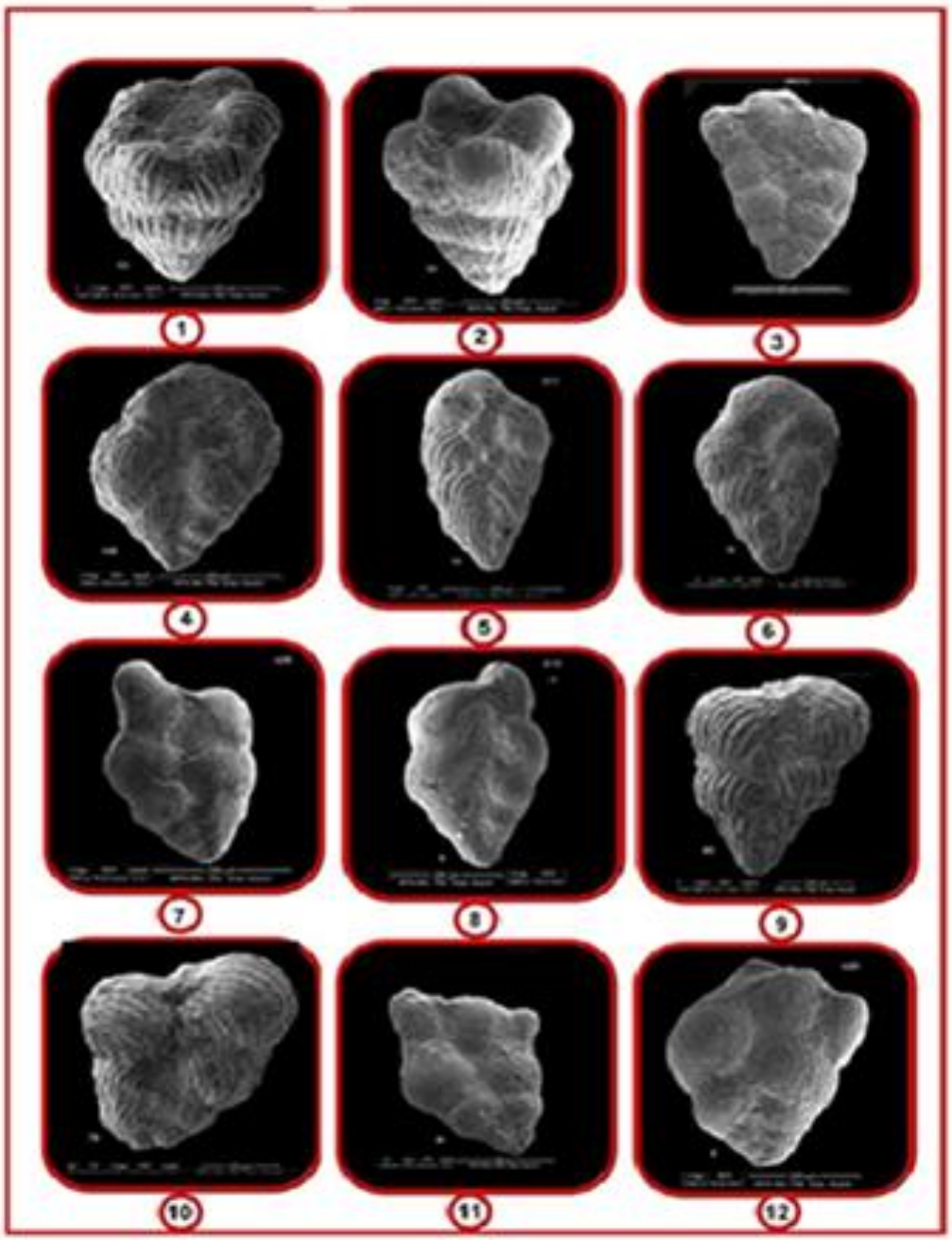

Plate -3-

Figs.1,2,: Pseudoguembelina kempensis Esker, Figs.3,4: Pseudoguembelina palepbra Bronnimann & Brown, Fig. 5: Globigerinelloides prairiehillensis Pessagno, Fig. 6: Globigerinelloides subcarinata (Brönnimann) , Figs.7,8,9,10,11,12: Hedbergella holmdelenesis Olsson.

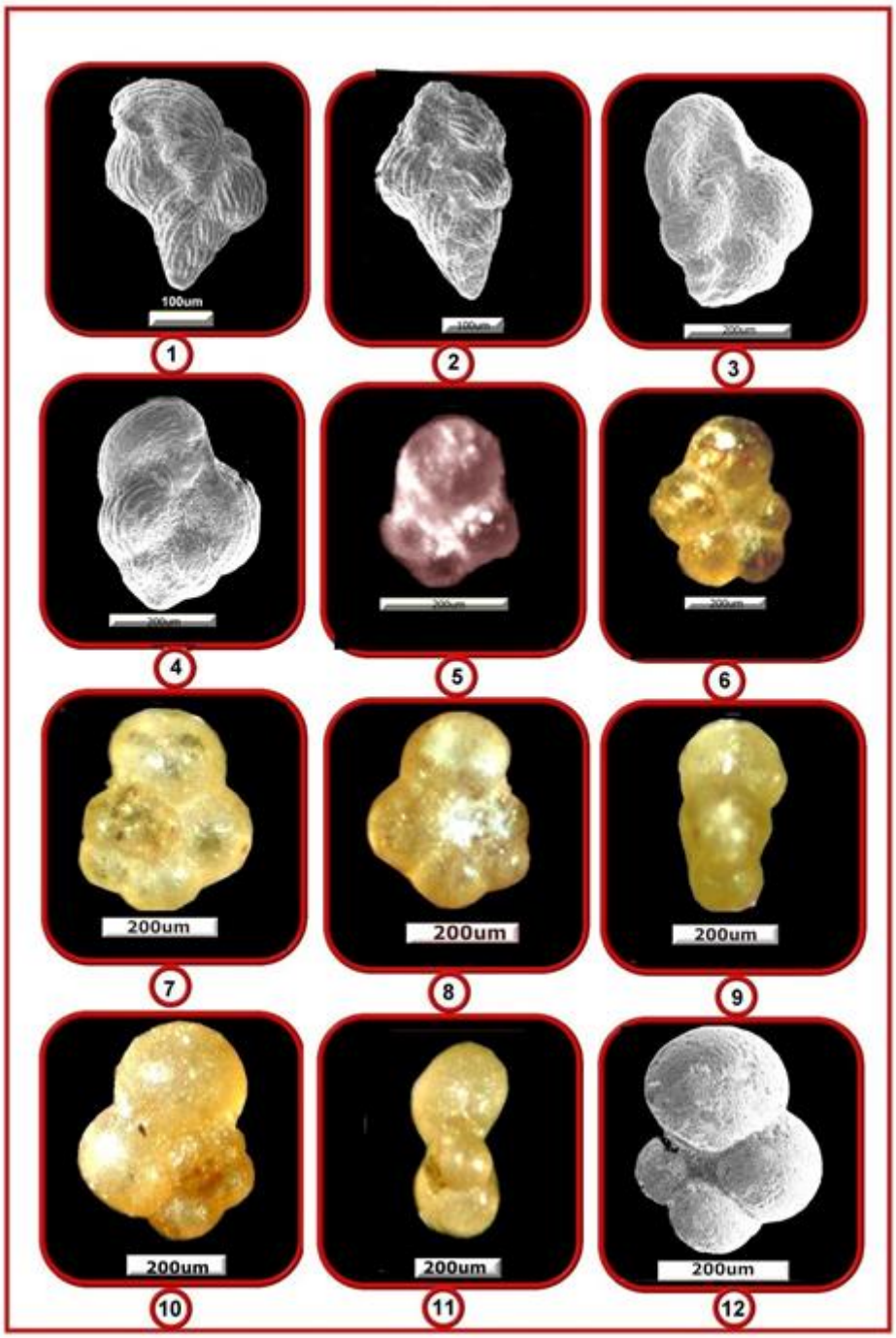

Plate-4-

Fig.1: Globotruncanella petaloidea (Gandolfi). Fig.2: Abathomphalus mayaroensis (Bolli). Figs.3,4,5,6: Plummerita hantkeninoides (Brönnimann). Figs.7,8: Rugoglobigerina reicheli (Brönnmann). Figs.9,10: Rugoglobigerina hexacamerata Brönniman. Figs.11,12: Rugoglobigerina macrocephala Brönnimann.

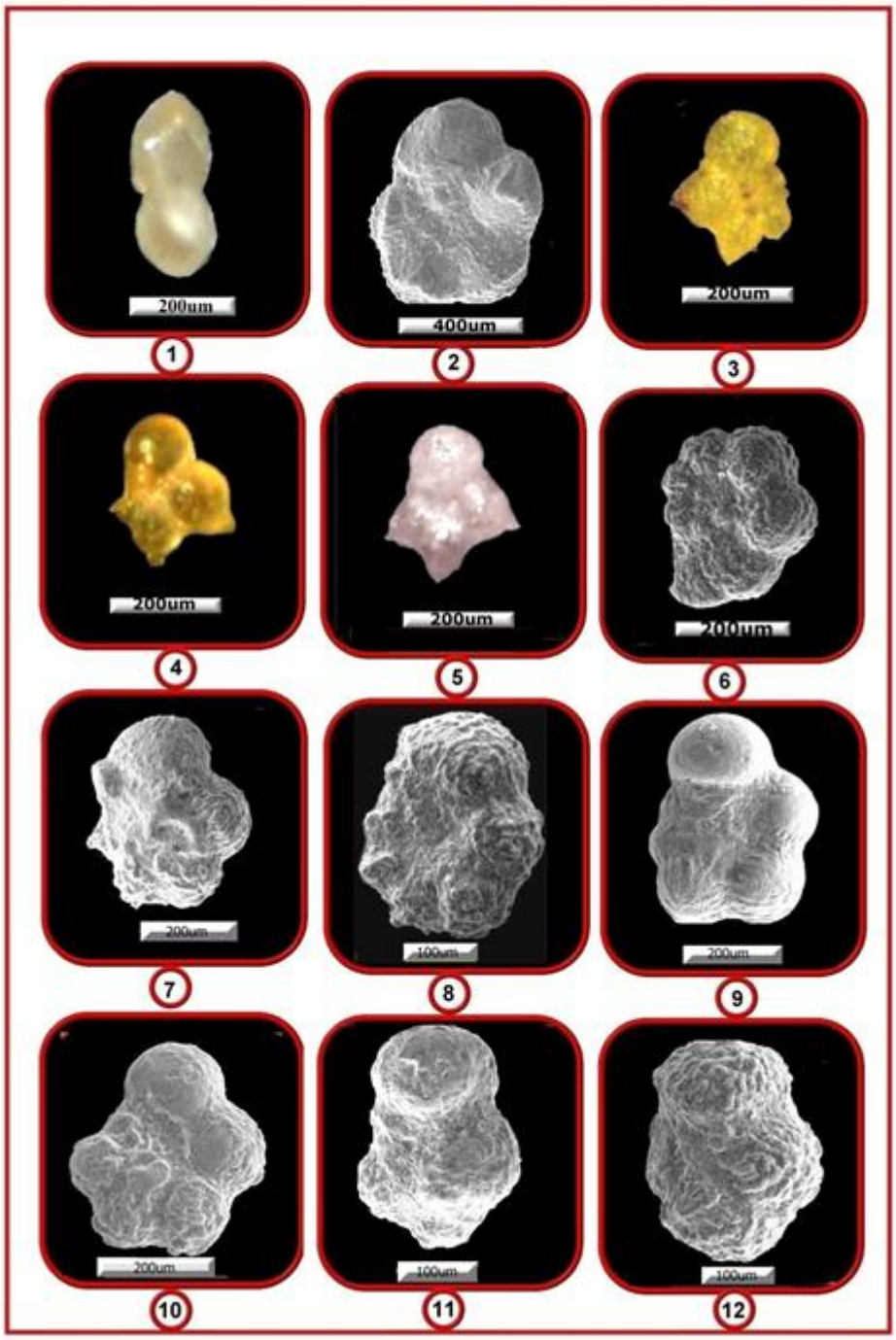
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Plate-5-

Figs.1,2,3: Praemurica pseudoinconstance (Blow,1979). Figs.4,5 : Globanomalina archeocompressa (Blow,1979). Figs.6,7: Globanomalina compressa (Plummer) , Figs.8,9: Globanomalina planocompressa (Shutskaya). Figs.10,11: Eoglobigerina edita (Subbotina). Fig.12 : Subbotina trivialis (Subbotina)

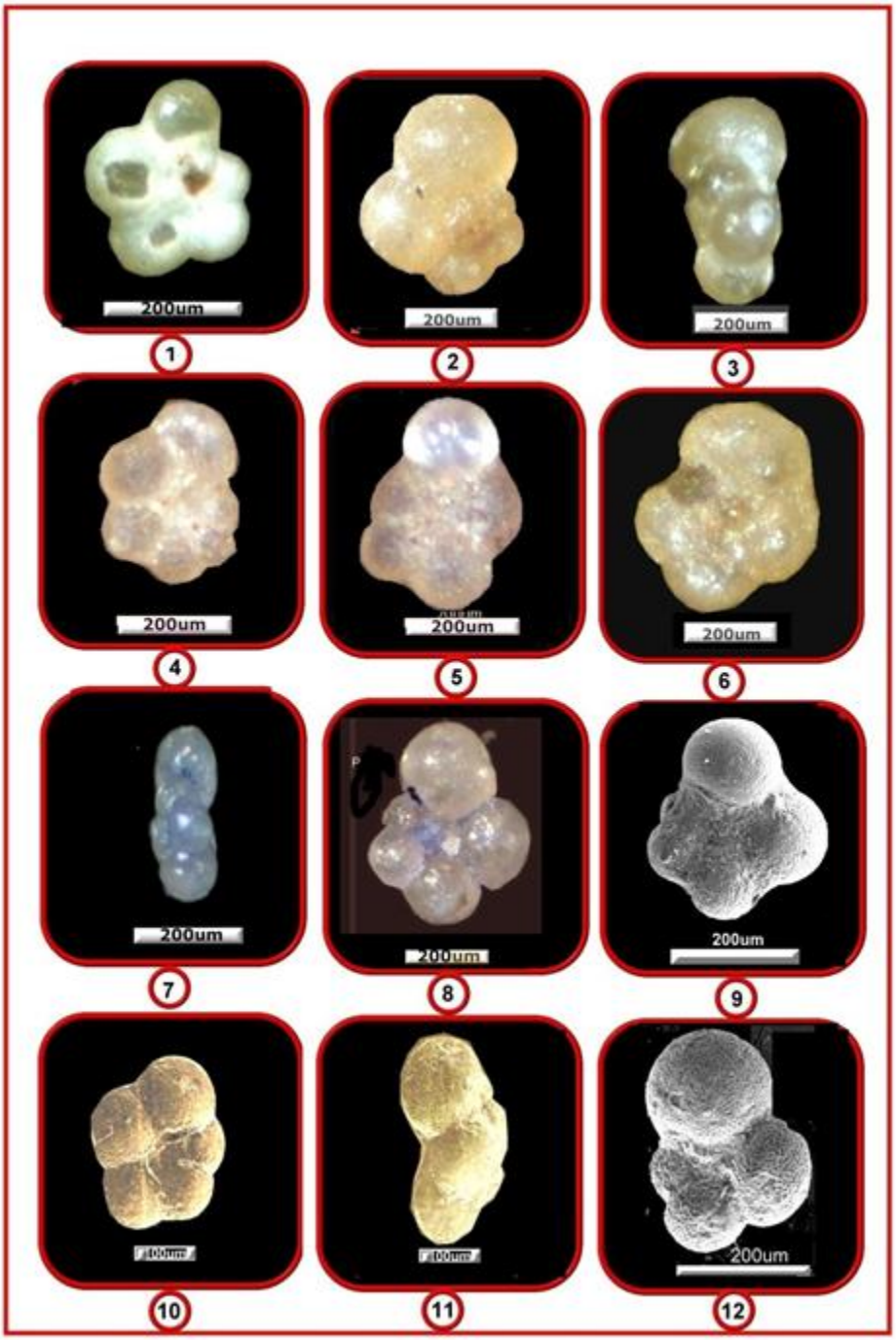
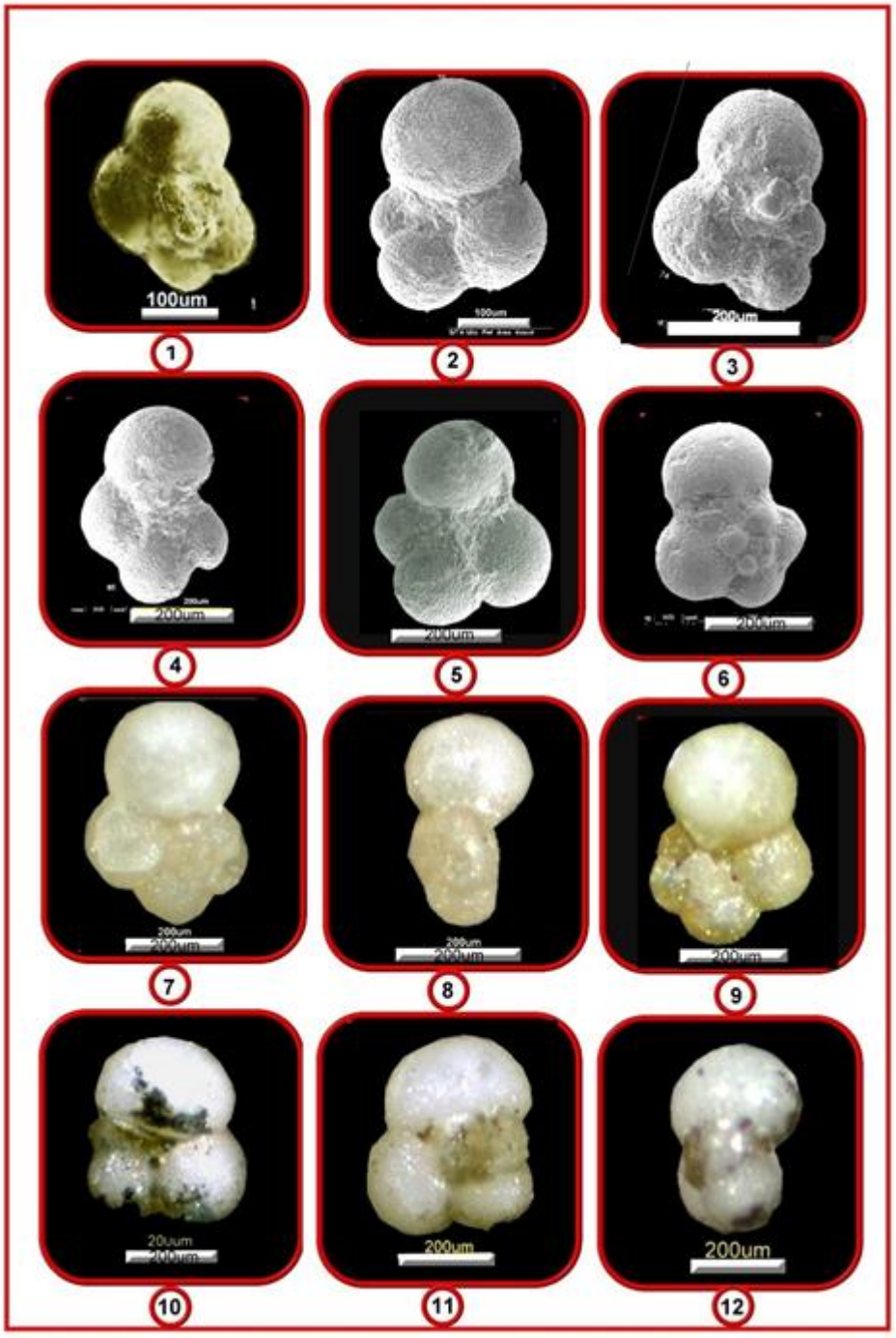


Plate-6-

Figs.1,2,3: *Eoglobigerina eobulloides* (Morozova). Figs.4,5,6: *Parasubbotina* aff. *Pseudobulloides* (Plummer). Figs7,8,9: *Parasubbotina Pseudobulloides* (Plummer). Figs.10,11,12: *Subbotina triloculinoides* (Plummer)



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