ISTANBUL TECHNICAL UNIVERSITY ★ EURASIAN INSTITUTE OF EARTH SCIENCES

PLANKTONIC FORAMINIFERAL EVENTS AND BIOSTRATIGRAPHY OF UPPER CRETACEOUS AND LOWER PALAEOCENE CARBONATES (AKVEREN FORMATION) OF KOCAELI PENINSULA, NW TURKEY

M.Sc. Thesis by
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Department : Climate and Marine Sciences

Programme : Earth System Science

JUNE 2011

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ AVRASYA YER BİLİMLERİ ENSTİTÜSÜ

AKVEREN FORMASYONU (KOCAELİ YARIMADASI, KB TÜRKİYE) ÜST KRETASE VE ALT PALEOSEN KARBONATLARININ PLANKTONİK FORAMİNİFERLERİ VE BİYOSTRATİGRAFİSİ

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SUMMARY

Three stratigraphic sections (Nasuhlar-Bulduk, Belen and Toylar measured sections) covering the Upper Campanian and Palaeocene interval of the Akveren Formation, which is mainly composed of planktonic foraminiferal deep-marine limestones and fine clastics, have been analysed for their planktonic foraminiferal composition and biostratigraphic aspects. A special attention has been paid to the stratigraphic development of assumedly transitional K-Pg boundary beds based on a more detailed study of planktonic foraminifera and some early diagenetic features that led to development of breccia and also iron stained levels just at the top of upper Maastrichtian portion of the sequence. In the studied sections, *Gansserina gansseri*, *Contusotruncana contusa/Racemiguembelina fructicosa* and *Abathomphalus mayaroensis* zones representing Late Campanian-Maastrichtian, *Guembelitria cretacea* (P0), *Parvularugoglobigerina eugubina* (Pα), *Globanomalina compressa*/*Praemurica inconstans* (P1c) *Praemurica uncinata* (P2), *Morozovella angulata/Igorina pusilla* (P3), *Globanomalina pseudomenardii* (P4) zones representing Palaeocene have been recognised. In two of the sections (Nasuhlar-Bulduk and Belen), the succesive zones, P0, Pα, P1a and P1b, representing the earliest Palaeocene have not been recognised suggesting a hiatus at these levels of the Akveren Formation. Palaeontological data and the field observations showing the the development of breccias, with limited lateral extent, and development of iron stained levels, further provide evidence for a hiatus. A hypotetial model is suggested to show the non-uniform depositional conditions during uppermost Maastrichtian and earliest Palaeocene.

Key words: Upper Cretaceous-Palaeocene, Kocaeli Peninsula, planktonic foraminifera, taxonomy, biostratigraphy.

AKVEREN FORMASYONU (KOCAELİ YARIMADASI, KB TÜRKİYE) ÜST KRETASE VE ALT PALEOSEN KARBONATLARININ PLANKTONİK FORAMİNİFERLERİ VE BİYOSTRATİGRAFİSİ

ÖZET

Bu tez kapsamında, Kocaeli yarımadasında geniş yüzlekler veren, ve genel olarak pelajik kireçtaşları ve ince taneli kırıntılıları içeren Akveren Formasyonu'nu temsil eden üç (3) kesitin (Nasuhlar-Bulduk, Belen ve Toylar kesitleri) planktonik foraminifer taksonomisi ve biyostratigrafisi çalışılmıştır. Bu kesitler Akveren Formasyonu'nun sadece Üst Kampaniyen-Mastrihtiyen-Paleosen aralığını temsil etmekte olup bu çalışma kapsamında daha önceki çalışmalarda uyumlu olduğu önerilen K-Pg sınırı detaylı bir şekilde irdelenmiştir. Çalışılan istiflerde Geç Kampaniyen-Mastrihtiyen'i temsil eden *Gansserina gansseri*, *Contusotruncana contusa/Racemiguembelina fructicosa* ve *Abathomphalus mayaroensis* zonları, ve Paleosen'i temsil eden *Guembelitria cretacea* (P0), *Parvularugoglobigerina eugubina* (Pα), *Globanomalina compressa*/*Praemurica inconstans* (P1c) *Praemurica uncinata* (P2), *Morozovella angulata/Igorina pusilla* (P3), *Globanomalina pseudomenardii* (P4) zonları değişik kesitlerde tanımlanmıştır. Her üç kesitte de Geç Mastrihtiyen'i temsil eden biyozonlar tanımlanmış olmakla beraber, iki kesitde (Nasuhlar-Bulduk ve Belen) Erken Paleosen zonlarının (P0, Pα, P1a ve P1b) eksikliği belirlenmiştir. Arazi gözlemleri, biyostratigrafik eksikliğin gözlendiği seviyelerde, istifin Üst Mastrihtiyen'i temsil eden kısımlarında yanal gelişimi sınırlı olan breşik seviyeler ve demirce zengin zonların varlığını göstermektedir. Paleontolojik veriler ve arazi gözlemleri, daha önceki çalışmaların tersine, Kocaeli yarımadasında K-Pg sınırı dolaylarında bazı bölgelerde çökelmezlik olduğunu ortaya koymakta olup bunun gelişimi hipotetik bir model ile açıklanmıştır.

Anahtar kelimeler: Geç Kretase-Paleosen, Kocaeli Yarımadası, planktonik foraminifer, taksonomi, biyostratigrafi.

1. INTRODUCTION

1.1. Purpose of the Study

The goal of this thesis is to analyse the Upper Cretaceous and Lower Palaeocene planktonic foraminiferal fauna and to test the assumed conformable relationship of Cretaceous-Palaeogene boundary in the Kocaeli Peninsula, NW Turkey (Figure 1.1). In addition, a detailed planktonic foraminiferal biostratigraphy of Campanian-Thanetian interval has been established.

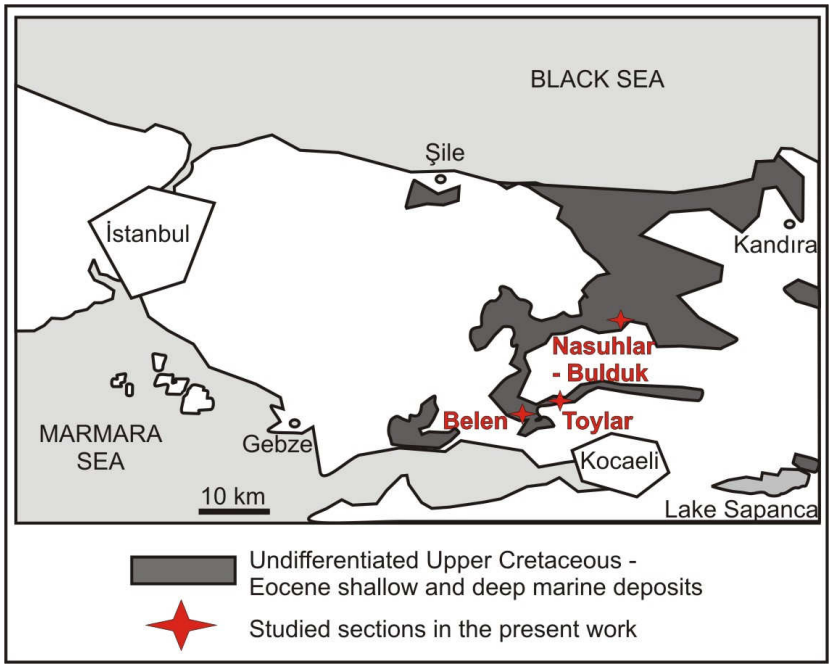


Figure 1.1: Distribution of Upper Cretaceous-Eocene shallow to deep marine clastic and carbonate units in the Kocaeli Peninsula and location of the studied sections (simplified from MTA, 2002).

Three sections covering the Upper Cretaceous-Lower Eocene marine units in Kocaeli Peninsula have been previously measured in the context of project "Upper Cretaceous-Eocene paleogeographic evolution of Kocaeli Peninsula, NW Turkey", project no ITU-BAP-332491, under the supervision of Professor Okan TÜYSÜZ. Since the resolution of sampling intervals in these sections is not high, additional samples have been collected in critical intervals, especially around Upper Cretaceous- Palaeogene boundary. Over 100 samples in three measured stratigraphic

sections have been examined (Figure 1.1), and the study of planktonic foraminifera depends on the analysis of about 150 thin sections.

The high resolution sampling is concentrated at the Cretaceous-Palaeogene boundary, comprises a sampling interval of ca. 10 cm. Mr. Ömer SABUNCU is thanked for his help for his accompany in some of the field trips and collecting the samples.

In addition to the analysis of planktonic foraminifera from thin sections, some indurated limestones samples especially collected from the K-Pg boundary, were processed by using a washing method (acetic acid + chloroform) to obtain free planktonic foraminiferal test. However, both in Cretaceous and Palaeogene, applied method has not been successful to extract planktonic foraminifera from the most of the samples since they contain high percentage of carbonate and are well-cemented. Therefore, the results are solely based on the thin section studies. Besides the palaeontologic analysis and biostratigraphic approaches, some comments have been done on the some sedimentary features (See section 2.3).

Finally, I would like to thank my thesis advisors Prof. Dr. Ercan ÖZCAN and Dr. Aynur HAKYEMEZ for their guidance during the study.

1.2. Previous Studies within the Study Area and Surroundings

1.2.1. A synthesis of lithostratigraphy of Upper Cretaceous – Palaeocene units in Kocaeli Peninsula

Upper Cretaceous-Palaeogene units of the Kocaeli Peninsula have been noticed since the first study of Hommaire de Hell, who discovered the Nummulitic facies (Viquesnel, 1850). The first detailed studies belong to de Tchihatchef (1869), Fitzner (1903), Endriss (1910, 1926), Arabu (1917) and Böhm (1927), providing the first information about the general geological aspects.

The first series lithostratigraphic subdivisions of Upper Cretaceous and Lower Palaeogene has been given by Baykal (1942, 1943), Erguvanlı (1949), Bagdley (1959), Ketin and Gümüş (1963), Altınlı (1968) and Altınlı *et al.* (1970), which are adopted in the current studies.

The studied sections in this thesis belong to Akveren Formation, the first description of which has been given by two different researchs, first in 1959 by Bagdley (crossref. from Gedik and Korkmaz, 1984) and later in 1963 by Ketin and Gümüş, both unpublished reports of different petroleum companies. The following studies have commonly referred to the work of Ketin and Gümüş (1963) to adopt the lithostratigraphic nomenclature. Since the formal description of a lithostratigraphic unit follows specific requirements for its definition (Salvador, 1994), the name for this formation is informal. Şemsettin kireçtaşı (Şemsettin limestone) described by Altınlı (1968) should be considered as the official formation name. However, considering its common use in the previous and current studies, the "Akveren Formation" has been followed in this study. Because of similar reasons same formation name also has been adopted for this unit by Tüysüz *et al.* (2004) in the official report of the Turkish Stratigraphic Comitee.

1.2.2. A synthesis of planktonic foraminiferal biostratigraphy of Upper Cretaceous – Palaeocene units in Kocaeli Peninsula and surrounding regions

The earliest identification of Upper Cretaceous and Palaeocene planktonic foraminifera in the Kocaeli Peninsula dates back to the studies of Baykal (1942, 1943). This has been followed by more comprehensive studies concerning the distribution of planktonic foraminifera and biostratigraphy by Dizer and Meriç (1981), then, Bargu and Sakınç (1987), Tansel (1989a,b), Özer *et al.* (1990), Kırcı and Özkar (1999), Özkan-Altıner and Özcan (1999), Güray (2006) and Özer and Toker (2009) respectively (Table 1.1).

First biostratigraphic zonation was proposed by Dizer and Meriç in 1981, from some Upper Cretaceous-Palaeocene sections in NW Anatolia, showing a conformable relation at the Cretaceous-Palaeogene boundary. These authors demonstrated the presence of Upper Maastrichtian strata based on the identification of *Globotruncana contusa contusa* (now *Contusotruncana contusa*). However, the presence of Early Danian strata in their studied sections is unambiguous as the first planktonic foraminiferal assemblage, *Globorotalia compressa*, *Globorotalia pseudobulloides*, *Globorotalia trinidadensis* suggested to represent the earliest part of the Danian by these authors, in fact, corresponds to the later part of the Danian (P1c Zone, see

Table 1.2). Since the first appearance datum of G*loborotalia* (now *Globanomalina*) *compressa* is observed in P1c Zone (Premoli Silva *et al.* 2003), it is highly possible that the Lower Danian in their sections is missing.

The works of Tansel (1989a,b) suggested that all the planktonic foraminiferal biozones of the Upper Cretaceous and Palaeocene are present at at the close vicinity of Ağva, NE Istanbul. In Palaeocene, she identified *Globigerina* (now *Parvularugoglobigerina*) *eugubina* (see its stratigraphic range in presently used zonation scheme in Table 1.2) as the oldest specied appearing at the K-Pg boundary and correlated the FAD of this species with the base of Danian following the zonation by Premoli Silva and Bolli (1973, see Table 3.3). As the FAD of this species is presently (Table 1.2) placed above the boundary, assumed conformity between the Maastrichtian and the Danian beds cannot be verified.

Özer *et al.* (1990) has also investigated the biostratigraphy of rudist and planktonic foraminifera bearing Upper Cretacous units and planktonic bearing Palaeocene deep marine units, assuming a conformable relation between them. In Upper Cretaceous, the youngest zone is represented by *Gansserina gansseri* Zone is succeded by *Morozovella* (now *Parasubbotina*) *pseudobulloides* Zone in Danian. The absence of *Abathomphalus mayaroensis* Zone in the Cretaceous part of their sections and extended definition of *Morozovella* (now *Parasubbotina*) *pseudobulloides* Zone as to cover whole Danian (see the vertical ranges of this zone in currently used scheme in Table 1.2), do not strictly imply a continuous sedimentation across K-Pg boundary.

Kırcı and Özkar (1999) studied around Cide of Kastamonu region, stating the absence of *Globigerina* (now *Parvularugoglobigerina*) *eugubina* Zone below *Morozovella* (now *Parasubbotina*) *pseudobulloides* Zone. They argued that this zone may have been missed because of the restricted thickness of the unit representing *Globigerina* (now *Parvularugoglobigerina*) *eugubina* Zone, thus the nature of the boundary has been stated as conformable (Table 1.1). They also referred to the work of Tansel-Özkar and Kırcı (1997) at Eastern Pontides to propose the stratigraphic continuity around K-Pg boundary in their section, although these localities are geographically very far away from each other, thus they may not represent the same geological evolution around the boundary.

In 1999, Özkan-Altıner and Özcan examined several sections both at NW Anatolia, including the Kokaksu section, formerly had been studied by Dizer and Meriç (1981). In all of their sections, Upper Cretaceous sequence and the base of the Palaeocene have been suggested to be complete, although *Guembelitria cretacea* and *Parvularugoglobigerina eugubina* zones have not been recorded. In addition, their sampling intervals are very large, as also the authors admit, and also not representative to propose a high resolution perspective, thus a hiatus at K-Pg boundary cannot be ruled out.

Güray (2006) re-examined the Kokaksu section, formerly studied by both Dizer and Meriç (1981) and Özkan-Altıner and Özcan (1999), integrating heterohelicid zonation into the classical globotruncanid zonation. Her biozonation based on Robaszynski and Caron (1995) was established by calibrating the base of Maastrichtian with *Planoglobulina acervulinoides* Zone as the base Maastrichtian, following Odin (2001), Odin and Lamaurelle (2001), Odin and the Maastrichtian Working Group Members (2001). She suggested that the Upper Cretaceous is complete since *Pseudoguembelina hariaensis* and *Abathomphalus mayaroensis* zones (Table 1.1) have been recognized. She commented that the K-Pg boundary is continuous although her study does not cover the Palaeocene interval and no data have been shown for this time interval.

The most recent biostratigraphic study of the Upper Cretacous sequence in the Bartın region in NW Anatolia has been carried out by Özer and Toker (2009). Their results suggest a continuous sedimentation during the Upper Cretaceous since the biostratigraphic zones representing the Campanian-Maastrichtian time interval have been illustrated. No comment about the nature of K-Pg boundary has been given as Palaeocene has not been included in their study.

Table 1.1: The correlation of previously established biostratigraphic scheme in Kocaeli Peninsula and surrounding regions with present study and currently the most widely used zonation in Tethys. The question marks denote the poor planktonic foraminiferal data to establish the zonation. FAD: first appearance datum, LAD: last appearance datum.

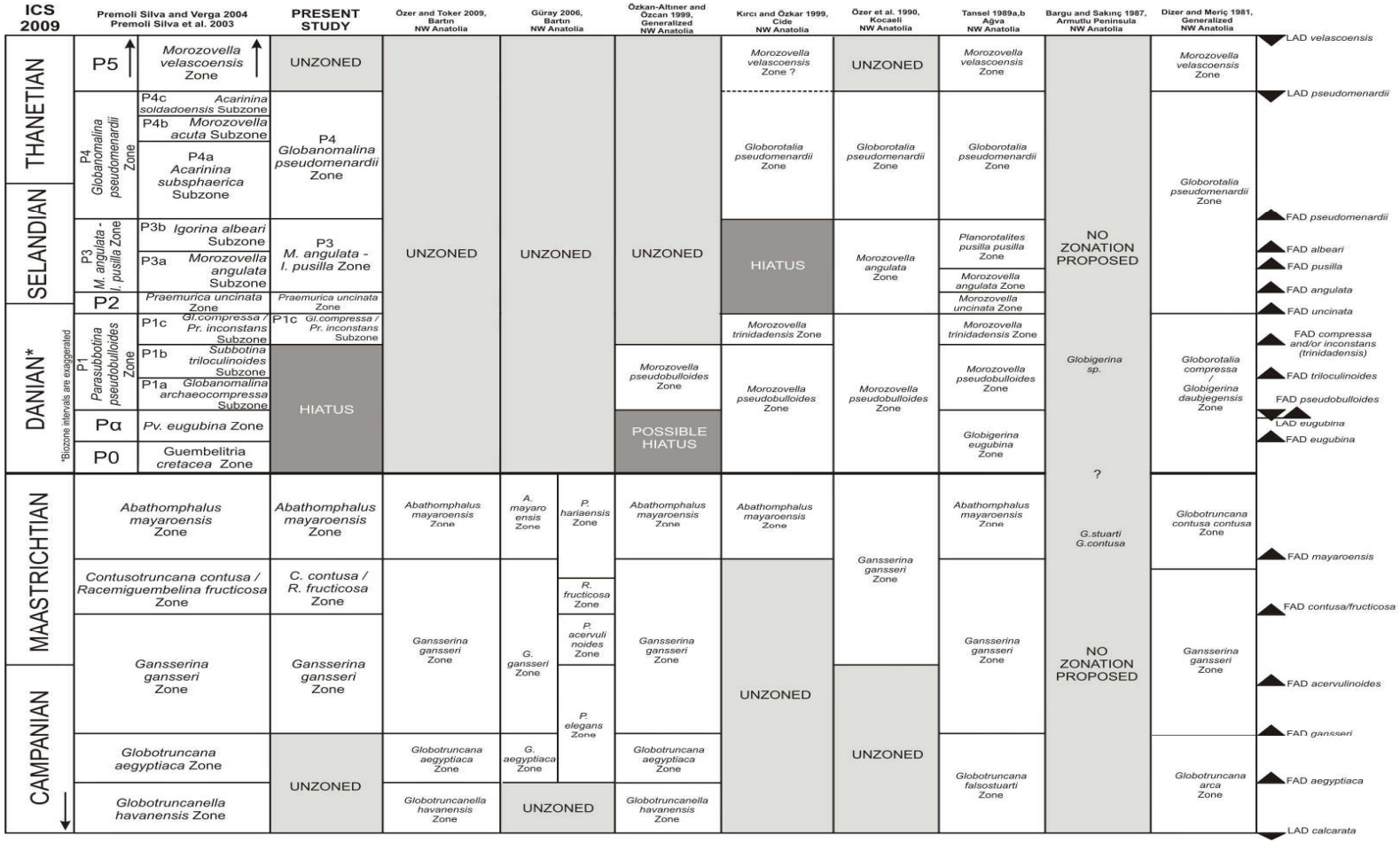
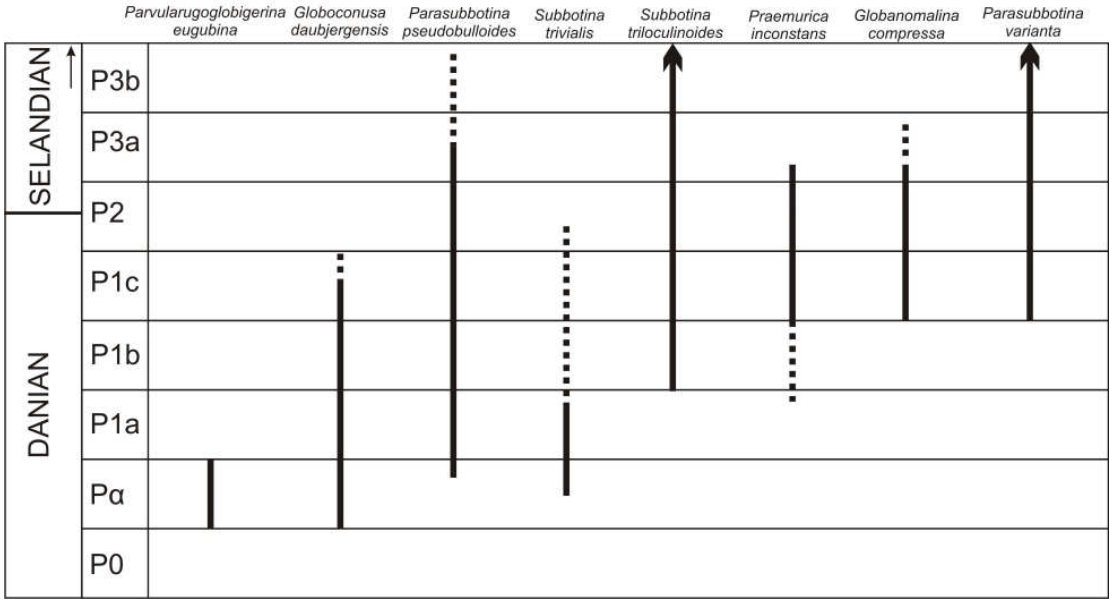


Table 1.2: Distribution of selected Danian – Selandian planktonic foraminifera and biozonation by Olsson *et al.* (1999) and Premoli Silva *et al.* (2003). Dashed lines indicate uncertain occurrences. The first appearance datum of most taxa follows P0. For the explanation of abbreviations of the zones, see Table 1.1.



Up to Özkan-Altıner and Özcan (1999), planktonic foraminiferal biozonations established for Upper Cretaceous and Palaeocene in Kocaeli Peninsula and surrounding regions are based on the works of Bolli (1966), Postuma (1971), van Hinte (1972), Premoli Silva and Bolli (1973), Robaszynski *et al.* (1984) for Cretaceous (Table 3.1 and 3.2) and of Luterbacher and Premoli Silva (1964), Bolli (1966) and Toumarkine and Luterbacher (1985) for Palaeocene (Table 3.3 and 3.4). The recalibrated and recent biozonation of Robaszynski and Caron (1995), which also comprises the recalibration of Campanian-Maastrichtian boundary, is first mentioned in Özkan-Altıner and Özcan (1999), but also adopting earlier works. The recent work of Özer and Toker (2009) is also based on the biostratigraphic model of Robaszynski and Caron (1995).

2. STRATIGRAPHY AND STUDIED SECTIONS

2.1. Stratigraphy of Upper Cretaceous and Lower Palaeogene Units in Kocaeli Peninsula

The pre-Upper Cretaceous units in Kocaeli Peninsula are represented by Palaeozoic to Lower Cretaceous units which are out of the scope in this study (Figure 2.1 and 2.2). These units are, in general, constituted of various lithologies from shallow marine clastics to carbonates and deep water sediments. The first remarkable unit overlying Palaeozoic and Mesozoic units, and very widespread in the Pontides including the Kocaeli Peninsula, is a volcanoclastic unit known as Yemişliçay Formation (Figure 2.2). This Late Cretaceous aged unit is composed of continental and fluvial deposits at its lower part and a thick flysch sequence consisting of fine to coarse clastics with volcanic intervals at its main development (Figure 2.2).Yemişliçay Formation is overlain by Akveren Formation which is mainly a planktonic foraminifera-bearing deep marine unit. This unit is represented by beige to pink coloured pelagic limestones and turbiditic levels (Figure 2.2). The upper part which corresponds to Palaeocene is more marly and grades into the fine clastics and calciturbidites. The carbonates in the Akveren Formation, a part of which is a subject of this study, are light coloured, thick to medium bedded and the fine clastics, grey to green coloured at its upper part, are represented by medium to thick bedded and locally massif shales, marls and turbiditic beds. The Eocene contains more diverse facies including the shallow marine carbonates, fine clastics and sandstones, which are Şile, Çaycuma and Yunuslubayır formations, respectively (Özcan, 2010) (Figure 2.2).

2.2. Description of the Sections

This study is based on three sections, which are Nasuhlar-Bulduk, Belen and Toylar, studied from the Akveren Formation at two different localities in the Kocaeli Peninsula, NW Turkey, (Figure 2.1). Belen and Toylar sections are geographically close to each other ca. 10 km and Nasuhlar-Bulduk, located to the north of these

sections, is about ca. 30 km away from them. The lithology of the examined sections is made of carbonates, with the dominance of indurated pelagic limestones, and also with different facies such as marl with intercalated calciturbidite layers, especially in Palaeocene. The investigated part of Akveren Formation is composed of a monotonous sequence of pelagic limestones. Thus, in the field, the Upper Cretaceous part of the sequence is hardly differentiated from the Lower Palaeocene. However, the presence of brecciated zone in the upper part of the Cretaceous sequence, which is locally developed and with a restricted lateral extent, may be used to place the disconformable boundary between the Maastrichtian and Danian beds. Additionaly, in uppermost part of Maastrichtian beds, just below the Danian strata, the carbonates are represented by ferrigenous-rich levels which gives a pinkish colour to the rock. This may be a helpful physical tool to differentiate the top of Maastrictihan. Description of each section and their planktonic foraminiferal biostratigraphy are given below.

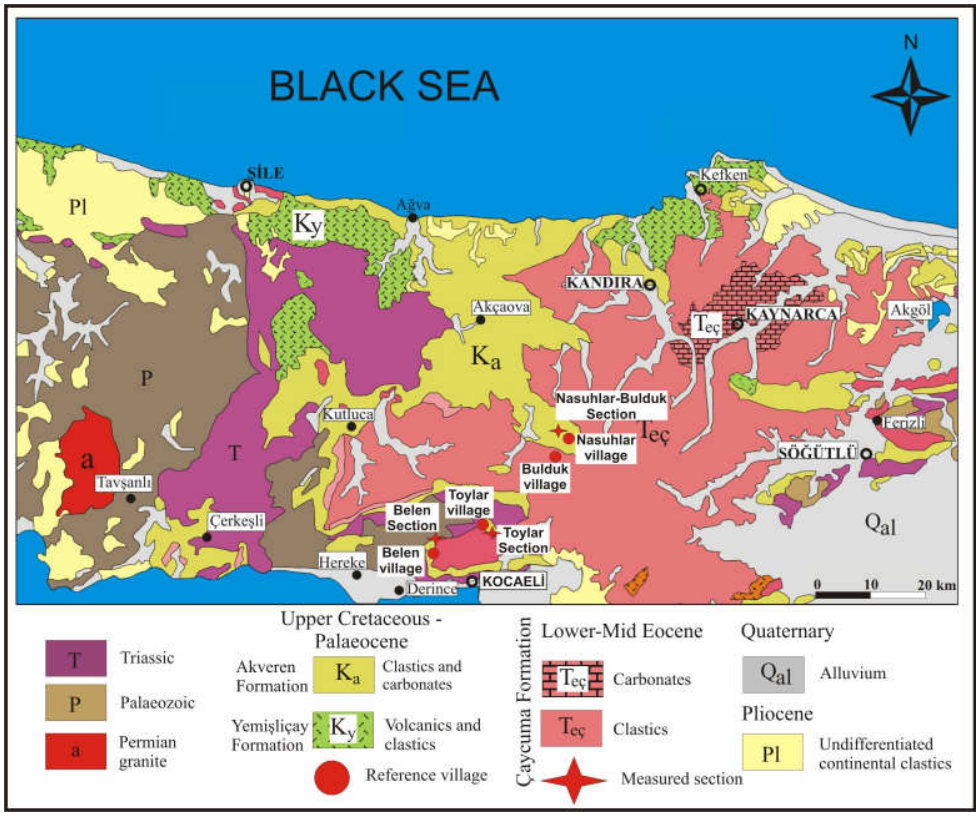


Figure 2.1: Distribution of Upper Cretaceous to Lower Palaeogene units in Kocaeli Peninsula and position of studied sections. Map simplified by Özcan (2010) from various sources.

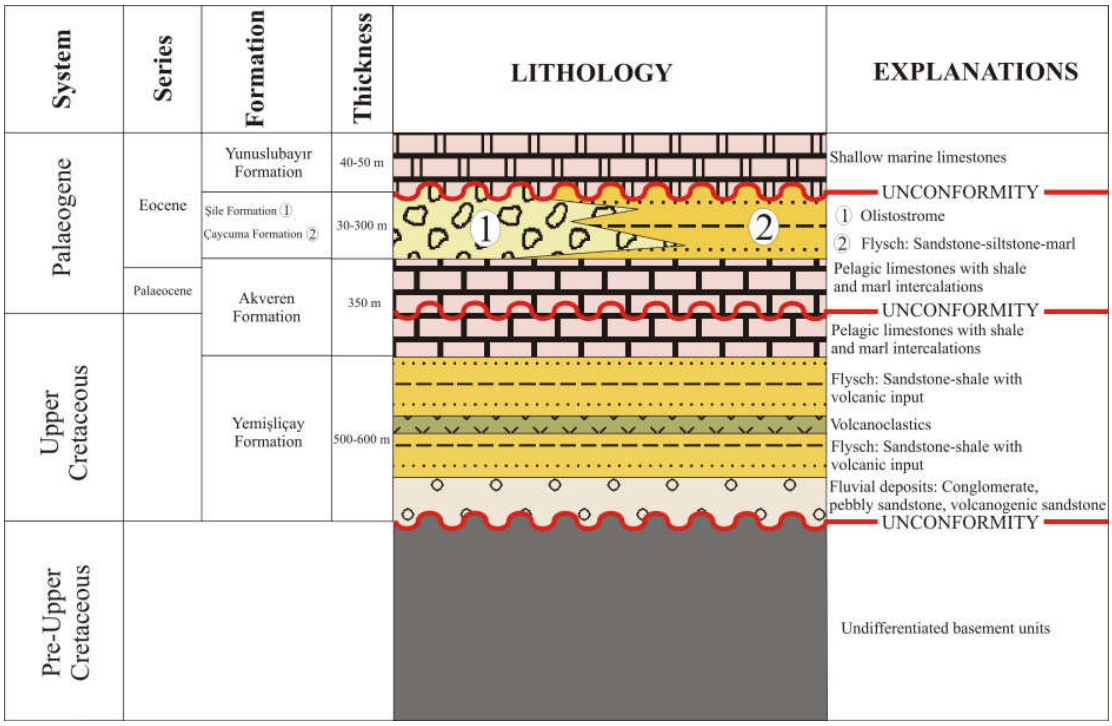


Figure 2.2: Generalized stratigraphic section of Upper Cretaceous to Palaeogene units in Kocaeli Peninsula. Pre-Upper Cretaceous units are considered as basement units in this study. Section simplified from Özcan (2010), who also adopted it from various sources.

2.2.1. Nasuhlar-Bulduk section

Nasuhlar-Bulduk section is located at the middle of the Kocaeli Peninsula (Figure 2.1), north of the Nasuhlar village. The section consists of a 39 m-thick monotonous sequence of pelagic limestones in Upper Cretaceous and pelagic limestones, marls and calciturbidites in the Palaeocene (Figure 2.3). The Upper Cretaceous part of the section is about 7 m-thick, with its lower part characterized by medium to thick bedded, cream to beige coloured pelagic limestones which grade into medium-bedded, cream to reddish coloured levels (Figures 2.4 and 2.5). The interpretation of the development of breccia zone and the reddish colour in connection with hardground formation is given in section 2.3. The Lower Palaeocene beds are represented by beige coloured, medium-bedded, pelagic limestones at its lower part and medium-bedded, beige to green coloured marls with calciturbidite intercalations, consisting of a rich Upper Thanetian larger benthic foraminifera, such as orthophragmines and nummulitids (see Figure 2.3 for the composition).

The almost all levels studied from the Akveren Formation in this section contain a rich association of planktonic foraminifera. In the Upper Cretaceous part of the

section the planktonic genera are represented by *Contusotruncana*, *Globotruncana*, *Globotruncanella*, *Globotruncanita*, *Kuglerina*, *Macroglobigerinelloides*, *Planoglobulina*, *Pseudotextularia*, *Racemiguembelina*, *Rugoglobigerina* and *Trinitella* in the Palaeocene part by *Acarinina*, *Globoconusa*, *Globanomalina*, *Morozovella*, *Parasubbotina*, *Praemurica* and *Subbotina* (see Figures 2.3 and 2.5 for a complete list of species identified).

In the Cretaceous part of the Akveren Formation, the presence of *Contusotruncana contusa* and *Racemiguembelina fructicosa* and the absence of *Abathomphalus mayaroensis*, permits us to recognize the *Contusotruncana contusa-Racemiguembelina fructicosa* zone, characterising the "lower to mid Maastrichtian". In the Palaeocene part, the presence of the P1c Zone marker, *Globanomalina compressa*, together with other P1 Zone species, indicates an unconformable relation between the Danian and Maastrichtian levels. The first appearance of the *Preamurica uncinata*, the zonal marker of the P2 Zone, is in sample 13 (Figure 2.3). The P3 Zone is determined by the co-appearances of zonal markers such as *Morozovella angulata* and *Morozovella conicotruncata*, first appearances of which correspond to the base and lower part of P3 Zone, respectively. A precise zonal boundary cannot be placed between P3 Zone and P4 Zone because of wide sampling interval. The presence of the P4 Zone is confirmed by the appearance of *Morozovella occlusa*, an auxillary marker for the zone, accompanied by other taxa such as *Morozovella velascoensis* and *Acarinina* sp. This zone could not be subdivided, as the other marker taxa cannot be identified at species level. The taxonomy of the identified species is given in systematics section.

2.2.2. Belen section

Belen section is located at the southern part of the Kocaeli Peninsula (Figure 2.1), north of the Belen village. The section consists of a 200 m-thick monotonous sequence of pelagic limestones, with few intercalations of calciturbidites in the upper part (Figure 2.6). The Upper Cretaceous part of the section is about 100 m-thick and is characterized by medium to thick bedded, cream to beige coloured pelagic limestones which ends up with reddish coloured levels (Figure 2.8). The development of the reddish colour and the hardground is discussed in section 2.3.

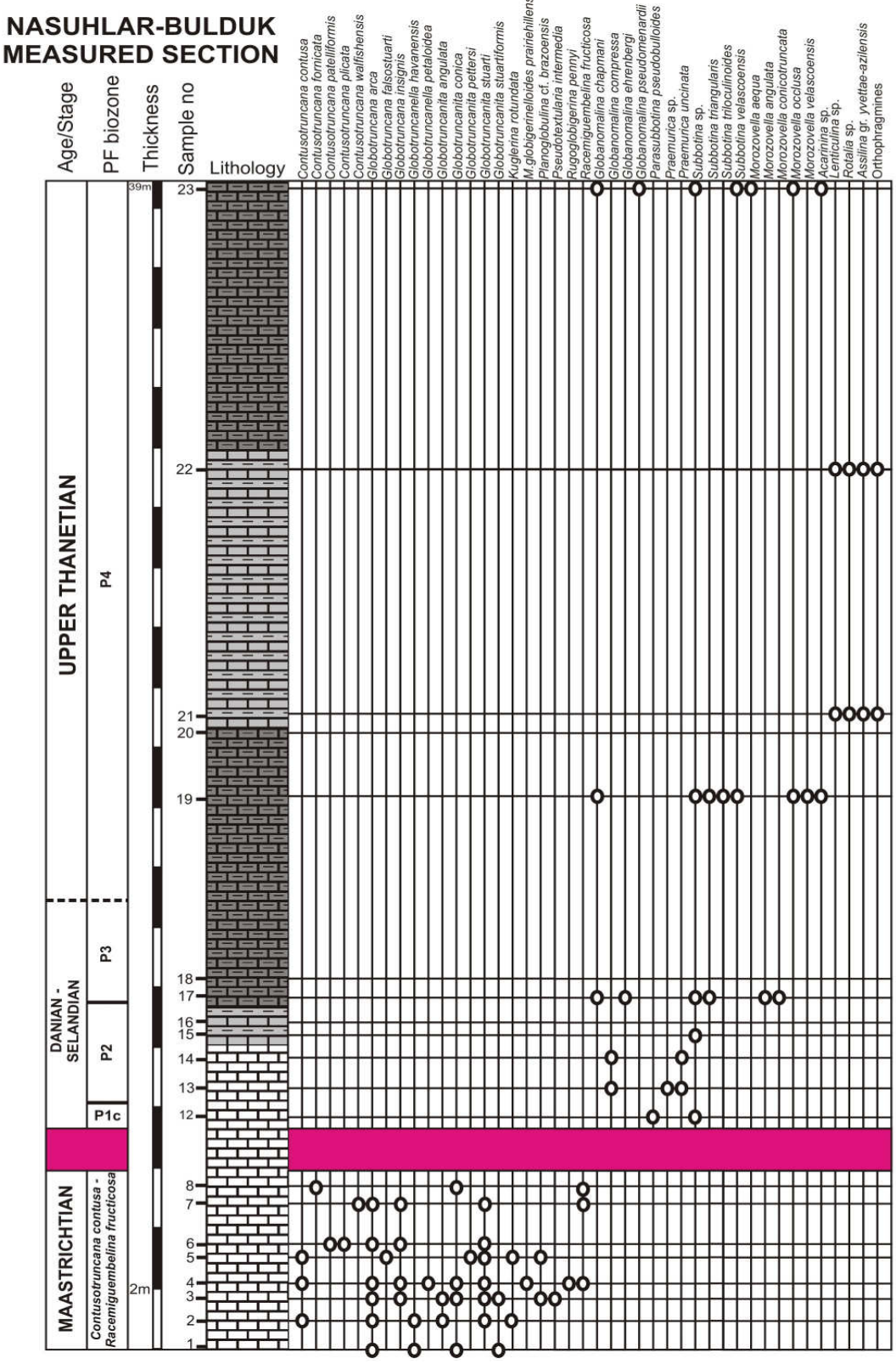


Figure 2.3 : Lithology, distribution of planktonic foraminifera and biostratigraphy of Nasuhlar-Bulduk section. Upper part of the Cretaceous and the lowermost part of the Palaeocene is detailed in Figure 2.5 (interval shown by pink colour).The taxa in the detailed part is not presented here and shown in Figure 2.5. See also Figure 2.5 for the legend.

Figure 2.4 : Field aspects of Nasuhlar-Bulduk section (below). This figure represents only a part of the measured section between sample 8 and 16. Details of the brecciated zone in Maastrichtian just below unconformably overlying Danian beds are shown in the figure above. The marker pen denotes the unconformity surface. Details of the stratigraphy of the portion enclosed is shown in Figure 2.5.

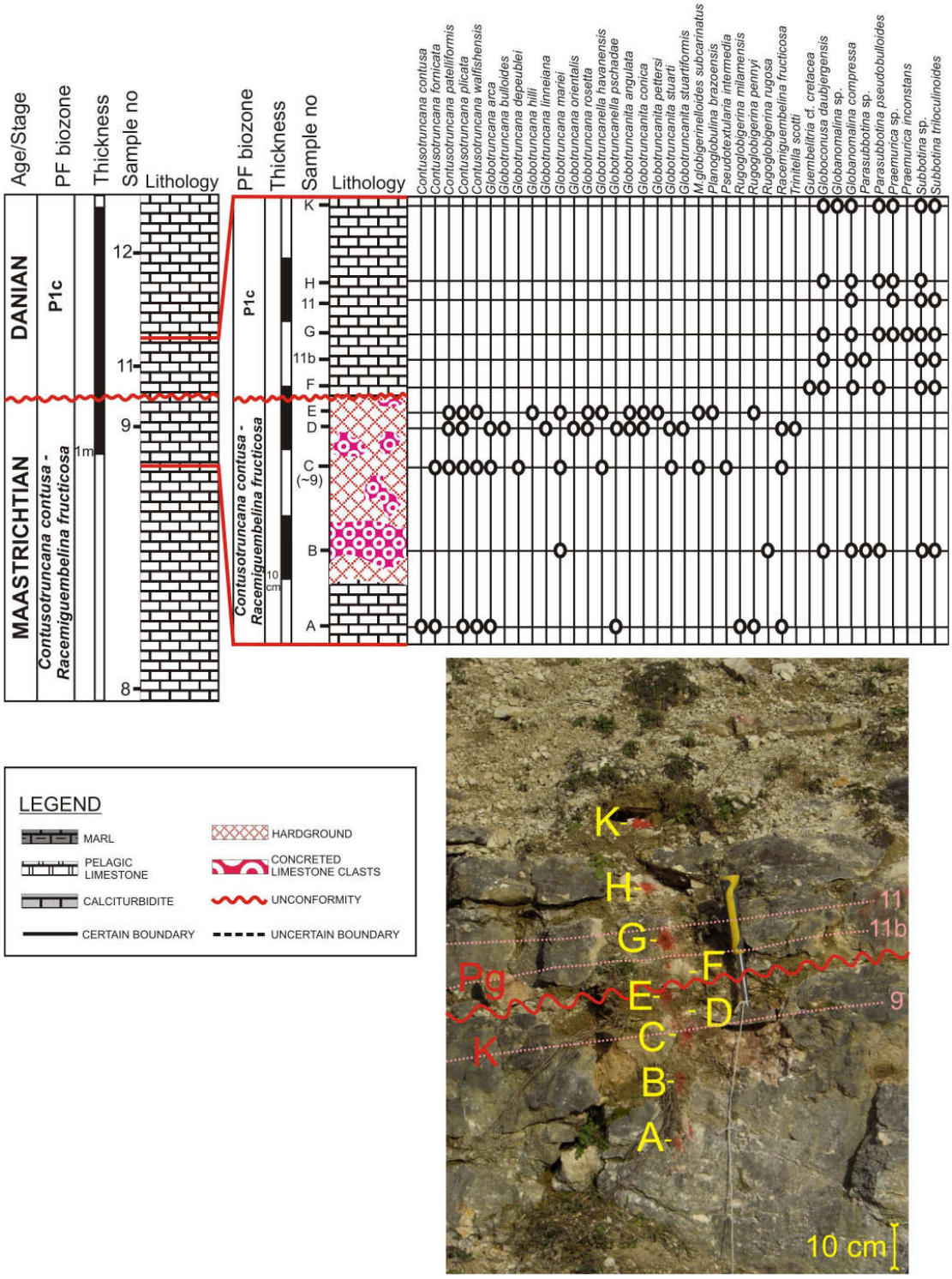


Figure 2.5 : The distribution of planktonic foraminifera just detailed for uppermost part of the Maastrichtian and unconformably overlying Danian in Nasuhlar-Bulduk section (See Figure 2.3 for the general section). Sample C in the right column tentatively corresponds to sample 9 in the left column. The field aspects of the lithology and location of the samples at exposure are shown in the photo. The brecciated zone at the top of the Maastrichtian corresponds to the interval between samples B and E.

The Lower Palaeocene sequence is also thick as Cretaceous part (~100 m), and is represented by beige coloured, medium-bedded, pelagic limestones at its lower portion and pelagic limestones and calciturbidites at its upper part. The calciturbidites contain a rich Upper Thanetian larger benthic foraminifera, such as orthophragmines and nummulitids (see Figure 2.6 for the composition).

The planktonic foraminifera occur equally abundant both in Upper Cretaceous and Lower Palaeocene part of the section. In the Upper Cretaceous part of the section the planktonic genera are represented by *Abathomphalus, Contusotruncana, Globotruncana, Globotruncanella, Globotruncanita, Heterohelix, Kuglerina, Macroglobigerinelloides, Planoglobulina, Pseudotextularia, Racemiguembelina, Rugoglobigerina* and *Trinitella* and in the Palaeocene part by *Globanomalina, Globoconusa, Igorina, Morozovella, Parasubbotina, Praemurica* and *Subbotina* (see Figures 2.6, 2.7 and 2.8 for a complete list of species identified).

In the Upper Cretaceous part of this section, the *Gansserina gansseri* Zone is recognized by the presence of auxillary zonal markers *Globotruncanita angulata* and *Rugoglobigerina milamensis* and the zonal marker *Gansserina gansseri,* which appears only in the higher part of the zone. The successive first appearances of *Racemiguembelina fructicosa* and *Abathomphalus mayaroensis* in the section permits us to recognize the *Contusotruncana contusa-Racemiguembelina fructicosa* Zone, characterising the "lower to mid Maastrichtian". The first appearance of *Abathomphalus mayaroensis* in the sample C (Figure 2.8) determine the base of *Abathomphalus mayaroensis* Zone, which refers to the upper part of the Maastrichtian. In the lowermost of the Palaeocene, *Globanomalina compressa,* the first appearance of which characterizes the base of P1c Zone is determined. This suggests that the planktonic foraminiferal zones below P1c are missing, thus, we suppose that Danian beds unconformably overlie the Upper Cretaceous sequence (Figure 2.8). P2 Zone is determined by the first appearance of *Morozovella praeangulata*, an auxillary marker, in sample 14-7 (Figure 2.7) where its first appearance datum is correlated with the base of P2 Zone (Premoli Silva *et al.* 2003), whereas the zonal marker *Praemurica uncinata* appears in sample 14-8 (Figure 2.7). The P2+P3 zonal boundary could not be identified due to the absence of the marker species in our samples, but the presence of *Subbotina velascoensis* signifies the presence of P3 Zone at sample 14-10. As the sampling interval in this part is wide,

the P3 Zone has not been subdivided. The association of *Morozovella occlusa*, a characteristic taxon of the P4 Zone, and the zonal marker *Globanomalina pseudomenardii*, indicates the P4 Zone. The upper boundary of P4 Zone could not be identified due to scarcity of marker species. Some Thanetian larger benthic foraminifera, obtained from calciturbidite layers such as *Discocyclina seunesi* cf. *karabuekensis*, *Orbitoclypeus multiplicatus haymanaensis* and *Orbitoclypeus schopeni ramaraoi* suggest that these layers are of in Late Thanetian in age (Figure 2.6, Plate 14). The taxonomy of the identified planktonic foraminifera is given in systematics section.

2.2.3. Toylar section

Toylar section located at southern part of the Kocaeli Peninsula to the southeast of the Toylar, to the northeast of the Belen villages (Figure 2.1). The section consists of a 135 m-thick monotonous sequence of pelagic limestones in the Upper Cretaceous and pelagic limestones, marls and a calciturbidite layer in the Palaeocene (Figure 2.9). The Upper Campanian-Maastrichtian part of the Cretaceous is about ~102 m-thick and is characterized by medium to thick bedded, white to beige coloured pelagic limestones. The Lower Palaeocene beds are represented by beige coloured, medium-bedded, pelagic limestones and medium-bedded, beige to green coloured marls with calciturbidite intercalations, containing a rich Upper Thanetian larger benthic foraminifera, such as orthophragmines and nummulitids (see Figure 2.9 for the composition) in a single layer.

In the Upper Campanian-Maastrichtian part of the section the planktonic foraminifera are represented by *Abathomphalus, Contusotruncana, Globotruncana, Globotruncanella, Globotruncanita, Heterohelix, Kuglerina, Macroglobigerinelloides, Planoglobulina, Pseudotextularia, Rugoglobigerina, Racemiguembelina* and *Trinitella* and in the Palaeocene part by *Acarinina, Globanomalina, Globoconusa, Guembelitria, Igorina, Morozovella, Parasubbotina, Parvularugoglobigerina, Praemurica, Subbotina*, and *Woodringina* (see Figures 2.9 and 2.10 for a complete list of species identified).

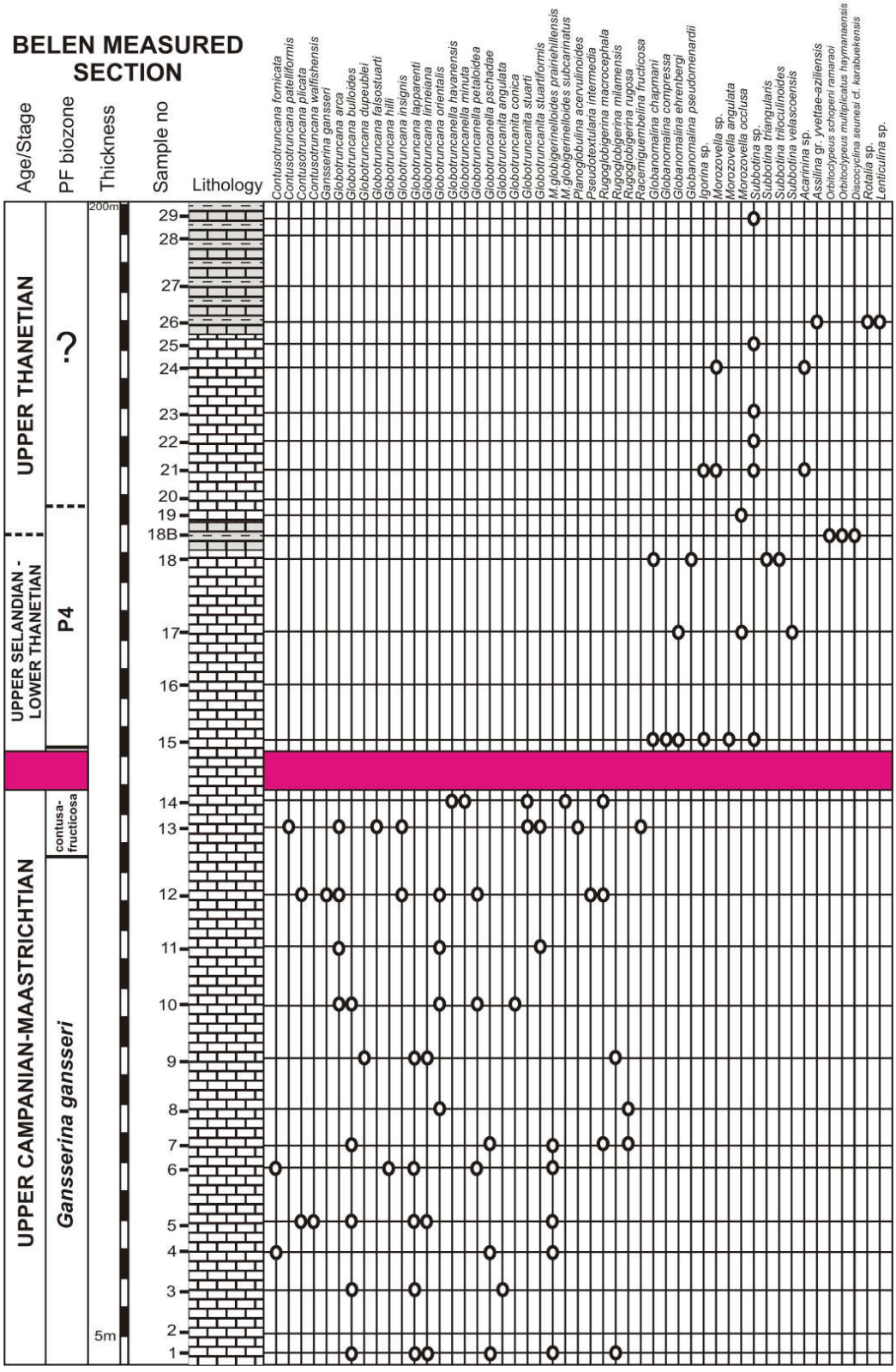


Figure 2.6 : Lithology, distribution of planktonic foraminifera and biostratigraphy of Belen section. Upper part of the Cretaceous and the lowermost part of the Palaeocene is detailed in Figure 2.7 (interval shown by pink colour) and Figure 2.8. The taxa in the detailed part is not given here and shown in Figures 2.7 and 2.8. See Figure 2.5 for the legend.

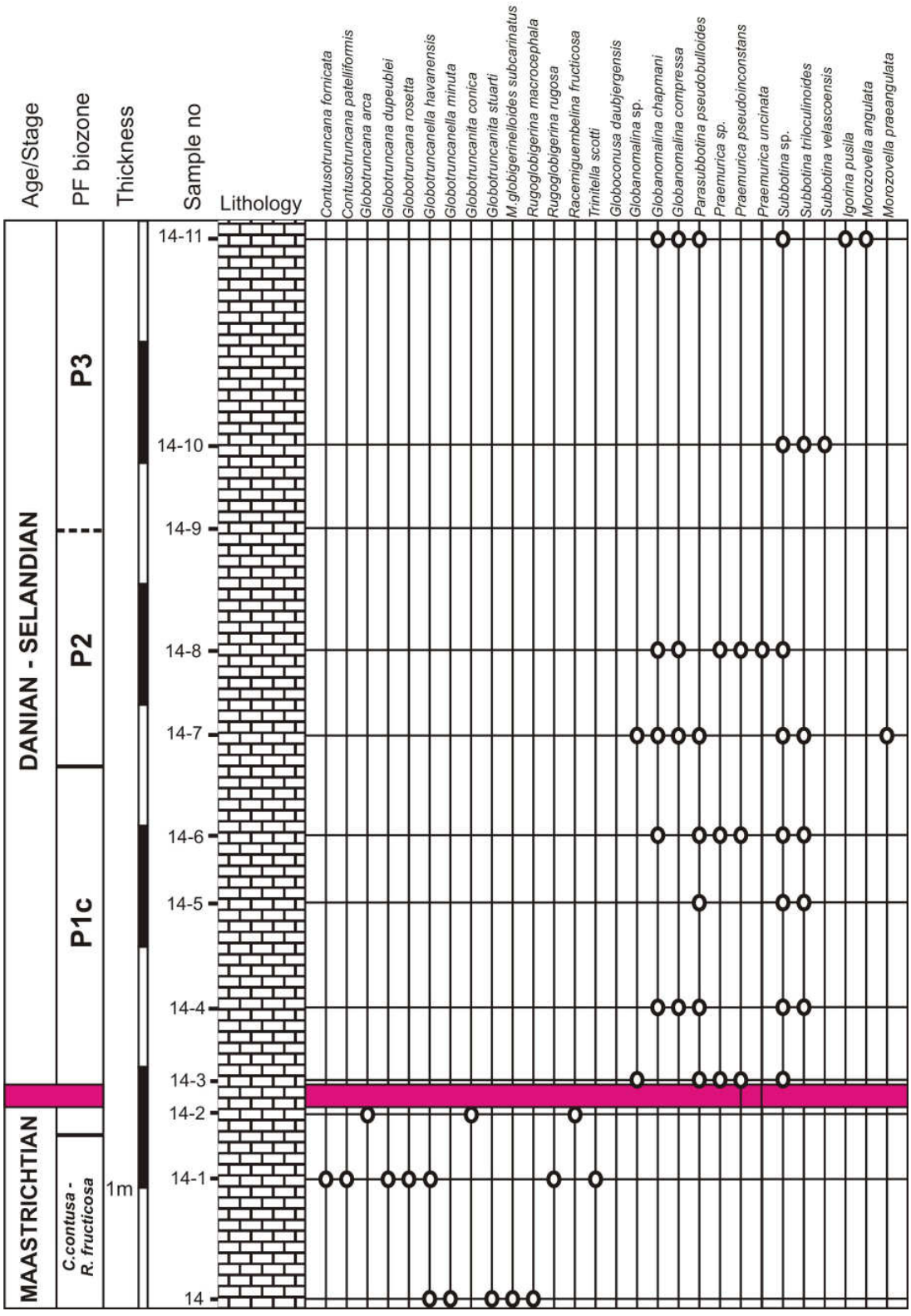


Figure 2.7 : Details of the studied part shown in Figure 2.6. See Figure 2.8 for the stratigraphic interval, shown by pink colour in this figure. The taxa in the detailed part is not represented here and shown in Figure 2.8. See Figure 2.5 for the legend.

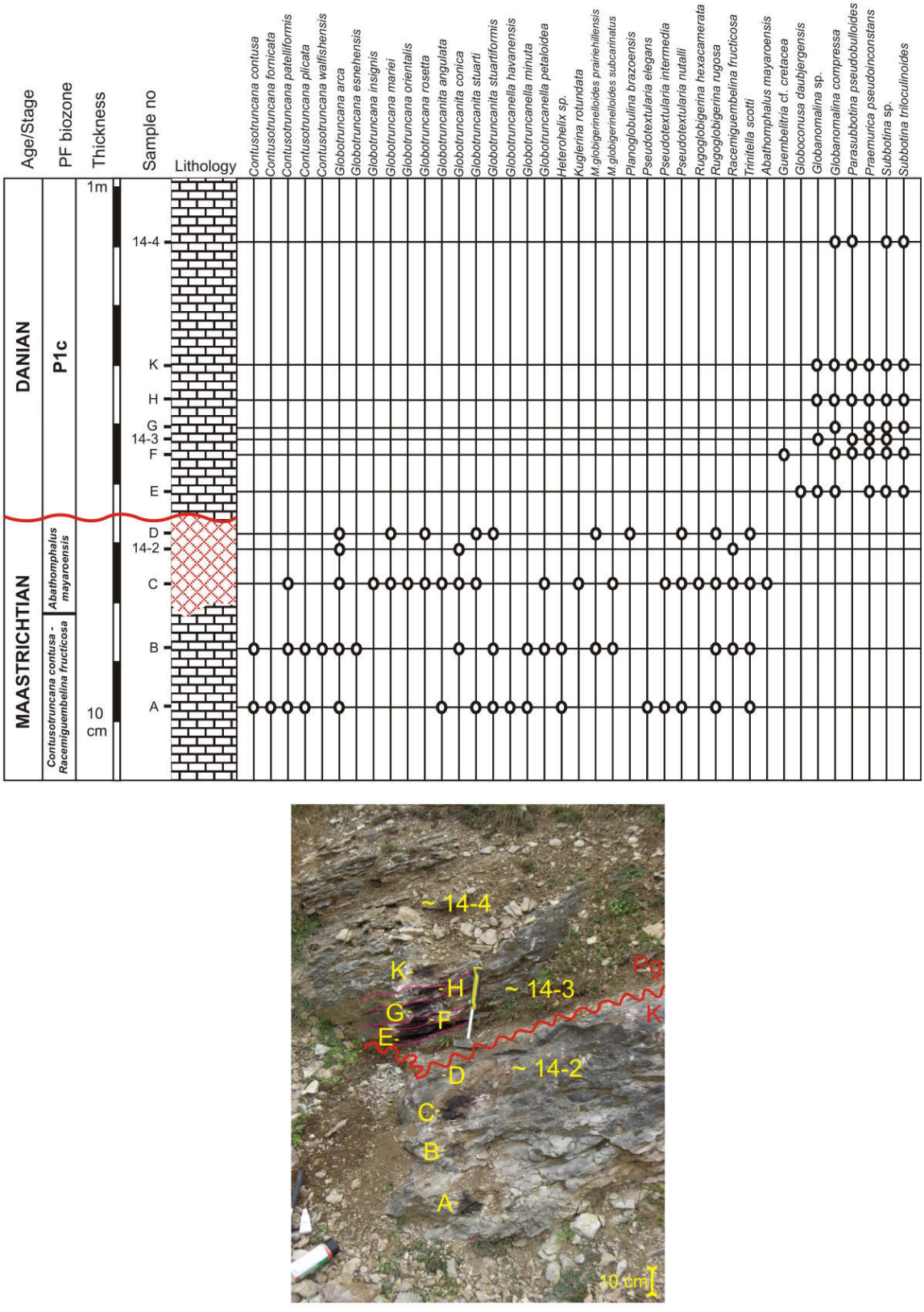


Figure 2.8 : The distribution of planktonic foraminifera just detailed for uppermost part of the Maastrichtian and unconformably overlying Danian in Belen section (See Figure 2.6 and 2.7 for the generalized sections). The field aspects of the lithology and location of the samples at exposure are shown in the photo. See Figure 2.5 for the legend.

In the Cretaceous part of the section, the *Gansserina gansseri* Zone is recognized by the presence of auxillary zone markers *Kuglerina rotundata* and *Globotruncanella pschadae.* The zonal marker *Gansserina gansseri* is also present in upper parts of the zone. In addition, the first appearance of *Globotruncanita conica* is recognized in the upper part of the *Gansserina gansseri* Zone. The first six samples of this section are considered as unzoned, because this part does not contain any characteristic species for *Gansserina gansseri* Zone nor any other Upper Cretaceous zone. Interval from the first appearance of *Contusotruncana contusa* to the first appearance of *Abathomphalus mayaroensis* is represented by the *Contusotruncana contusa-Racemiguembelina fructicosa* Zone corresponding the "lower to mid Maastrichtian". The first appearance of *Abathomphalus mayaroensis* in the sample A (Figure 2.10) determine the base of *Abathomphalus mayaroensis* Zone, which is referred to the upper part of the Maastrichtian.

The nature of the boundary between the Cretaceous and Palaeogene beds is questionable (Figure 2.10). We consider that this boundary is probably a conformable one, implying a continuous sedimentation at K-Pg boundary with the identification. The identified taxa, *Guembelitria* cf. *cretacea*, *Parvularugoglobigerina* cf. *eugubina* and *Woodringina* cf. *hornertownensis*, suggest that the interval between the samples E and G representes Pα Zone and a probable P0 Zone. As the section above the Pα Zone is not exposed well in Toylar section the interval covering P1a and P1b could not be detected (Figure 2.10). The presence of *Globanomalina compressa* indicates the presence of P1c Zone at sample 29. Since the zonal markers of P2 and P3 zones have not been recognized, a composite zone covering these two zones is given (Figure 2.9). P4 zone is identified with the appearances of auxillary marker forms such as *Acarinina subsphaerica* and *Morozovella occlusa* (FAD of both is at the base P4 Zone). Although the first appearance of *Globanomalina pseudomenardii*, the zonal marker of P4 Zone, lies at a level (sample 38) above the first appearance of auxillary zonal markers, *Acarinina subsphaerica* and *Morozovella occlusa*, in sample 37, we place the zonal boundary in sample 37 (Figure 2.9). The taxonomy of the identified species is given in systematics section.

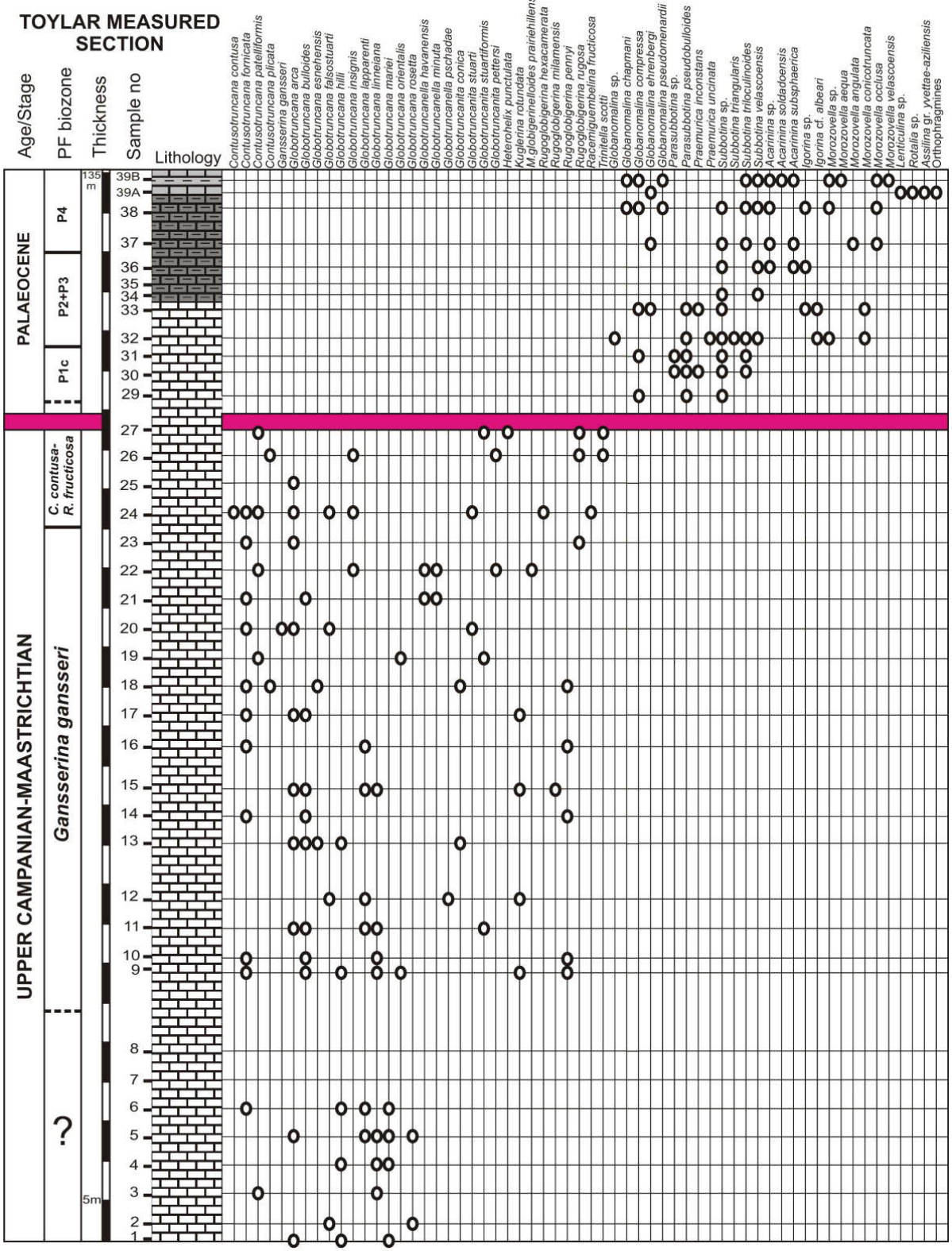


Figure 2.9 : Lithology, distribution of planktonic foraminifera and biostratigraphy of Toylar section. Upper part of the Cretaceous and the lowermost part of the Palaeocene is detailed in Figure 2.10(interval shown by pink colour). See Figure 2.5 for the legend.

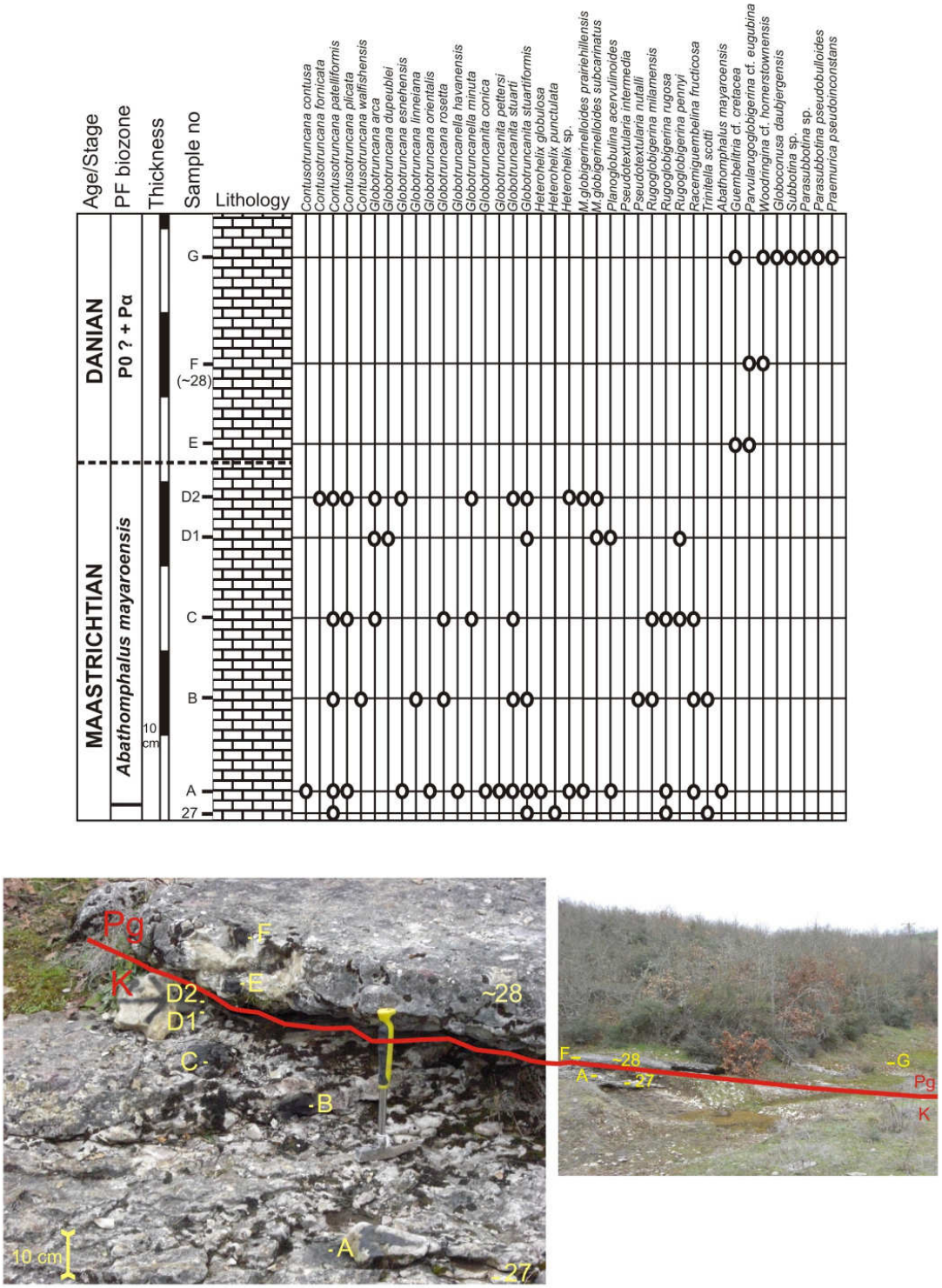


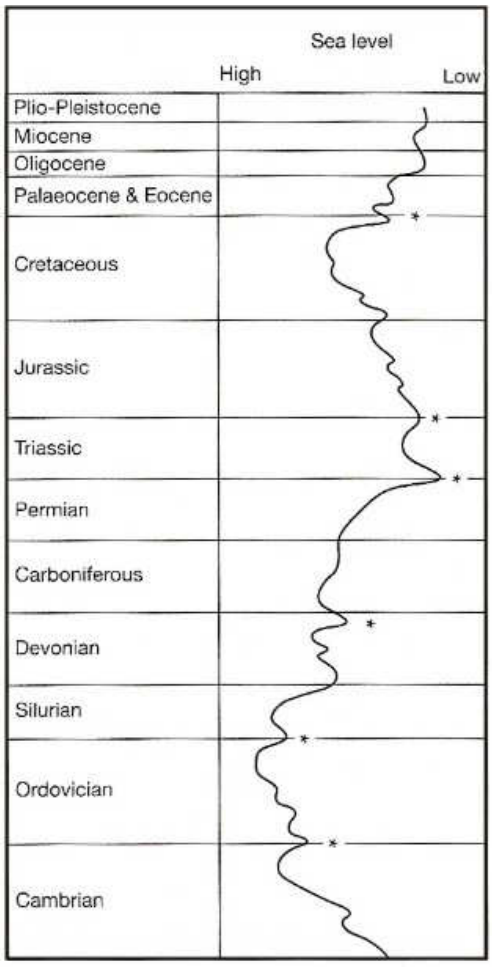
Figure 2.10 : The distribution of planktonic foraminifera just detailed for uppermost part of the Maastrichtian and Danian in Toylar section (See Figure 2.9 for the generalized section). The field aspects of the lithology and location of the samples at exposure are shown in the photos. See Figure 2.5 for the legend.

2.3. The Significance of the Early Diagenetic Events

2.3.1. About the nature of the boundary

The global regression in Late Cretaceous is widely known since 19th century. The famous example of eroded Upper Cretacous part of The Chalk in England, unconformably overlien by Lower, not the basal, Palaeocene (Hallam, 2004), motivate researchers to study undisturbed strata for unconformities under the ocean, with ocean drilling programs.

Table 2.1 : Hallam's first order Palaeozoic sea level curve, with major marine extinctions marked by asterisks [Hallam (2004), after Hallam and Wignall (1997)]



A summary of combined biostratigraphic and chronostratigraphic analyses of K-Pg boundary sequences (both terrestrial and DSDP cores) suggest that, both complete and uncomplete records are related with sediment income (MacLeod and Keller, 1991). According to this work, nearly all deep-sea sequences are marked by high intervals of nondeposition or hiatus formation from the uppermost Maastrictian to the Lower Danian as a result of sediment starvation which is, in deep ocean basins, often magnified by carbonate dissolution originated hiatuses (Macleod and Keller, 1991, p. 500, and references therein). In contrary, many continental shelf and upper slope sequences appear to contain a temporally complete record of sediment accumulation. The reason for this situation is the latest Maastrichtian – earliest Palaeogene sea level rise (Table 2.1, as much as 130 m. due to Macleod and Keller, 1991), where deep-sea sediment accumulation ceased, as the shelf margin captures more material.

2.3.2. The significance of hiatus concretions; early diagenetic events and the hardground

Hiatus concretion is a discontinous process, formed by winnowing and replacement of bored and encrusted sediments in early diagenetic phase (Flügel 2004, p.204). Hiatus concretions, however, differ from conventional concretions in their pre-diagenetic history, including exhumation on the sea-floor, colonization by various encrusting and/or boring organisms during a break in sedimentation, and final burial (Figure 2.11)(Zaton, 2010).

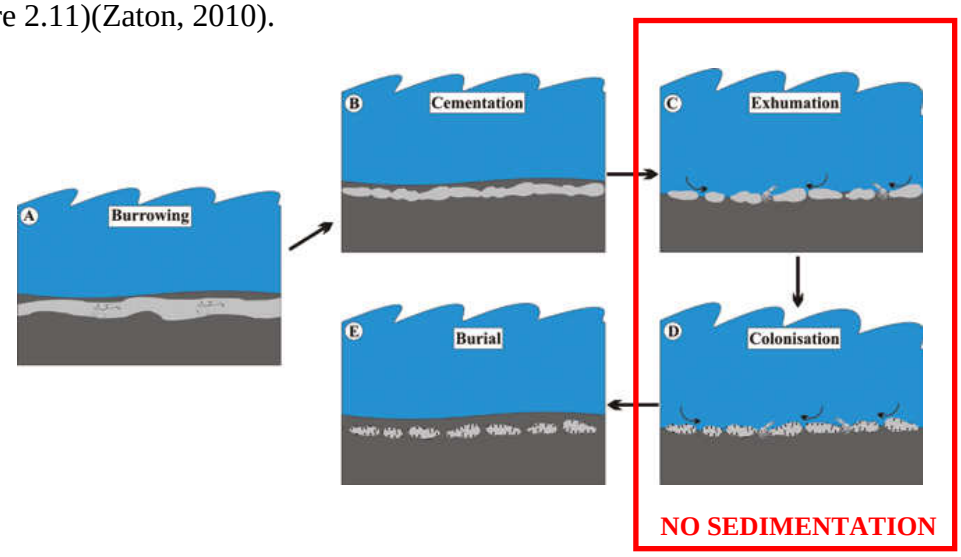


Figure 2.11 : The diagram showing formation of hiatus concretions (Zaton, 2010), see text for explanations

Main steps of hiatus concretion are;

A- Burrowing of sea floor by marine organisms, where it penetrates through the deposits. The cement, which directly precipitates from sea water during a slowdown of sedimentation, fills the burrows and spaces between carbonate grains, which will form the concretions.

B- Growth (post-sedimentary cementation) of concretions, formed below the seawater-sediment contact which is encouraged by alkaline environments (alkaline Ca^{2+} ions bonding with bicarbonates, resulting by bacterial anaeorobic oxidation of organic matter, i.e. sulfate reduction zone).

C and D - Exhumation of sediments and colonisation of existed concretions (i.e. boring and encrusting), in conditions of ceased sedimentation and sea-floor erosion (physical and/or biologic). During this phase, abrasion and deplacement of lithified hardgrounds are common.

E- Restarted sedimentation and burial of the concreted level. Steps C and D may repeat in multiple times before the final burial.

Hardgrounds are concreted surfaces formed in the phase A, resulting from submarine cementation by aragonite and magnesian calcite precipitation directly from seawater (Flügel, 2004, p. 206, Figure 2.12), and expands in the phase B. Besides the lithologic properities, they are commonly accompanied by encrusts of glauconite, calcium phosphate, iron and manganese salts (Bathurst, 1972).

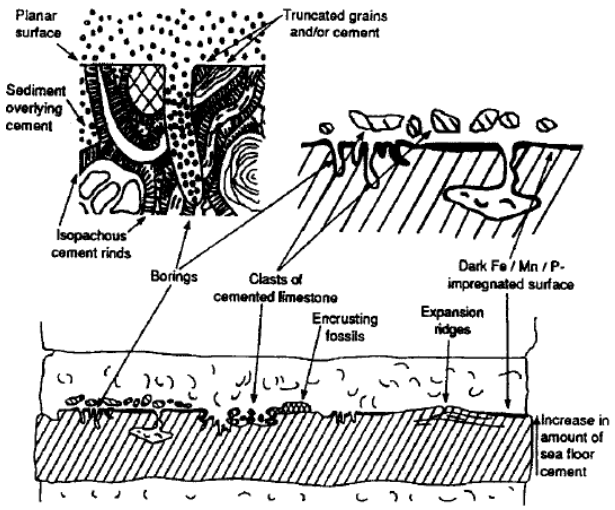


Figure 2.12 : The common scheme for carbonate hardgrounds (From Flügel, 2004 crossref. James and Choquette, 1983).

The significance of this event is first recognized by Ehrhard Voigt in 1968 (Zaton, 2010), where he stated that hiatus concretions represent discontinuous hardgrounds, and indicate short- and long-lived breaks in sedimentation (Voigt, 1968, from Flügel, 2004).

At Nasuhlar-Bulduk and Belen sections, a few centimeters thick layer of hardground is visible (Figures 2.13). Red/yellow or greenish bands of oxides are characteristic besides the significant hardness of the rock. In thin sections, the dominance of ferrous material is more obvious than the field obsevations of red strata, where a high contrast is shown with the carbonate tests of the fossils (Figure 2.14). Another significant event is limestone clasts and bioturbation (boring) infillings at Nasuhlar-Bulduk section, as a consequence of reworking. In thin section, the Cretaceous host rock and Palaeocene infilling are recognizable with an unusual richness of angular feldspar grains and some accessory unidentifiable opaque minerals (Figure 2.15).

Figure 2.13 : Hardground pictures from Belen section (left) and Nasuhlar-Bulduk section (right). The marker pen and the hammers at both pictures indicate the K-Pg boundary

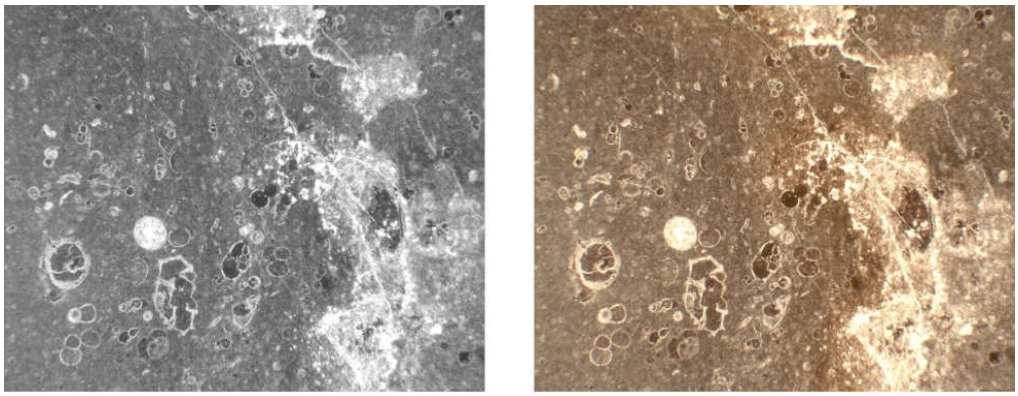


Figure 2.14 : Hardground thin section pictures from Belen section (sample no. D), where the contrast of ferroginous micrite with carbonate tests (left: in color, right: in grayscale)

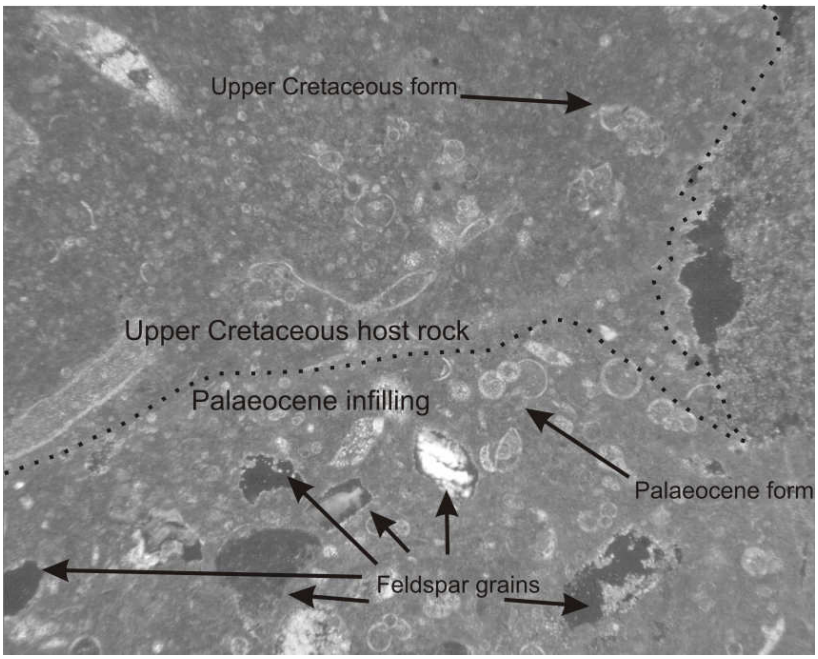


Figure 2.15 : Thin section view of the Palaeocene infiling in the Upper Cretaceous host rock at Nasuhlar-Bulduk section (sample no. B)

Hardgrounds are seen in other places in the world as well, as the famous K-Pg sequence of Stevns Klint in Denmark, not only at the boundary but observed in both Upper Maastrichtian and Lower Danian (Hart *et al.*, 2005). In Upper Maastrichtian the lower one of the "twin hardgrounds" has been phosphatised and shows little evidence of biological encrusting, and upper one has a prominent line of massive flints. In some places along the section those 2 strata merge into a single horizon. Lower Danian "twin hardgrounds", consist mainly of burrowings and phosphatised layers. Both hardground series are characterised by sequence boundaries, suggestive of a sea level drop.

2.3.3. A highly hypothetical model to explain the development of hardground and reddish colour in Akveren Formation

An unconformable relation at K-Pg boundary in two sections, Nasuhlar-Bulduk and Belen sections, is supported by both palaeontological data as well as early diagenetic features observed in the sediments. In both cases, Maastrichtian carbonates represented by *Abathomphalus mayaroensis* Zone contains a ferriginous micrite matrix, related with the overlying hardground. On contrary to this, Toylar section with the same age and facies, do not contain any sign of a hardground. The beds at the boundary, however, contain a rich radiolaria assemblage.

We have been unable to collect a sample for a geochemical analysis. However ferriginous matrix is obvious at macroscopic scale as it is clearly seen at boundary levels.

Thus the hypothetical scenario for the development of the hardgrounds can be summarized as follows;

- The hardground is a consequence of transgression event, where the sea-level rise and the carbonate starvation happen, due to the shelf drowning. Since foraminifera cannot survive without carbonate tests, and pelagic carbonates mainly consists of them, thus no sedimentation occured at the top of Maastrichtian and at the base of Danian, at the Belen and Nasuhlar-Bulduk sections (Figure 2.16).

- Therefore Cretaceous sequence also may not be complete, like the Lowermost Danian's, since the reworked parts and the hardground material belongs to the *Abathomphalus mayaroensis* Zone, it is very likely that unconformable events started at the Latest Maastricthian, not at the boundary.

- In Toylar section, this area may have been closer to the shore, since the accumulation of the carbonate material shows a possible conformable boundary. The sequence was continuous at the boundary, and possibly through all the Palaeocene. The possible time gap, mentioned at former part of this chapter, could not be enlighted within the present work. But if there is a real gap, comprised of the absence of P1 and P2 zones of Danian, the carbonate starvation must be spread to the mentioned area, later than other two sections.

- The clastic part of carbonate facies and the Palaeocene aged micrite infillings in Nasuhlar-Bulduk section, is the sign of bio-abrasion and reworking of pre-existed Cretaceous ground (compare with hardgrounds in Figure 2.13). Therefore that means those angular feldspars are also in Palaeocene age, since they are present only in the infillings. About the origin of those feldspars (Figure 2.15), a volcanic event may be speculated.

- At Early Palaeocene, global sea level drops back and the carbonate starvation at Nasuhlar-Bulduk and Belen regions ends up. The newcoming sediments constitute P1c zone of Early-Middle Danian, it is also in accord with the infillings of Nasuhlar-Bulduk section (Figure 2.16).

Finally, all those geobiological events point out a gap, a paraconformity, not mentioned and proposed in previous works.

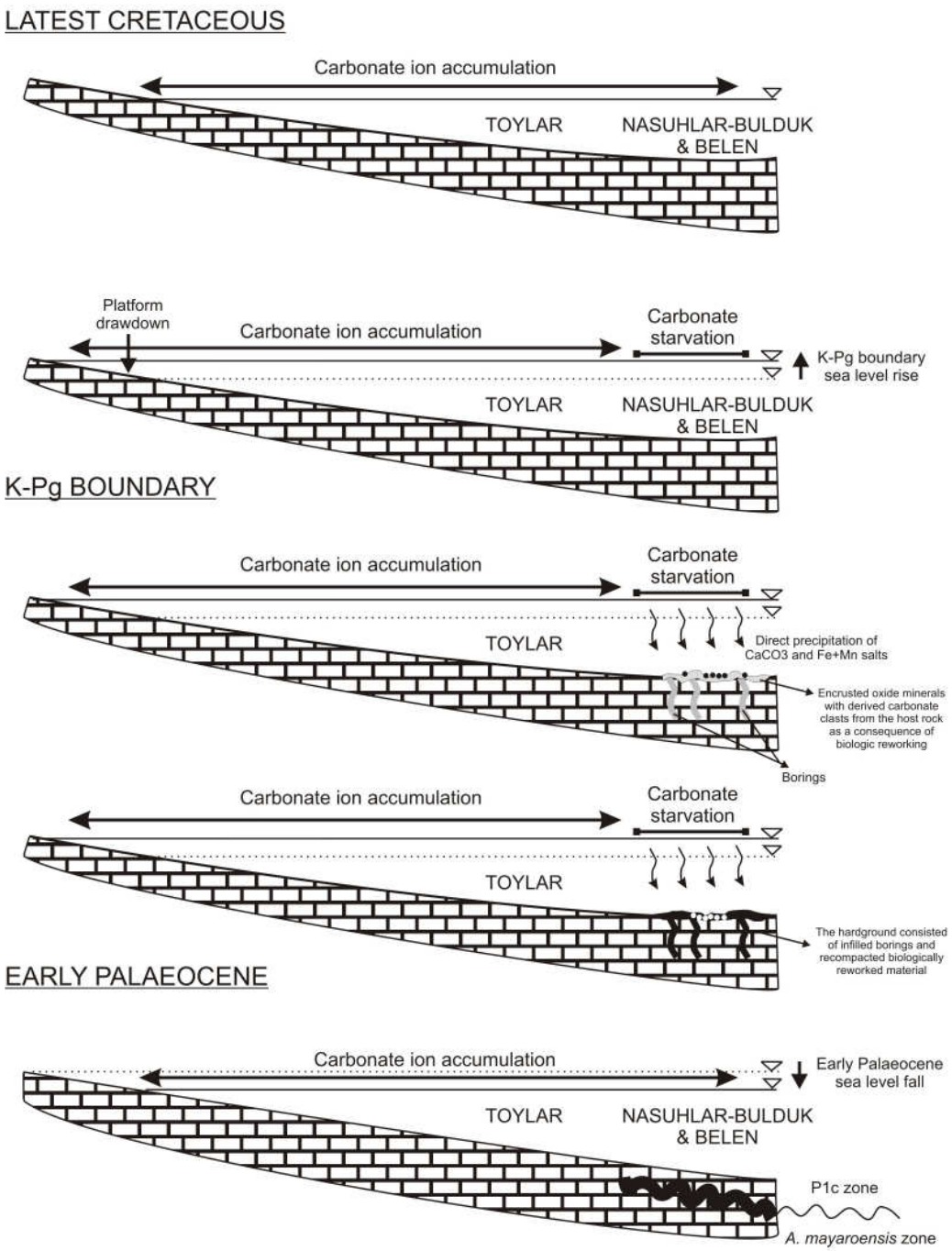


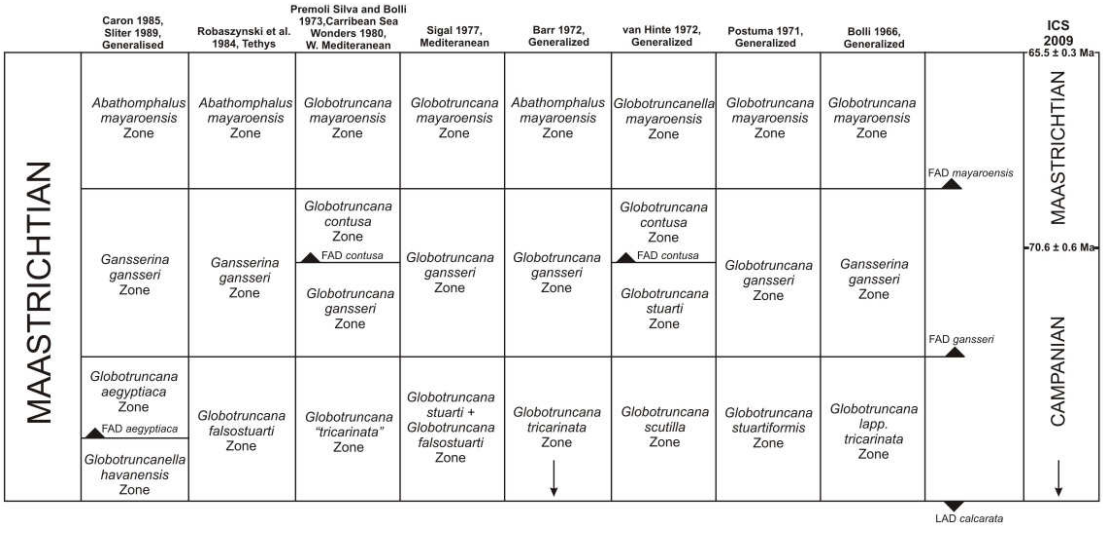
Figure 2.16 : The eustaticogeologic evolution of the study area

3. BIOSTRATIGRAPHY

3.1. Global Upper Cretaceous-Palaeocene Biostratigraphy and Planktonic Foraminiferal Bizonation

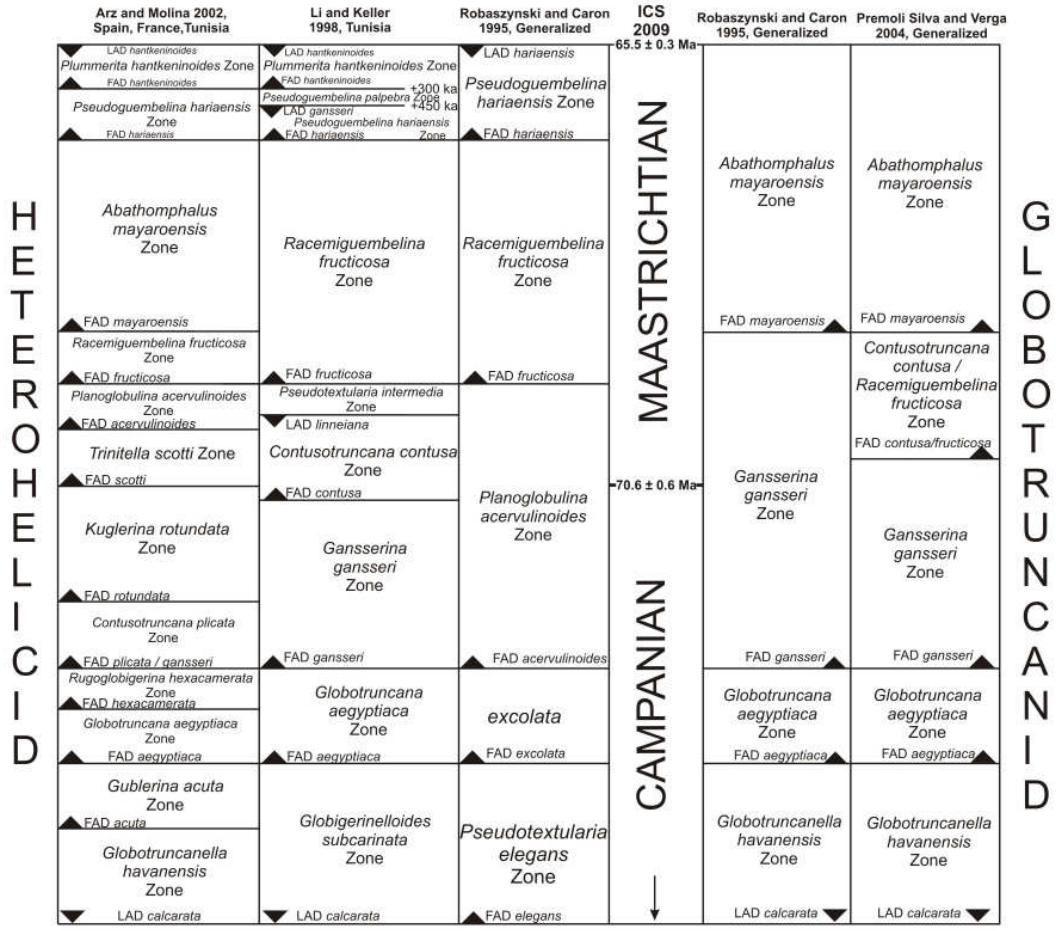
Some notable works on early biostratigraphy of Upper Cretaceous sequences were mostly based on globotruncanid forms. The major works of Bolli (1966; also based on earlier works in 1957a,b,c, 1959), Postuma (1971), Barr (1972), van Hinte (1972), Sigal (1977), Wonders (1980), Robaszynski *et al.* (1984), Caron (1985; also cited by Sliter, 1989) were important in the establishment of a global scale biozonation (Table 3.1).

Table 3.1: The Campanian-Maastrichtian planktonic foraminiferal biozonations proposed by different workers before Robaszynski and Caron (1995), and their correlation with the time scale according to Caron (1985) (left column) and ICS [(2009; based on Gradstein *et al.* (1994, 2004)] (right column). FAD: first appearance datum, LAD: last appearance datum.



The zonation and their correlation with standard stages before the time scale of Gradstein *et al.* (1994), in which the Campanian-Maastrictian boundary recalibrated, is shown in Table 3.2. Following the work of Gradstein *et al.* (1994), some previous zones characterizing the Maastrichtian stage are now belong to the Upper Campanian stage (See Tables 3.1 and 3.2).

Table 3.2 : The recently proposed and widely used Campanian-Maastrichtian planktonic foraminiferal zonations. ICS Time Chart 2009 is shown to illustrate the correlation of these zones with time scale. FAD: first appearance datum, LAD: last appearance datum.



The recalibrated Upper Cretaceous planktonic foraminiferal biozonation, presented by Robaszynski and Caron (1995), proposed a standard biozonation framework for Mediteranean part of the Neotethys Ocean. This zonation, in fact, integrates the previous zonations of Bolli (1966), Sigal (1977), Robaszynski *et al.* (1984) and Premoli Silva and Sliter (1995) based on globotruncanids and Nederbragt (1990) and Premoli Silva and Sliter (1995) based on heterohelicids (Table 3.2). Later on, Li and Keller (1998), and Arz and Molina (2002) unified the basic works of Caron (1985) and Robaszynski and Caron (1995) in a single biozonation including both heterohelicid and globotruncanid zones (Table 3.2).

In the Paleocene, the zonation is more stable. The earlier works, with lower resolutions, adopted the evolution and proliferation of genus *Globorotalia* (now a junior synoynm for several new genera). The major works concerning the biostratigraphy of Palaeocene is based on Luterbacher and Premoli Silva (1964),

Bolli (1966; later cited by Premoli Silva and Bolli, 1973) Berggren (1969), Blow (1979), Smit (1982), Toumarkine and Luterbacher (1985), Berggren and Miller (1988) and Keller (1988) (Table 3.3). The "P" notation for the Palaeocene planktonic foramiferal biozonation is proposed by Berggren (1969) and followed by various authors (Table 3.3). The work of Smit (1982), is a milestone for the zonation of the lowermost part of Palaeocene since the P0 Zone was first introduced in this study. Following this, two different zonation schemes were created by Keller (1988) who proposed a new model with a high resolution and Berggren *et al.* (1995), who established a more unified zonation mainly based on the previous works (Table 3.4).

The most recent studies follow two main trends in the application of zonation in Palaeocene; first, the works of Keller (1993), Pardo *et al.* (1996) and Keller *et al.* (2009) based on the model work of Keller (1988), and second, the works of Olsson *et al.* (1999), Premoli Silva *et al.* (2003), Arenillas *et al.* (2004), Berggren and Pearson (2005) based on the proposed zonation of Berggren *et al.* (1995) (Table 3.4).

In this work, the chart of International Commission of Stratigraphy (ICS) 2009, based on the original chart of Gradstein *et al.* (2004), is used for both Upper Cretaceous and Palaeocene time scale. For the zonation of Upper Cretaceous and Palaeocene units in Koceali Peninsula, zonal schemes of Premoli Silva and Verga (2004) and Premoli Silva *et al.* (2003) have been used respectively.

Table 3.3 : Historical development of biostratigraphic zonation of Danian to Thanetian, based on major works. All zonations are calibrated with ICS Time Chart 2009. FAD: first appearance datum, LAD: last appearance datum.

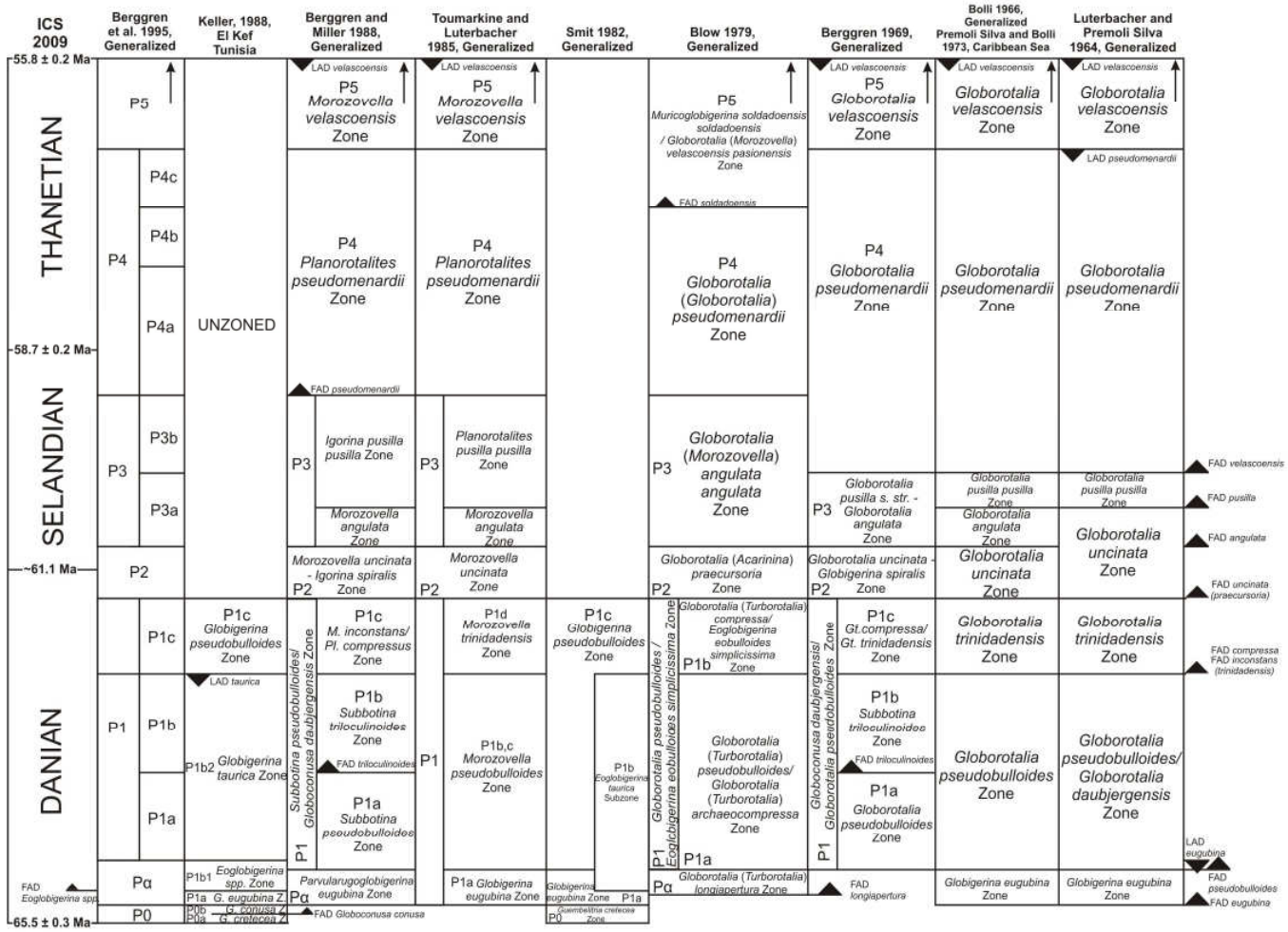
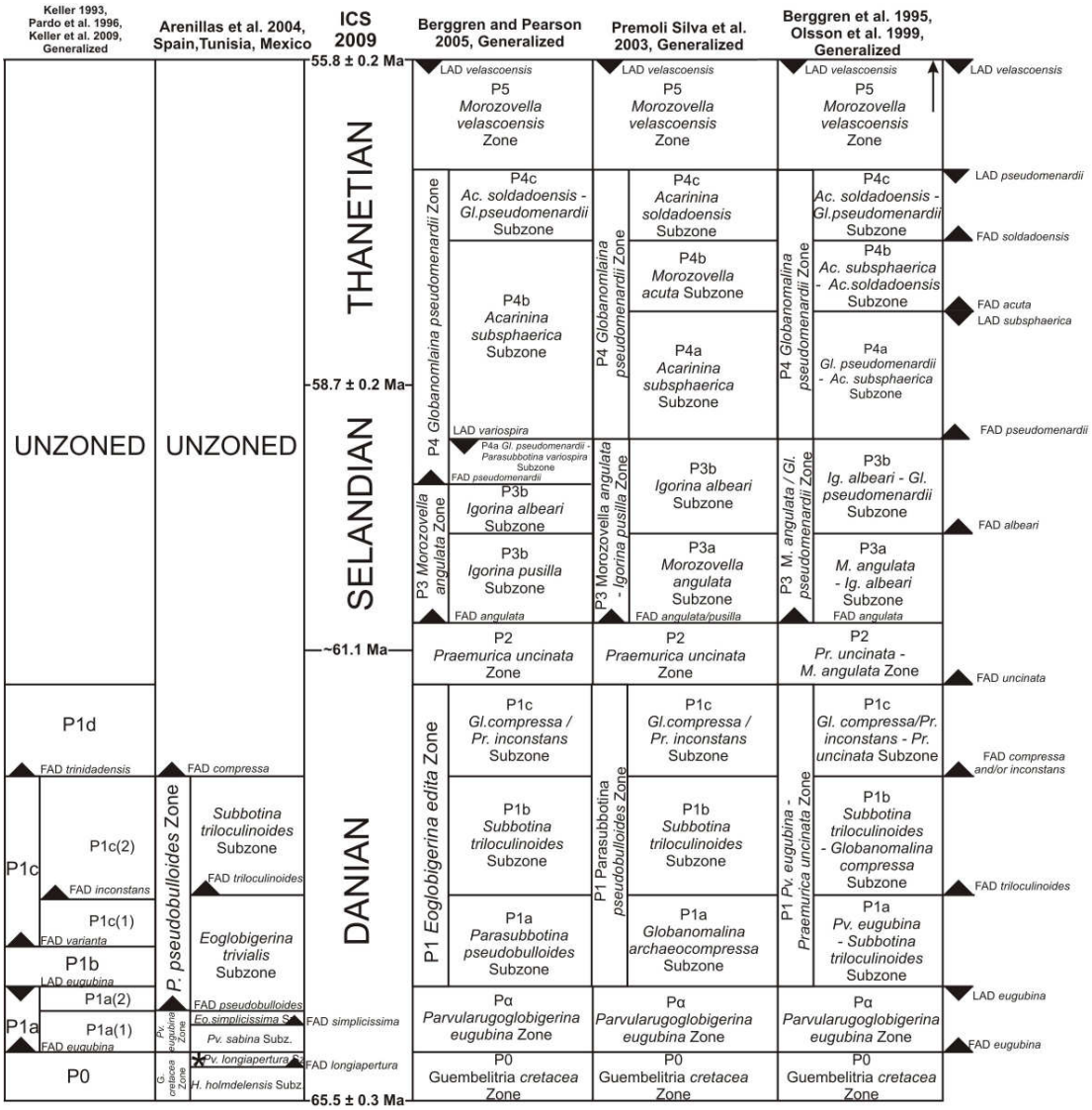


Table 3.4 : The recent and most widely used Palaeocene planktonic foraminiferal biozonations. All zonations are calibrated with ICS Time Chart 2009. *Since *Parvularugoglobigerina longiapertura* is differentiated from *Parvularugoglobigerina eugubina* by Canudo *et al.* (1991), a more detailed biozonation is proposed by Arenillas *et al.* (2004) for P0 Zone. FAD: first appearance datum, LAD: last appearance datum.



3.2. Biozonation

Cretaceous estimated biozone durations and biozonation are based on Premoli Silva and Verga, 2004, Palaeocene biozone durations and biozonation are based on Olsson *et al.* 1999 and Premoli Silva *et al.*, 2003 respectively.

***Gansserina gansseri* Interval Zone**

Bronnimann, 1952

Age: Latest Campanian to Early Maastrichtian; app. duration ~3.8 Ma

Definition: The Interval between first appearance datum (FAD) of *Gansserina gansseri* and FAD of *Racemiguembelina fructicosa* and *Contusotruncana contusa*.

Remarks: The presence of this zone is in Belen and Toylar sections. As the zonal marker species, *Gansserina gansseri* has been recorded at the upper part of the zone and is rarely present in both sections. Based on the presence of, *Globotruncanella pschadae* (FAD lowermost *G. gansseri* Zone), *Rugoglobigerina milamensis* (FAD lowermost *G. gansseri* Zone), *Globotruncanita angulata* (FAD base *G. gansseri* Zone) and *Kuglerina rotundata* (FAD lower *G. gansseri* Zone), *Globotruncanita pettersi* (FAD mid *G. gansseri* Zone), *Globotruncanella minuta* (FAD mid *G. gansseri* Zone), *Contusotruncana walfishensis* (FAD mid *G. gansseri* Zone) and *Globotruncanita conica* (FAD top *G. gansseri* Zone), which are auxillary markers of *Gansserina gansseri* Zone has been defined in the studied sections (Figures 2.6 and 2.9).

Contusotruncana fornicata, Contusotruncana patelliformis, Contusotruncana plicata, Globotruncana arca, Globotruncana bulloides, Globotruncana dupeublei, Globotruncana esnehensis, Globotruncana falsostuarti, Globotruncana hilli, Globotruncana insignis, Globotruncana lapparenti, Globotruncana linneiana, Globotruncana orientalis, Globotruncanella havanensis, Globotruncanella petaloidea, Globotruncanita stuarti, Globotruncanita stuartiformis, Macroglobigerinelloides prairiehillensis, Pseudotextularia intermedia Rugoglobigerina macrocephala, Rugoglobigerina pennyi and *Rugoglobigerina rugosa* are other faunal constituents of this zone at the study area (Figures 2.6 and 2.9).

Local section range: The zone has been recorded in the Belen section between the sample 9 and sample 23 (~60 m, Figure 2.6) and in the Toylar section between the base of the section and the sample 23 (~100 m, Figure 2.9).

***Contusotruncana contusa / Racemiguembelina fructicosa* Interval Zone**
Smith and Pessagno, 1973

Age: Early to Late Maastrichtian; approx. duration ~1.2 Ma

Definition: Interval between FAD of *Contusotruncana contusa* / *Racemiguembelina fructicosa* and FAD of *Abathomphalus mayaroensis*. Different definitions about the nominate species have been proposed by Li and Keller (1998) and Robaszynski (1998), which are not covering the mentioned zonal boundaries in the present work (Table 3.2).

Remarks: *Contusotruncana contusa* Zone was separated from the *Gansserina gansseri* Zone by Premoli Silva and Bolli (1973) and then was emended by Premoli Silva and Sliter (1995) as the *Contusotruncana contusa* / *Racemiguembelina fructicosa* zone. Although the first occurrences of *Contusotruncana contusa* and *Racemiguembelina fructicosa* are regarded as coeval in Premoli Silva and Sliter (1995)'s zonal scheme, Li and Keller (1998), and Arz and Molina (2002) recognized their first appearances in two successive levels. In this work, first occurrences of two taxa are very close and this work is based on the thin section analysis (e.g. bias of limited resolution), this zone is defined where even if only one of the zonal markers is identified. *Trinitella scotti* (FAD mid *Contusotruncana contusa / Racemiguembelina fructicosa* Zone) is present at the upper parts of the zone as an auxillary marker species of the zone, besides the zonal markers (Figures 2.3, 2.5-2.9).

Contusotruncana fornicata, Contusotruncana patelliformis, Contusotruncana plicata, Contusotruncana walfischensis, Globotruncana arca, Globotruncana bulloides, Globotruncana dupeublei, Globotruncana esnehensis, Globotruncana falsostuarti, Globotruncana hilli, Globotruncana insignis, Globotruncana lapparenti, Globotruncana linneiana, Globotruncana mariei, Globotruncana orientalis, Globotruncana rosetta, Globotruncanella havanensis, Globotruncanella minuta, Globotruncanella pschadae, Globotruncanella petaloidea, Globotruncanita angulata, Globotruncanita conica, Globotruncanita pettersi, Globotruncanita

stuarti, Globotruncanita stuartiformis, Heterohelix punctulata, Heterohelix sp., *Kuglerina rotundata, Macroglobigerinelloides prairiehillensis, Macroglobigerinelloides subcarinatus, Planoglobulina acervulinoides, Planoglobulina brazoensis, Pseudotextularia elegans, Pseudotextularia intermedia, Rugoglobigerina hexacamerata, Rugoglobigerina macrocephala, Rugoglobigerina milamensis, Rugoglobigerina pennyi* and *Rugoglobigerina rugosa* are other faunal constituents of this zone at the study area (Figures 2.3, 2.5-2.9).

Local section range: The zone has been recorded in the Nasuhlar-Bulduk section between the base of the section and sample E (~7 m), in Toylar section by the sample 24 to the sample A (~12 m), and in the Belen section from the sample 13 to the sample C (~10 m).

***Abathomphalus mayaroensis* Taxon Range Zone**

Brönnimann, 1952

Age: Late Maastrichtian; approx. duration ~2.5 Ma

Definition: Interval defined by the taxon range of *Abathomphalus mayaroensis*

Remarks: *Abathomphalus mayaroensis* is an index and significant species to determine *A. mayaroensis* Zone of the Uppermost Cretaceous. It is mentioned as a rare taxon in many previous studies and a more detailed heterohelicid zonation has widely used (Table 3.2). Although our facies is not available for specimen-based examination, three *Abathomphalus mayaroensis* specimens could be recorded due to the most detailed sampling in the Belen and Toylar sections (Figures 2.8 and 2.10).

Contusotruncana fornicata, Contusotruncana patelliformis, Contusotruncana plicata, Contusotruncana walfischensis, Globotruncana arca, Globotruncana dupeublei, Globotruncana esnehensis, Globotruncana insignis, Globotruncana linneiana, Globotruncana mariei, Globotruncana orientalis, Globotruncana rosetta, Globotruncanella havanensis, Globotruncanella minuta, Globotruncanella petaloidea, Globotruncanita conica, Globotruncanita pettersi, Globotruncanita stuarti, Globotruncanita stuartiformis, Heterohelix globulosa, Heterohelix sp., *Kuglerina rotundata, Macroglobigerinelloides prairiehillensis, Macroglobigerinelloides subcarinatus, Planoglobulina acervulinoides, Planoglobulina brazoensis, Pseudotextularia intermedia, Pseudotextularia nutalli, Rugoglobigerina hexacamerata, Rugoglobigerina milamensis, Rugoglobigerina*

pennyi and *Rugoglobigerina rugosa*, *Racemiguembelina fructicosa* and *Trinitella scotti* are other faunal constituents of this zone at the study area (Figures 2.8 and 2.10).

Local section range: The zone has been recorded in Toylar section by the sample B to the sample D2 (~40cm), and in Belen section by the samples C and D (~15cm).

P0 *Guembelitria cretacea* Partial Range Zone

Keller 1988, emendation of Smit 1982 +

Pα *Parvulaglobigerina eugubina* Taxon Range Zone

Liu 1993, emendation of Pα of Blow 1979; Luterbacher and Premoli Silva, 1964

Age: P0; Earliest Danian; 65.0 - 64.97 mya; approx. duration ~30.000 yrs

Pα; Earliest Danian; 64.97 - 64.9 mya; approx. duration ~70.000 yrs

Definition: P0 Zone is the partial range zone, defined by the partial range of *Guembelitria cretacea* between LAD of Cretaceous taxa to the FAD of *Parvulaglobigerina eugubina.* Pα Zone is defined by the total range of the nominate taxon, *Parvulaglobigerina eugubina*. The same name was used for a more limited interval (upper limit is FAD of *Parasubbotina pseudobulloides*) in in the biozonations of Bolli (1966), Toumarkine and Luterbacher (1985) and Berggren and Miller (1988), shown in Table 3.3 and Arenillas *et al.* (2004), in Table 3.4. This zone is altered to P1a Zone with different zone limits by Keller (1988, Table 3.3), Keller (1993), Pardo *et al.* (1996) and Keller *et al.* (2009), shown in Table 3.4.

Remarks: P0+Pα Zone is could not differentiated in the Toylar section. Because *Parvularuglobigerina eugubina*, marker species of the P0 Zone, was not precisely defined in thin section analysis although all Cretaceous species are extinct and no characteristic P1 Zone (*Parasubbotina pseudobulloides* Zone, Table 3.4) is present. This biozone is recognized only in the Toylar section, where all Cretaceous forms have gone extinct and no characteristic P1 Zone (*Parasubbotina pseudobulloides* Zone, Table 3.4) was present, small forms which exist in thin sections. Small forms (~100 μm) in the samples E and F (Figure 2.10) were identified as *Parvularugoglobigerina* cf. *eugubina*, *Guembelitria* cf. *cretacea*, *Woodringina* cf. *hornertownensis* and thus, the Pα Zone was defined combining with the P0 Zone.

Globoconusa daubjergensis, *Subbotina* sp., *Parasubbotina* sp., *Parasubbotina pseudobulloides* and *Praemurica pseudoinconstans* are other faunal constituents of this zone at the study area (Figure 2.10).

Local section range: Toylar section, represented by the samples E and F (~20 cm.)

P1 *Parasubbotina pseudobulloides* Partial Range Zone

Berggren *et al.*, 1995, emendation of Berggren and Miller, 1988

Age: Danian; 64.9-61.2 mya; approx. duration ~3.7 Ma

Synoynms: *Parvulaglobigerina eugubina* - *Praemurica uncinata* Zone in Berggren *et al.* (1995) and Olsson *et al.* (1999).

Definition: Interval between LAD of *Parvulaglobigerina eugubina* to FAD of *Praemurica uncinata*. Previous P1 comprising zones, define the base ot this zone with the FAD of *Parasubbotina pseudobulloides* (see Table 3.3 for earlier Palaeogene biozonations).

Remarks: This biozone is represented by only the P1c Subzone in this study. Lower zones of the P1 Zone, which are not mentioned in the present study, are P1a and P1b zones, defined by the interval between the LAD of *Parvulaglobigerina eugubina* and the FAD of *Subbotina triloculinoides* and by the interval between the FAD of *Subbotina triloculinoides* and the FAD of *Globanomalina compressa* and/or *Praemurica inconstans*, respectively.

P1c *Globanomalina compressa*/*Praemurica inconstans* Interval Subzone

Berggren *et al.*, 1995; emendation of, but equivalent to, Subzone P1c in Berggren and Miller, 1988

Age: Mid-Late Danian; 63.0-61.2 mya; approx. duration ~1.8 Ma

Definition: Biostratigraphic interval between the FAD of *Globanomalina compressa* and/or *Praemurica inconstans* to the FAD of *Praemurica uncinata*. The same definition under a different subzone name is also used in Berggren *et al.* (1995) and Olsson *et al.* (1999) (Table 3.4)

Remarks: This is the first biozone of Danian represented in the studied sequence. The unconformity and the nature of the K-Pg boundary in our sections were previously explained in Chapter 2. The zonal marker *Globanomalina compressa* is continuously present in thin sections (Figures 2.3, 2.5, 2.7-2.9).

Guembelitria cf. *cretacea, Globoconusa daubjergensis, Globanomalina* sp., *Globanomalina chapmani, Parasubbotina* sp., *Parasubbotina pseudobulloides, Praemurica* sp., *Praemurica inconstans, Praemurica pseudoinconstans, Subbotina* sp. *and Subbotina triloculinoides* are other faunal constituents of this zone at the study area (Figures 2.3, 2.5, 2.7-2.9).

Local section range: The zone has been recorded in the Nasuhlar-Bulduk section between the sample F and the sample 12 (~1 m), in the Toylar section from the sample 29 to the sample 31 (~7,5 m) and in Belen section from the sample 14-3 to the sample 14-6 (~2,15 m).

P2. *Praemurica uncinata* Interval Zone

Berggren *et al.*, 1995; emend. of, but biostratigraphically equivalent to, Zone P2 in Berggren and Miller, 1988

Age: Late Danian; 61.2-61.0 mya; approx. duration ~0.2 Ma

Definition: Biostratigraphic interval between the FAD of *Praemurica uncinata* and the FAD of *Morozovella angulata*. This zone is synonymous with the *Preamurica uncinata–Morozovella angulata* Zone of Berggren *et al.* (1995) and Olsson *et al.* (1999) (Table 3.4).

Remarks: This zone is recognized by the co-appereance of *Praemurica uncinata* (zonal marker) and *Morozovella praeangulata* (auxillary marker) in the Belen section (Figures 2.3, 2.7 and 2.9). It is defined in the interval between the first appearances of *Praemurica uncinata* and *Morozovella angulata* in the Nasuhlar-Bulduk section.

Globanomalina sp., *Globanomalina chapmani, Globanomalina compressa, Praemurica* sp., *Praemurica pseudoinconstans, Subbotina* sp., *Subbotina triloculinoides* and *Parasubbotina pseudobulloides* are other faunal constituents of this zone at the study area (Figures 2.3 and 2.7).

In the Toylar section, P2 Zone could not be differentiated from the P3 Zone possibly due to the large sampling interval. The fauna which is consisted of *Acarinina* sp., *Acarinina subsphaerica, Globanomalina* sp., *Globanomalina compressa, Globanomalina ehrenbergi, Igorina* cf. *albeari, Igorina pusilla, Morozovella* sp. and *Morozovella conicotruncata, Parasubbotina pseudobulloides, Praemurica inconstans, Praemurica uncinata, Subbotina* sp., *Subbotina triangularis, Subbotina*

triloculinoides, Subbotina velascoensis, is considered as a combined zone of P2+P3 (Figure 2.9).

Local section range: The zone has been recorded in the Nasuhlar-Bulduk section between the sample 13 (~1,8 m) and the sample 16, in the Belen section from the sample 14-7 to the sample 14-9 (~2 m). The composite P2+P3 Zone in the Toylar section is between the sample 32 and the sample 36 (~12 m).

P3. *Morozovella angulata/Igorina pusilla* Zone Interval Zone

Berggren *et al.*, 1995; emendation of Zone P3 in Berggren and Miller, 1988

Age: Early-Mid Selandian; 61.0-59.2 mya; approx. duration ~1.8 Ma

Definition: Biostratigraphic interval between the FAD of *Morozovella angulata* and the FAD of *Globanomalina pseudomenardii*. This zone is synonymous with the *Morozovella angulata-Globanomalina pseudomenardii* Zone of Berggren *et al.* (1995) and Olsson *et al.* (1999) (Table 3.4). Berggren and Pearson (2005) has reduced the upper zone limit to the FAD of *Parasubbotina variospira* (Table 3.4).

Remarks: This zone is recognized based on the FAD of *Morozovella angulata* in studied sections. Other zonal marker *Igorina pusilla* is identified only in the Belen section, at the sample 14-11. The zonal fauna assemblage consist of also contains the other remarkable species such as *Morozovella conicotruncata* and *Subbotina velascoensis* as auxillary P3 markers (Figures 2.3 and 2.7).

Globanomalina chapmani, Globanomalina compressa, Globanomalina ehrenbergi, Parasubbotina pseudobulloides, Subbotina sp. and *Subbotina triloculinoides* are other faunal constituents of this zone at the study area (Figures 2.3 and 2.7).

In the Toylar section, P2 Zone could not be differentiated from the P3 Zone possibly due to the large sampling interval. The fauna which is consisted of *Acarinina* sp., *Acarinina subsphaerica, Globanomalina* sp., *Globanomalina compressa, Globanomalina ehrenbergi, Igorina* cf. *albeari, Igorina pusilla, Morozovella* sp. and *Morozovella conicotruncata, Parasubbotina pseudobulloides, Praemurica inconstans, Praemurica uncinata, Subbotina* sp., *Subbotina triangularis, Subbotina triloculinoides, Subbotina velascoensis,* is considered as a combined zone of P2+P3 (Figure 2.9).

Local section range: The zone has been recorded in the Nasuhlar-Bulduk section at the sample 17, in the Belen section from the sample 14-10 to the sample 14-11 (~2,5 m). The composite P2+P3 Zone in the Toylar section corresponds to the interval between the sample 32 and the sample 36 (~12 m).

P4. *Globanomalina pseudomenardii* Taxon Range Zone

Bolli, 1957

Age: Late Selandian-Mid Thanetian; 59.2-55.9 mya; approx. duration ~3.3 Ma

Definition: Biostratigraphic interval defined by the total range of the nominate taxon, *Globanomalina pseudomenardii*. Berggren *et al.* (1995) and Olsson *et al.* (1999) also used the same zone name with the same definition (Table 3.4). Berggren and Pearson (2005) have redefined the lower zonal boundary by the FAD of *Parasubbotina variospira* (Table 3.4).

Remarks: The recognition of this zone is based on FAD of other auxillary markers such as *Acarinina subsphaerica* and *Morozovella occlusa* (Premoli Silva *et al.* 2003), since the zonal taxon, *Globanomalina pseudomenardii* is rare in the examined sections (Figures 2.3, 2.6 and 2.9).

Acarinina sp., *Acarinina soldadoensis, Acarinina subsphaerica, Globanomalina chapmani, Globanomalina compressa, Globanomalina ehrenbergi, Igorina* sp., *Morozovella* sp., *Morozovella aequa, Morozovella angulata, Morozovella occlusa, Morozovella velascoensis, Subbotina* sp., *Subbotina triangularis, Subbotina triloculinoides* and *Subbotina velascoensis* are other faunal constituents of this zone at the study area (Figures 2.3, 2.6 and 2.9).

Local section range: P4 Zone has been recorded in the Nasuhlar-Bulduk section between the sample 19 and the sample 23 (~23 m) but the lower zonal boundary could not been determined (see Nasuhlar-Bulduk section, Chapter 2), in the Toylar section from the sample 37 to the sample 39B (~10 m), and in the Belen section from the sample 15 to the sample 19 (~42 m).

3.3. Systematics and Taxonomy

Identification of the planktonic foraminifera is generally based on three-dimensional views than two dimensional views. Contrary to the Cretaceous planktonic foraminifera, most of which are recognizable as two dimensions because of their distinctive morphologies, only several Paleocene taxa can be identified in species level from thin section views. Planktonic foraminifera are diagnosed in species level by the description of numerous morphologic characters from three views of the free test (spiral, umbilical and side views).

In thin section studies some other morphologic characters are recognizable both in axial and subaxial sections such as, coiling mode (trochospiral, planospiral or serial), shape of the test (concavity and/or convexity of both spiral and umbilical parts), peripheral outline of the chamber (globular, hemispherical, angular, subangular, truncated, ovoid etc.), characteristic overall test periphery in axial section (rectangular, triangular, flabelliform etc.), presence of carina / keel (single or double) and their positions in peripheral part (widely or closely spaced, at spiral and/or umbilical side), height of the spire (height difference of the former and latter chambers, valued from very low to very high), umbilical state (narrow, wide, small, deep etc.), test wall texture (pustulose, rugose, spinose etc.) and some peculiar features (presence of pseudokeel, thickness of the carinal band, thickness of the chamber wall, specific last chamber geometry, additional chamberlets). Therefore, the correct identification of the planktonic foraminiferal depends on studying them in axially oriented secions, which is the main concern in the examination method of the present study. Some morphologic characters are only useful in identification of the individuals (free test) such as, wall structure (perforation level, i.e. the pore diameter), number of the whorls, chamber shape and increasing of the chamber size (especially in the last whorl), shape of the suture and being deep or raised, shape and position of the primary aperture, presence of the secondary or relict apertures and modifications of the aperture (bulla, tegilla, portici, lip).

The modern cladistic method based on synapomorphic characters is more scientific as supported by detailed biological and palaeontological analysis and is compatible with new discoveries, thus, has suppressed the classical Linnean taxonomy, a hierarchial classification designed to cover living beings, later on, adapted to cover

also the fossil beings. Since the ancient method is just based on empirical definitions, its aggregate hierarchy always confuses minds, while new discoveries and technics force to replace the original positions of existing taxa. As a crucial example, the Foraminifera group is ranked as Phylum (also cited in here), as Classis or sometimes as Subclassis in various sources. Besides inventing new names for the aggregated ranks, a taxonomy based on groups of equivalent ranks in evolutionary sense has to be the point, in other words, modern phylogenetic groups should be considered instead of the ranks while constructing the taxonomy, as used in synapomorphy based cladistics (Hennig 1965, 1966). Janvier 1984, de Queiroz and Gauthier 1990, Valentine 2004 and references all therein, discusses about the comparison of eclectic method versus cladistic method, which are recommended for further reading.

Some modern phylogeny-based classifications, comparing the stems of the foraminifera group as (hierarchial nomenclature in parantheses);

EUCARYA (WOESE *et al.*, 1990, Domain)

in Woese *et al.* (1990). Besides this work, a revised six-kingdom system has also been proposed by Cavalier-Smith, in 1998, 2002 and 2003 respectively.

EUKARYOTA (CAVALIER-SMITH, 1998, Empire)
PROTOZOA (CAVALIER-SMITH, 2002, 2003, Kingdom)
RHIZARIA (CAVALIER-SMITH, 2002, Infrakingdom)

Afterwards, the consensus group within the phylogeny of eukaryotes according to Baldauf *et al.* (2003);

CERCOZOA (CAVALIER-SMITH, 1998)

The rest are widely used classification terms for the morphospecies, with the supposed Linnean hierarchial equivalents in parantheses, based on various sources. Only the binominal nomenclature has to be used, in any case, this is the only distinguishable feature in any life form in evolutionary sense.

FORAMINIFERA (D'ORBIGNY, 1826 phylum)
ROTALIDIA (classis)
GLOBIGERINIDA (DELAGE and HÉROUARD, 1896 ordo)
GLOBIGERININA (subordo)
GLOBOTRUNCANACEA (BROTZEN, 1942 superfamilia)
GLOBOTRUNCANIDAE (BROTZEN, 1942 familia)
ABATHOMPHALINAE (PESSAGNO, 1967 subfamilia)

ABATHOMPHALUS (BOLLI, LOEBLICH and TAPPAN 1957, genus)

Type species: *Globotruncana mayaorensis* BOLLI, 1951

Abathomphalus mayaroensis (BOLLI, 1951)

Pl. 3, figs. 1-3

1951. *Globotruncana mayaroensis* BOLLI; pl. 35, figs. 10-12.

1971. *Globotruncana mayaroensis* BOLLI; POSTUMA, p.50, 51.

1984. *Abathomphalus mayaroensis* (BOLLI); ROBASZYNSKI *et al.*, p.272, pl.46, fig.5 a-c.

1999. *Abathomphalus mayaroensis* (BOLLI); ÖZKAN-ALTINER and ÖZCAN, p. 294, fig. 5/7.

2004. *Abathomphalus mayaroensis* (BOLLI); PREMOLI SILVA and VERGA, p.72, pl.2, figs. 1-4, p.231, p.1, figs.3-8.

2010. *Abathomphalus mayaroensis* (BOLLI); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, figs. 10, 11, 15.

Description & Remarks: Test low trochospiral, spiral side slightly convex, umbilical side concave, periphery rectangular, truncated, with two widely spaced keels. Chamber surface on spiral side slightly inflated, keel band of last chamber generally wider than its opposite chamber. Umbilicus is wide.

It differs from *Globotruncana linneiana* by its narrower and often asymmetrical keel band.

Only 3 specimens present in all sections, two in Belen section, one in Toylar section.

Local Stratigraphic Range: Identified only within the *Abathomphalus mayaroensis* Zone in Belen (Figure 2.8) and Toylar (Figure 2.10) sections.

GLOBOTRUNCANINAE (BROTZEN, 1942 subfamilia)

CONTUSOTRUNCANA (KOREHAGIN, 1982, genus)

Type species: *Pulvulina arca* var. *contusa*, CUSHMAN, 1926

Contusotruncana contusa (CUSHMAN, 1926)

Pl. 1, figs. 1-4

1926. *Pulvinulina arca* CUSHMAN var. *contusa* CUSHMAN; p. 23, no type figure given.

1971. *Globotruncana contusa* (CUSHMAN); POSTUMA, p. 30, 31.

1984. *Rosita contusa* (CUSHMAN); ROBASZYNSKI *et al*., p. 247, pl. 36, figs. 1-2; p. 249, pl. 37, figs. 1-3.

1988. *Globotruncana contusa* (CUSHMAN); KELLER, p. 250, pl. 1, fig. 9.

1988. *Rosita contusa* (CUSHMAN); ÖZKAN and KÖYLÜOĞLU, pl. 4, figs. 3, 4.

1997. *Contusotruncana contusa* (CUSHMAN); LUCIANI, p. 804, text fig. 3, fig. 1.

1999. *Contusotruncana contusa* (CUSHMAN); ÖZKAN-ALTINER and ÖZCAN, p. 294, fig. 5/2.

2002. *Rosita contusa* (CUSHMAN); KELLER *et al*., p. 279, pl. 2, figs. 9, 10.

2004. *Contusotruncana contusa* (CUSHMAN); CHACON *et al*., p. 590, text fig. 4, figs. C, D.

2004. *Contusotruncana contusa* (CUSHMAN); PREMOLI SILVA and VERGA, p. 78, pl. 8, figs. 1-2; p. 233, pl. 3, figs. 1-12.

2010. *Contusotruncana contusa* (CUSHMAN); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, fig. 26.

Description & Remarks: Test large and very high trochospiral, axial periphery conical, spiral side strongly convex, umbilical side concave with large and deep umbilicus, two spaced keels developed, last chamber generally one keeled due to lack of umbilical keel.

It differs from the other species of *Contusotruncana* by having very high-spired test and large and deep umbilicus.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

***Contusotruncana fornicata* (**PLUMMER 1931)

Pl. 1, figs. 5, 6

1931. *Globotruncana fornicata* PLUMMER; p. 130, pl. 13, figs. 4 a-c.

1971. *Globotruncana fornicata* PLUMMER; POSTUMA, p. 38, 39.

1984. *Rosita fornicata* (PLUMMER); ROBASZYNSKI *et al.*, p. 251, pl. 38, figs.1-4.

1987. *Rosita fornicata* (PLUMMER); ÖZKAN and ALTINER, pl. 5, fig. 7.

1988. *Rosita fornicata* (PLUMMER); ÖZKAN and KÖYLÜOĞLU, pl. 4, figs. 5, 6.

1992. *Globotruncana fornicata* (PLUMMER); NORRIS, p. 171, pl.2, figs. d-g.

2000. *Globotruncana fornicata* (PLUMMER); ROBASZYNSKI *et al.*, p. 481, pl.20, fig 3.

2003. *Contusotruncana fornicata* (PLUMMER); PREMOLI SILVA and VERGA, p.78-9, pl. 8, figs 3-4, pl. 9, figs. 1, p.233-4, pl. 3, fig 13-15, pl. 4, figs. 1-9.

Description & Remarks: Test low to medium trochospiral, spiral side moderately convex, umbilical side flat, umbilicus large and shallow, periphery with double keels, keel band broad.

It is easily distinguished from *Contusotruncana contusa, Contusotruncana patelliformis, Contusotruncana plicata and Contusotruncana walfischensis* by its less convex spiral side, from *Contusotruncana plummera* by having flattened surfaces of chambers in the last whorl.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Contusotruncana patelliformis (GANDOLFI, 1955)

Pl. 1, figs. 7-11

1955. *Globotruncana* (*Globotruncana*) *contusa* (Cushman) subsp. *patelliformis* GANDOLFI; p.126, pl.34, figs. 7- 9.

1984. *Rosita patelliformis* (GANDOLFI); ROBASZYNSKI *et al.*, p. 253, pl. 39, figs. 1-3.

1988. *Rosita patelliformis* (GANDOLFI); ÖZKAN and KÖYLÜOĞLU, pl. 4, fig. 8.

2000. *Contusotruncana patelliformis* GANDOLFI; ROBASZYNSKI *et al.*, p. 481, p. 20, fig. 5.

2004. *Contusotruncana patelliformis* GANDOLFI; PREMOLI SILVA and VERGA, p.79, pl. 9, figs. 2-4.

Description & Remarks: Test moderate to high trochospiral, spiroconvex, spiral side strongly convex, umbilical side flat. Periphery double keeled, umbilicus wide. Surface of last chamber somewhat concave on spiral side.

It differs from *Contusotruncana contusa* by having less convexity of its spiral side; from *Contusotruncana plicata* by having more higher spired test.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Contusotruncana plicata (WHITE, 1928)

Pl. 2, figs. 1-5

1928. *Globotruncana conica* White var. *plicata* White, p.285, pl. 38, figs. 8a-c.
1984. *Rosita plicata* (WHITE); ROBASZYNSKI *et al.*, p. 255, pl. 40, figs. 1-2.
1987. *Rosita plicata* (WHITE); ÖZKAN and ALTINER, pl. 5, fig. 8.
1988. *Rosita plicata* (WHITE); ÖZKAN and KÖYLÜOĞLU, pl. 4, fig. 7.
2000. *Contusotruncana plicata* WHITE; ROBASZYNSKI *et al.*, p. 469, p. 14, fig. 3.
2004. *Contusotruncana plicata* WHITE; PREMOLI SILVA and VERGA, p. 80, p. 10, figs. 1, 2.

Description & Remarks: Test moderately high trochospiral, spiroconvex, spiral side moderately convex, umbilical side flat, umbilicus wide. Periphery with two keels, umbilical keel often weakly developed on the last chamber. Height of the chambers on the last whorl (opening of the spire) much more than inner whorls. Surface of the chambers on the last whorls inflated.

It is distinguished from *Contusotruncana contusa* and *Contusotruncana patelliformis* by having inflated chambers on the last whorl and less convexity of its spiral side.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Contusotruncana walfischensis (TODD, 1970)

Pl. 2, figs. 6-9

1970. *Globotruncana walfischensis* TODD; p. 153, pl. 5, fig. 8.
1984. *Rosita walfischensis* (TODD); ROBASZYNSKI *et al*., p. 259, pl. 42, figs. 1-4.
1987. *Rosita walfischensis* (TODD); ÖZKAN and ALTINER, pl. 5, fig. 11.
1997. *Contusotruncana walfischensis* (TODD); LUCIANI, p. 804, text fig. 3, fig. 2.
2003. *Rosita walfischensis* (TODD); ABRAMOVICH *et al*., p. 15, pl. 5, fig. 19.
2004. *Contusotruncana walfischensis* (TODD); CHACON *et al*., p. 589, text fig. 3, fig. B; p. 590, text fig. 4, figs. E, F.
2004. *Contusotruncana walfischensis* (TODD); PREMOLI SILVA and VERGA, p. 81, pl. 11, figs. 2-4; p. 235, pl. 5, figs. 1-3.

Description & Remarks: Test high trochospiral, spiroconvex, spiral side broadly conical, almost ovoid, umbilical side flat. Periphery with two closely spaced keels, umbilical keel often less developed. Umbilicus medium sized and deep.

It differs from other *Contusotruncana* species by its broadly conical spiral side (nearly ovoid); from *Globotruncanita conica* by its double keeled periphery.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

GANSSERINA (CARON, GONZALES DONOSO, ROBASZYNSKI and WONDERS, 1984, genus)

Type species: *Globotruncana gansseri*, BOLLI, 1951

Gansserina gansseri (BOLLI 1951)

Pl. 3, figs. 4, 5

1951. *Globotruncana gansseri* BOLLI; p.196, pl. 35, figs. 1-3.
1971. *Globotruncana gansseri* (BOLLI); POSTUMA, p. 42, 43.
1984. *Gansserina gansseri* (BOLLI); ROBASZYNSKI *et al.*, p. 295, pl. 52, figs. 1-4.
1988. *Gansserina gansseri* (BOLLI); ÖZKAN and KÖYLÜOĞLU, pl. 2, fig. 9.
1999. *Gansserina gansseri* (BOLLI); ÖZKAN-ALTINER and ÖZCAN, p. 294, fig. 5/8- 10.
2010. *Gansserina gansseri* (BOLLI); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, figs.12, 13.

Description & Remarks: Test very low trochospiral, planoconvex, spiral side almost flat or slightly convex, umbilical sidestrongly inflated, periphery distinctly single keeled. Chambers hemispherical, surface of the test (generally except last chamber) and around the umbilicus pustulose. Umbilicus wide and deep.

It differs from *Globotruncanita angulata* by its hemispherical chambers in the last whorl and no subangular periphery in axial profile.

Only 2 specimens present in all sections, one in Belen section, the other in Toylar section.

Local Stratigraphic Range: Identified only within the *Gansserina gansseri* Zone in Belen (Figure 2.6) and Toylar (Figure 2.9) sections.

GLOBOTRUNCANA (CUSHMAN 1927, genus)

Type species: *Pulvulina arca*, CUSHMAN, 1926

Globotruncana arca (CUSHMAN 1926)

Pl. 3, figs. 6-10

1926. *Pulvinulina arca* CUSHMAN; p. 23, pl.3, fig.1.

1971. *Globotruncana arca* (CUSHMAN); POSTUMA, p. 18, 19.

1984. *Globotruncana arca* (CUSHMAN); ROBASZYNSKI *et al*., p. 183, pl. 4, figs. 1-3.

1988. *Globotruncana arca* (CUSHMAN); ÖZKAN and KÖYLÜOĞLU, pl. 1, figs. 4, 6.

2004. *Globotruncana arca* (CUSHMAN); PREMOLI SILVA and VERGA, p. 104, pl. 34, figs. 3, 4; p.105, pl. 35, fig. 1; p. 240, pl. 10, figs. 11-15; p. 241, pl. 11, figs. 1-4.

Description & Remarks: Test large, moderately high trochospiral, unequally biconvex, spiral side convex, broadly arched, umbilical side moderately inflated. Axial periphery truncated, with widely spaced double keels. Umbilicus wide.

It differs from *Globotruncana falsostuarti* by having well developed broad keel band; from *Globotruncana oientalis* by having double keels on the last chamber.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncana bulloides VOGLER, 1941

Pl. 3, figs. 11-14

1941. *Globotruncana linnei* (D'ORBIGNY) subsp. *bulloides* VOGLER; p. 287, pl. 23, figs. 32-39.

1971. *Globotruncana bulloides* VOGLER; POSTUMA, p. 20, 21.

1984. *Globotruncana bulloides* VOGLER; ROBASZYNSKI *et al.*, , p. 187, pl. 6, figs. 1–4.

1988. *Globotruncana bulloides* VOGLER; ÖZKAN and KÖYLÜOĞLU, pl. 1, figs. 7, 8.

2004. *Globotruncana bulloides* VOGLER; PREMOLI SILVA and VERGA, , p. 105, p. 35, figs. 2-4.

Description & Remarks: Test very low trochospiral, spiral side almost flat or slightly convex, surfaces of the chambers inflated on both spiral and umbilical side. Axial periphery truncated by widely spaced double keel. Umbilicus wide.

This species is easily differentiated from the other *Globotruncana* species by its much characteristic feature (inflated chambers surface on spiral and umbilical side).

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

Globotruncana dupeublei CARON, GONZALES DONOSO, ROBASZYNSKI and WONDERS, 1984

Pl. 3, figs. 15, 16

1984. *Globotruncana dupeublei* CARON *et al*.; p. 188, 190, pl. 7, fig. 1, 2.

1984. *Globotruncana dupeublei* CARON *et al.*; ROBASZYNSKI *et al*., p.189, pl. 7, figs.1-2.

1988. *Globotruncana dupeublei* CARON *et al.*; ÖZKAN and ALTINER, pl. 5, fig. 3.

1999. *Globotruncana dupleubei* CARON *et al.*; ÖZKAN-ALTINER and ÖZCAN, p. 294, fig. 4/7.

2004. *Globotruncana dupeublei* CARON *et al.*; PREMOLI SILVA and VERGA, p. 106, pl. 36, figs. 1, 2.

Description & Remarks: Test moderately high trochospiral, biconvex, single peripheral keeled. Umbilicus wide and deep.

Globotruncana dupeublei show some morphological characteristics with *Globotruncana esnehensis* especially as the single keeled feature. It differs from *Globotruncana esnehensis* by its biconvex test; from *Globotruncana falsostuarti* and *Globotruncana orintalis* by its single keeled periphery; from *Globotruncanita stuarti* by its less convex spiral side.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncana esnehensis NAKKADY, 1950

Pl. 4, figs. 1, 2

1950. *Globotruncana arca* (CUSHMAN) var. *esnehensis* NAKKADY; p. 690, pl. 90, figs. 23–26.

1984. Globotruncana esnehensis NAKKADY; ROBASZYNSKI and others, 192, 301, pl. 9, figs. 1–4.

1987. *Globotruncana esnehensis* NAKKADY; ÖZKAN and ALTINER, pl. 5, figs. 1, 2, 10.

1988. *Globotruncana esnehensis* NAKKADY; ÖZKAN and KÖYLÜOĞLU, pl. 1, fig. 10.

2004. *Globotruncana esnehensis* NAKKADY; PREMOLI SILVA and VERGA, p.106, pl. 36, fig. 3-4.

2010. *Globotruncana esnehensis* NAKKADY; HAKYEMEZ and ÖZKAN-ALTINER pl. 2, fig. 29.

Description & Remarks: Test moderately high trochospiral, unequally biconvex, spiral side convex, umbilical side silghtly convex, periphery single keeled. Umbilicus wide.

It is somewhat similar to *Globotruncanita conica*. It differs from *Globotruncanita conica* by ts less convex spiral side; from *Globotruncana dupeublei* by its unequally biconvex and generally smaller test.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncana falsostuarti SIGAL, 1952

Pl. 4, figs. 3, 4

1952. *Globotruncana falsostuarti* SIGAL; p. 43, text fig. 46.

1971. *Globotruncana falsostuarti* SIGAL; POSTUMA, p. 36, 37.

1984. *Globotruncana falsostuarti* SIGAL; ROBASZYNSKI *et al*., p. 195, pl. 10, figs. 1-3.

1988. *Globotruncana falsostuarti* SIGAL; ÖZKAN and KÖYLÜOĞLU, pl. 2, fig. 1.

2004. *Globotruncana falsostuarti* SIGAL; PREMOLI SILVA and VERGA, p. 107, pl. 37, figs. 1, 2; p. 241, pl. 11, figs. 13-15; p. 242, pl. 12, figs. 1-6.

Description & Remarks: Test moderately high trochospiral, biconvex, truncated with very closely spaced keels in the axial profile. The closely spaced double keeled periphery is the most characteristic feature of this species. Umbilical keel often absent on the last chamber. Umbilicus wide and deep.

It differs from *Globotruncana arca* and *Globotruncana orientalis* by its very narrower keel band; from *Globotruncana dupeublei* and *Globotruncana esnehensis* by double keeled periphery.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

Globotruncana hilli PESSAGNO, 1967

Pl. 4, figs. 5-7

1967. *Globotruncana hilli* PESSAGNO; p. 343, 344, pl. 64, figs. 9-14, 21-23; pl. 94, fig. 1; pl. 97, fig. 7.

2004. *Globotruncana hilli* PESSAGNO; PREMOLI SILVA and VERGA, p. 107, pl. 37, figs.3, 4; p. 242, pl. 12, figs. 7-12.

Description & Remarks: Test small, very low trochospiral, spiral side almost flat, umbilical side inflated. Opposite chamber of the last one in the final whorl spherical, lacking double keel. Last chamber in axial profile truncated with widely spaced double keel of *Globotruncana linneiana* type. Surface of the last chamber slightly inflated or flat on the spiral side. Umbilicus medium sized and shallow.

It differs from *Globotruncana linneiana* by its smaller test and the presence of double keel on only last chamber.

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

Globotruncana insignis GANDOLFI, 1955

Pl. 4, figs. 8-10

1955. *Globotruncana rosetta* CARSEY subsp. *insignis* GANDOLFI, p. 67, pl. 6, figs. 2 a-c.

1984. *Globotruncana insignis* GANDOLFI, ROBASZYNSKI *et al.*, p. 197, pl. 11, figs. 1–3; p. 199, pl. 12, figs. 1-3.

2004. *Globotruncana insignis* GANDOLFI, PREMOLI SILVA and VERGA, , p. 108, p. 38, figs. 1, 2.

Description & Remarks: Test low trochospiral, umbilico-convex, spiral side slightly convex, umbilical side strongly convex. Axial periphery angular with single keel. Last and opposite chamber in the final whorl nearly equal in size. Umbilicus wide and deep.

This single keeled *Globotruncana* species differs from *Globotruncanita stuarti* by its less convex spiral side; from *Globotruncanita angulata* by its more acute periphery of the chambers; from *Globotruncanita stuartiformis* by more equal sized chambers of the last whorl in axial profile.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncana lapparenti BROTZEN, 1936

Pl. 4, figs. 11, 12

1936. *Globotruncana lapparenti* BROTZEN, p. 175-6, numerious figures of thin sections in de Lapparent's thesis, 1918.
1967. *Globotruncana lapparenti* BROTZEN; PESSAGNO, p.314 pl.2 (lectotype).
2004. *Globotruncana lapparenti* BROTZEN; PREMOLI SILVA and VERGA, p. 108-9, pl. 38, figs. 3-4, p. 243, pl. 13, figs. 2-5.

Description & Remarks: Test low trochospiral, spiral side slightly convex, umbilical side flat, truncated by well-developed double keel. Umbilicus wide.

It differs from *Globotruncana linneiana* by having narrower kell band; from *Globotruncana arca* by less convexity of the spiral side and narrower keel band.

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

Globotruncana linneiana (D'ORBIGNY, 1839)

Pl. 4, figs. 13, 14

1839. *Rosalina linneiana* D'ORBIGNY; p. 101, pl 5, figs. 10-12.
1984. *Globotruncana linneiana* (D'ORBIGNY); ROBASZYNSKI *et al.*, p. 201, pl. 13, figs. 1–4; p. 203, pl.14, figs. 1-5.
1988. *Globotruncana linneiana* (D'ORBIGNY); ÖZKAN and KÖYLÜOĞLU, pl. 1, figs. 11, 12.
2004. *Globotruncana linneiana* (D'ORBIGNY); PREMOLI SILVA and VERGA, p. 109, pl. 39, figs. 2-4.

Description & Remarks: Test very low trochospiral, relatively planiform both spirally and umbilically, spiral side flat to slightly convex, umbilical side flat, periphery with widely spaced double keel. Umbilicus deep. This species is characterized in axial profile by its box-like shape with widely spaced keels.

Globotruncana linneiana is most easily confused with *Globotruncana lapparenti.* It differs from *Globotruncana lapparenti* by its broad keel band and flattened spiral side. *Globotruncana linneiana* is also very close with morphological characteristics to *Abathomphalus mayaroensis*. It differs from *Abathomphalus mayaroensis* by its symmetrical axial profile with broad keel band.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncana mariei BANNER and BLOW, 1960

Pl. 4, figs. 15-18

1960. *Globotruncana mariei* BANNER and BLOW; pl. 11, fig. 6.

2004. *Globotruncana mariei* BANNER and BLOW; PREMOLI SILVA and VERGA, p. 110, pl. 40, figs.1-3; p. 244, pl. 14, fig. 1.

Description & Remarks: Test relatively small, low to mederately high trochospiral, biconvex or spiral side more convex than umbilical side. Periphery with double keel, umbilical keel often less developed. Umbilicus moderately wide.

It differs from *Globotruncana arca* by its smaller test and closely spaced keels.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

Globotruncana orientalis EL NAGGAR, 1966

Pl. 5, figs. 1-3

1966. *Globotruncana orientalis* EL NAGGAR; p. 125-127, pl. 12, figs. 4a-d.

1988. *Globotruncana orientalis* EL NAGGAR; ÖZKAN and KÖYLÜOĞLU, pl. 2, figs. 1-3.

1999. *Globotruncana orientalis* EL NAGGAR; ÖZKAN-ALTINER and ÖZCAN, p. 294, fig. 4/6.

2004. *Globotruncana orientalis* EL NAGGAR; PREMOLI SILVA and VERGA, p. 110, pl. 40, fig. 4; p. 111, pl. 41, figs. 1, 2; p. 244, pl. 14, figs. 2-9.

Description & Remarks: Test large, moderately high trochospiral, spiral side convex, umbilical side flat. Axial periphery truncated by with doubled keel, umbilical keel lacking on the spiral side.

Globotruncana orientalis is morphologically very similar to *Globotruncana arca*. It is distinguished from *G.arca* by its narrower keel band and not developed umbilical keel on the last chamber; from *Globotruncana falsosuarti* by its widely spaced keels.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncana rosetta (CARSEY, 1926)

Pl. 5, figs. 4-6

1926. *Globigerina rosetta* CARSEY; p. 44, pl. 5, figs. 3 a-b.
1984. *Globotruncana rosetta* (CARSEY); ROBASZYNSKI *et al.*, p. 211, pl. 18, figs. 1–5.
1988. *Globotruncana rosetta* (CARSEY); ÖZKAN and KÖYLÜOĞLU, pl. 2, figs. 5, 6.
2004. *Globotruncana rosetta* (CARSEY); PREMOLI SILVA and VERGA, p. 111, p. 41, figs. 3, 4.

Description & Remarks: Test low trochospiral, spiral side slightly convex, umbilical side moderately convex, periphery subacute with closely spaced double keel. Last chamber larger and umbilical keel often less developed on it. Umbilicus wide.

It differs from *Globotruncana mariei* by its more convex umbilical side, larger and subacute last chamber.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

GLOBOTRUNCANITA (REISS 1957, genus)

Type species: *Rosalina stuarti*, De LAPPARENT, 1918

Globotruncanita angulata (TILEV, 1951)

Pl. 5, figs. 7, 8

1951. *Globotruncana lugeoni* TILEV var. *angulata* TILEV; p. 46, pl. 3, fig. 1.
1984. *Globotruncanita angulata* (TILEV); ROBASZYNSKI *et al*., p. 221, pl. 23,

figs. 1-5.

1988. *Globotruncanita angulata* (TILEV); ÖZKAN and KÖYLÜOĞLU, pl. 2, fig.10.

2004. *Globotruncanita angulata* (TILEV); PREMOLI SILVA and VERGA, p. 115, pl. 45, figs. 1, 2; p. 247, pl. 17, figs. 1-5.

Description & Remarks: Test low trochospiral, planoconvex, spiral side slightly convex, umbilical side strongly convex. Periphery with single keel, early chamber of the last whorl visible in axial section of the last whorl angular-subangular, last chamber inflated. Umbilicus wide and deep.

It differs from *Gansserina gansseri* by its subangular-angular chamber periphery at the beginning of the last whorl.

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

Globotruncanita conica (WHITE, 1928)

Pl. 5, figs. 9-12

1928. *Globotruncana conica* WHITE; p. 285, pl. 38, figs. 7a-c.

1971. *Globotruncana conica* WHITE; POSTUMA, p. 28, 29.

1984. *Globotruncanita conica* (WHITE); ROBASZYNSKI *et al*., p. 227, pl. 26, figs. 1-3.

1987. *Globotruncana conica* WHITE; ÖZKAN and ALTINER, pl. 5, fig. 4

1988. *Globotruncanita conica* (WHITE); ÖZKAN and KÖYLÜOĞLU, pl. 3, figs.1,2.

2004. *Globotruncanita conica* (WHITE); PREMOLI SILVA and VERGA, p. 116, pl. 46, figs. 2-4; p. 247, pl. 17, figs. 7-13.

2010. *Globotruncanita conica* (WHITE); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, fig. 28.

Description & Remarks: Test high trochospiral, spiroconvex, spiral side broadly conical, umbilical side flat or slightly convex, axial periphery subangular with single keel. Umbilicus wide and deep.

It differs from high trochospiral *Contusotruncana* species by its single keeled periphery; from *Globotruncana esnehensis* by having high trochospiral test.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncanita pettersi (GANDOLFI, 1955)

Pl. 5, fig. 14, 15

1955. *Globotruncana* (*Globotruncana) rosetta* CARSEY subsp. *pettersi* GANDOLFI; p. 68, pl.6, fig. 3.

1984. *Globotruncanita pettersi* (GANDOLFI); ROBASZYNSKI *et al*., p. 233, pl. 29, figs. 1-5.

1987. *Globotruncanita pettersi* (GANDOLFI); ÖZKAN and ALTINER, pl. 5, fig. 9.

1988. *Globotruncanita pettersi* (GANDOLFI); ÖZKAN and KÖYLÜOĞLU, pl. 3, figs. 5, 6.

1999. *Globotruncanita pettersi* (GANDOLFI); ÖZKAN-ALTINER and ÖZCAN, p. 294, fig.5/2.

2004. *Globotruncanita pettersi* (GANDOLFI); PREMOLI SILVA and VERGA, p. 117, pl. 47, figs. 3, 4; p. 118, pl. 48, fig. 1; p. 248, pl. 18, figs. 11-12.

2010. *Globotruncanita pettersi* (GANDOLFI); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, fig. 26.

Description & Remarks: Test low trochospiral, planoconvex, spiral side slightly convex to almost flat, umbilical side strongly convex. Periphery single keeled, chambers in the final whorl generally angular or early chambers somewhat inflated in some specimens. Umbilicus wide and deep.

It differs *Globotruncanita angulata* by its generally more flattened spiral side and distinctly angular chambers in the last whorl.

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

Globotruncanita stuarti (De LAPPARENT, 1918)

Pl. 6, figs. 1-4

1918. *Rosalina stuarti* De LAPPARENT; p. 11, pl. 12, fig. 7, pl. 13, fig. 5.

1971. *Globotruncana stuarti* (De LAPPARENT); POSTUMA, p.60, 61.

1984. *Globotruncanita stuarti* (De LAPPARENT); ROBASZYNSKI *et al*., p. 235, pl. 30, figs. 1-3; p. 237, pl. 31, figs. 1-3.

1987. *Globotruncana stuarti* (De LAPPARENT); ÖZKAN and ALTINER, pl.5, fig.5.

1988. *Globotruncanita stuarti* (De LAPPARENT); ÖZKAN and KÖYLÜOĞLU, pl.3, figs.7-8.

2004. *Globotruncanita stuarti* (De LAPPARENT); PREMOLI SILVA and VERGA, p. 118, pl. 48, figs. 3, 4; p. 119, pl. 49, fig. 1; p. 248, pl. 18, figs. 13-15; p. 249, pl. 19, figs.1-7.

2010. *Globotruncanita stuarti* (De LAPPARENT); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, figs. 22, 24.

Description & Remarks: Test large, moderately high to high trochospiral, nearly equally biconvex, spiral side broadly convex, umbilical side convex, axial periphery strongly acute, single keeled. Umbilicus wide and deep.

It differs from *Globotruncanita stuartiformis* and *Globotruncana insignis* by having high-spired test; from *Globotruncanita conica* by its convex umbilical side.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncanita stuartiformis (DALBIEZ, 1955)

Pl. 6, figs. 5-9

1955. *Globotruncana* (*Globotruncana) elevata* BROTZEN subsp. *stuartiformis* DALBIEZ; p. 169, text fig 10a-c.

1971. *Globotruncana stuartiformis* DALBIEZ; POSTUMA, p. 62, 63.

1984. *Globotruncanita stuartiformis* (DALBIEZ); ROBASZYNSKI *et al*., p. 239, pl. 32, figs 1-4.

1987. *Globotruncanita stuartiformis* (DALBIEZ); ÖZKAN and ALTINER, pl. 5, fig.6.

1988. *Globotruncanita stuartiformis* (DALBIEZ); ÖZKAN and KÖYLÜOĞLU, pl. 3, figs. 9, 10; pl. 4, figs. 1, 2.

2004. *Globotruncanita stuartiformis* (DALBIEZ); PREMOLI SILVA and VERGA, p. 119, pl. 49, figs. 2-4; p. 249, pl. 19, figs. 8-15.

2010. *Globotruncanita stuartiformis* (DALBIEZ); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, fig. 23.

Description & Remarks: Test low trochospiral, spiral side slightly convex, central part (inner whorls) vaulted, umbilical side slightly convex at the beginning of the last

whorl, strongly convex at the end of the whorl (last chamber). Axial periphery acute with single keel. Umbilicus large and deep.

It differs from by *Globotruncanita stuarti* by its less convexity and central cone of spiral side and asymmetrical axial periphery.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

GLOBOTRUNCANELLINAE (MASLAKOVA, 1964 subfamilia)

GLOBOTRUNCANELLA (REISS 1957, genus)

Type species: *Globotruncana citae*, BOLLI, 1951

(or *Globotruncana havanensis*, VOORWIJK, 1937)

(or *Globorotalia pschadae*, KELLER 1946)

Globotruncanella havanensis (VOORWIJK, 1937)

Pl. 7, figs. 1-3

1937. *Globotruncana havanensis* VOORWIJK; p. 195, pl. 1, figs. 25, 26, 29.

1984. *Globotruncanella havanensis* (VOORWIJK); ROBASZYNSKI *et al*., p. 267, pl. 44, figs. 4-6.

1999. *Globotruncanella havanensis* (VOORWIJK); ÖZKAN-ALTINER and ÖZCAN, p. 294, fig.5/9.

2004. *Globotruncanella havanensis* (VOORWIJK); PREMOLI SILVA and VERGA, p.113, pl. 43, figs. 1, 2; p. 246, pl. 16, figs. 1-9.

2010. *Globotruncanella havanensis* (VOORWIJK); HAKYEMEZ and ÖZKAN-ALTINER, pl. 2, fig. 19.

Description & Remarks: Test trochospiral, spiral side convex, umbilical side concave, periphery lacking keel, chambers compressed, chambers in the last whorl very rapidly enlarge, umbilicus small – moderately wide.

It differs *Globotruncanella petaloidea* by its less compressed chambers and less convexity of the spiral side.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncanella minuta CARON and GONZALEZ DONOSO, 1984

Pl. 7, figs. 6, 7

1984. *Globotruncanella minuta* CARON and GONZALEZ DONOSO; p. 266, 302, pl. 43, figs. 5-8.

2004. *Globotruncanella minuta* CARON and GONZALEZ DONOSO; PREMOLI SILVA and VERGA, p.113, pl. 43, figs. 3, 4; p. 246, pl. 16, figs. 10, 11.

Description & Remarks: Test low trochospiral, spiral side slightly convex or periphery nearly symetrical, has no keel, chambers ovoid, umbilicus small.

It differs fron the other species of *Globotruncanell*a in its ovoid chambers (not compressed).

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncanella petaloidea (GANDOLFI, 1955)

Pl. 7, figs. 4, 5

1955. *Globotruncana* (*Rugoglobigerina*) *petaloidea* GANDOLFI subsp. *petaloidea* GANDOLFI; p. 52, pl. 3, fig. 13.

1984. *Globotruncanella petaloidea* (GANDOLFI); ROBASZYNSKI *et al*., p. 267, pl. 44, figs. 1-2.

2004. *Globotruncanella petaloidea* (GANDOLFI); PREMOLI SILVA and VERGA, p.114, pl. 44, figs. 1, 2; p. 246, pl. 16, fig. 12.

Description & Remarks: Test trochospiral, spiral side convex, umbilical side concave, lacking keel. Chambers compressed, petaloid and very enlarged in respect to those of the earlier whorls. Umbilicus small.

It differs from the other *Globotruncanella* species in having more compressed petaloid chambers and generally more convex spiral side.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Globotruncanella pschadae (KELLER, 1946)

Pl. 7, figs. 8-10

1946. *Globorotalia pschadae* KELLER; p. 99, pl. 2, figs. 4-6.

1984. *Globotruncanella pschadae* (KELLER); ROBASZYNSKI *et al.*, p. 267, pl. 44, fig. 7.

2004. *Globotruncanella pschadae* (KELLER); PREMOLI SILVA and VERGA, p. 114, p. 44, figs. 3, 4.

2010. *Globotruncanella pschadae* (KELLER); HAKYEMEZ and ÖZKAN-ALTINER pl. 2, fig. 18.

Description & Remarks: Test low trochospiral, biconvex or slightly spiroconvex, early chamber in the last whorl ovoid, last chamber compressed along the margin. Umbilicus wide and shallow.

It differs *Globotruncanella havanensis* and *Globotruncanella petaloidea* by its nearly symetrical periphery; from *Globotruncanella minuta* by more compressed last chamber.

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

RUGOGLOBIGERINIDAE (SUBBOTINA 1959 familia)

KUGLERINA (BRONNIMANN and BROWN, 1956, genus)

Type species: *Rugoglobigerina rugosa* subsp. *rotundata*, BRONNIMANN, 1952

Kuglerina rotundata (BRONNIMANN, 1952)

Pl. 7, figs. 11-13

1952. *Rugoglobigerina* (*Rugoglobigerina*) *rugosa* (Plummer) subsp. *rotundata* BRONNIMANN; p. 34, pl. 4, figs. 7-9.

1971. *Rugoglobigerina rotundata* (BRONNIMANN); POSTUMA, p. 88, 89.

2004. *Kuglerina rotundata* BRONNIMANN; PREMOLI SILVA and VERGA, p. 146, pl. 76, figs. 1-4, p. 253, pl. 23, figs. 12-13.

Description & Remarks: Large and subrounded test low trochospiral in the inner whorls, becomes higher spired in the last whorl. Chambers hemispherical, wall thick, surface of the chambers covered with densely coarse rugosities. Surface of the last chamber often smooth. Umbilicus moderate sized and deep.

It differs from *Rugoglobigerina pennyi* by having high-spired test, from *Rugoglobigerina milamensis* by its thick test wall and coarsely rugose surface of the chambers.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

RUGOGLOBIGERINA (BRONNIMANN, 1952, genus)

Type species: *Globigerina rugosa*, PLUMMER, 1927

Rugoglobigerina hexacamerata BRONNIMANN, 1952

Pl. 8, fig. 1

1952. *Rugoglobigerina* (*Rugoglobigerina*) *reicheli* BRONNIMANN subsp. *hexacamerata* BRONNIMANN; p. 23, pl. 2, figs. 10-12.

1984. *Rugoglobigerina hexacamerata* BRONNIMANN; ROBASZYNSKI *et al.*, p. 283, pl. 49, fig. 8.

2004. *Rugoglobigerina hexacamerata* BRONNIMANN; PREMOLI SILVA and VERGA, p.199, pl. 129, figs. 1, 2; p. 269, pl. 39, figs. 1, 2.

Description & Remarks: Test very low trochospiral, spiral side flat, chambers globular-subglobular, umbilicus wide. Surface, especially in initial part of the last whorl, covered rugosities.

It differs from *Rugoglobigerina rugosa* by its less small test and last chamber; from *R. pennyi* by chambers incease gradually in size; from *Rugoglobigerina milamensis* by its low-spired test.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

Rugoglobigerina macrocephala BRONNIMAN, 1952

Pl. 8, fig. 2

1952. *Rugoglobigerina* (*Rugoglobigerina*) *macrocephala* BRONNIMANN subsp. *macrocephala* BRONNIMANN; p. 25, pl. 2, figs. 1-3.

1984. *Rugoglobigerina macrocephala* BRONNIMANN; ROBASZYNSKI *et al*., p. 283, pl. 49, fig. 7.

2004. *Rugoglobigerina macrocephala* BRONNIMANN; PREMOLI SILVA and VERGA, p. 200, pl. 130, figs. 1-4; p. 269, pl. 39, figs. 3, 4.

Description & Remarks: Test low trochospiral, slightly depressed in the initial part of the test. Chambers subglobular, last chamber very large and occupies almost ½ of the test. The surface of the chambers especially early ones in the last whorl is rugose. Umbilicus moderately wide.

This species is characterized by large last chamber and it is easily distinguished from the other *Rugoglobigerina* species by its large-sized last chamber.

Local Stratigraphic Range: Identified in the first zone of the study area, *Gansserina gansseri* Zone and in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone.

Rugoglobigerina milamensis SMITH and PESSAGNO, 1973

Pl. 8, figs. 3-5

1973. *Rugoglobigerina milamensis* SMITH and PESSAGNO; p. 56, 57, pl. 24, figs. 4-7.

1984. *Rugoglobigerina milamensis* SMITH and PESSAGNO; ROBASZYNSKI *et al*., p. 287, pl. 50, fig. 3.

2004. *Rugoglobigerina milamensis* SMITH and PESSAGNO; PREMOLI SILVA and VERGA, p. 201, p. 131, fig. 1; p. 269, pl. 39, figs. 5, 6.

Description & Remarks: Test high trochospiral, spiral side convex, inner whorls more elevated to the last whorl, chambers spherical- subspherical, surface of the chambers finely rugose. Umbilicus moderate sized and deep.

It differs from all the other *Rugoglobigerina* species by having high spired test; from *Kuglerina rotundata* by generally having thin test wall and finely rogose surface of chambers.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Rugoglobigerina pennyi BRONNIMANN, 1952

Pl. 8, figs. 6-8

1952. *Rugoglobigerina* (*Rugoglobigerina*) *rugosa* (PLUMMER) subsp. *pennyi* BRONNIMANN; p. 34, pl. 4, figs. 1-3.

1984. *Rugoglobigerina pennyi* BRONNIMANN; ROBASZYNSKI *et al*., p. 287, pl. 50, fig.1.

2004. *Rugoglobigerina pennyi* BRONNIMANN; PREMOLI SILVA and VERGA, p. 201, pl.131, figs. 2-4; p. 269, pl. 39, fig. 7.

Description & Remarks: Test low trochospiral, spiral side flattened, umbilical side inflated, chambers subglobular, last chamber and its opposite one in the last whorl

nearly equal in size. Surface covered with strong rugosities but last chamber may be smooth. Umbilicus moderately wide and deep.

It differs from *Rugoglobigerina rugosa* and *Rugoglobigerina macrocephala* by having chambers increase slowly in size in the last whorl; from *Rugoglobigerina hexacamerata* by having larger chambers in the last whorl; from *Rugoglobigerina milamensis* by its low spired test.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Rugoglobigerina rugosa (PLUMMER, 1926)

Pl. 8, figs. 9-14

1926. *Globigerina rugosa* PLUMMER; p. 38, pl. 2, fig. 10 a.

1971 *Rugoglobigerina rugosa* (PLUMMER); POSTUMA, p. 90, 91.

1984. *Rugoglobigerina rugosa* (PLUMMER); ROBASZYNSKI *et al*., p. 283, pl. 49, figs. 4, 6.

2004. *Rugoglobigerina rugosa* (PLUMMER); PREMOLI SILVA and VERGA, p. 202, pl. 132, figs. 1-3; p. 269, pl. 39, figs. 8-11.

Description & Remarks: Test low trochospiral, spiral side almost flat, umbilical side inflated, chambers subglobular, last chamber is about twice as large as its opposite one in the last whorl. Surface of the chambers covered rugosities. Umbilicus wide.

It differs from *Rugoglobigerina macrocephala* by its less smaller last chamber; from *Rugoglobigerina hexacamerata* and *Rugoglobigerina pennyi* by its more larger last chamber; from *Rugoglobigerina milamensis* by its low spired test.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

TRINITELLA (BRONNIMANN, 1952, genus)

Type species: *Trinitella scotti*, BRONNIMANN, 1952

Trinitella scotti BRONNIMAN, 1952

Pl. 9, figs. 1-4

1952. *Trinitella scotti* BRONNIMANN; p. 57, pl. 4, figs. 4-6, p.58, text figs. 30 a-m.

1971. *Rugoglobigerina scotti* (BRONNIMANN); POSTUMA, p. 92, 93.

2003. *Trinitella scotti* BRONNIMANN; PREMOLI SILVA and VERGA, p.211, pl.141, figs. 1-4, p.272, pl. 42, figs. 6-8.

2010. *Trinitella scotti* BRONNIMANN; HAKYEMEZ and ÖZKAN ALTINER pl. 2, figs. 14, 16.

Description & Remarks: Test low trochospiral, spiral side flat, elongate in the direction of the last chamber. Opposite chamber of the last chamber in the last whorl subglobular and covered by coarse rugosities. Last chamber compressed, elongate, flattened on the spiral side and its surface smooth. Umbilicus large and shallow.

This species is easily distinguished from all *Rugoglobigerina* species by its elongate and compressed last chamber.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

PLANOMALINACEA (BOLLI, LOEBLICH and TAPPAN, 1957, superfamilia)

GLOBIGERINELLOIDIDAE (LONGORIA, 1974, familia)

GLOBIGERINELLOIDINAE (LONGORIA, 1974, subfamilia)

MACROGLOBIGERINELLOIDES

(VERGA and PREMOLI SILVA, 2004, genus)

Type species: *Anomalina bentonensis*, MORROW 1934

Macroglobigerinelloides prairiehillensis (PESSAGNO, 1967)

Pl. 9, figs. 5, 6

1967. *Globigerinelloides prairiehillensis* PESSAGNO; p. 277, 278, pl. 60, figs. 2, 3; pl. 83, fig. 1; pl. 90, figs. 1, 2, 4; pl. 97, figs. 3, 4.

1996. *Globigerinelloides prairiehillensis* PESSAGNO; p. 311, pl. 1, fig. 2.

2004. *Macroglobigerinelloides prairiehillensis* (BRONNIMANN); PREMOLI SILVA and VERGA, p. 156, pl. 86, figs. 4-6; p. 256, pl. 26, figs. 4-6.

Description & Remarks: Test planispiral, chambers spherical and rapidly increasing in size.

It differs from *Macroglobigerinelloides subcarinatus* and *Macroglobigerinelloides messinae* in having spherical chambers; differs from *Macroglobigerinelloides alvarezi* and *Macroglobigerinelloides ultramicrus* in rapidly increasing chamber size.

Local Stratigraphic Range: Ranged from the first zone of the study area, *Gansserina gansseri* Zone to the *Abathomphalus mayaroensis* Zone.

Macroglobigerinelloides subcarinatus (BRONNIMANN, 1952)

Pl. 9, figs. 7-9

1952. *Globigerinella messinae* BRONNIMANN subsp. *subcarinata* BRONNIMANN; p. 44, pl. 1, figs. 10, 11; text figs. 21a-m.

1964. *Globigerinelloides subcarinatus* (BRONNIMANN); OLSSON, p. 187, pl. 7, figs. 9, 10.

1967. *Globigerinelloides subcarinatus* (BRONNIMANN); PESSAGNO, p. 278, pl. 62, figs. 12, 13.

1988. *Globigerinelloides subcarinatus* (BRONNIMANN); KELLER, p. 252, pl. 2, fig. 2.

2004. *Macroglobigerinelloides subcarinatus* (BRONNIMANN); PREMOLI SILVA and VERGA, p. 157, pl. 87, figs. 1-3; p. 256, pl. 26, figs. 10-13.

Description & Remarks: Test planispiral, chambers much compressed, subcarinate and slowly or gradually increasing in size.

It differs from *Macroglobigerinelloides messinae* by its more compressed chambers.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

HETEROHELICACEA (CUSHMAN, 1927, superfamilia)

HETEROHELICIDAE (CUSHMAN, 1927, familia)

HETEROHELICINAE (CUSHMAN, 1927, subfamilia)

PSEUDOTEXTULARIA (RZEHAK, 1891, genus)

Type species: *Cuneolina elegans* RHEZAK, 1891

Pseudotextularia elegans (RZEHAK, 1891)

Pl. 9, fig. 10

1891. *Cuneolina elegans* RZEHAK; p. 4, pl. 7, figs. 1a, b (lectotype), holotype not given.

1988. *Pseudotextularia elegans* (RZEHAK); KELLER, p. 250, pl. 1, fig. 17.

2004. *Pseudotextularia elegans* (RZEHAK); PREMOLI SILVA and VERGA, p. 185, pl. 115, figs. 1-3; p. 264, pl. 34, figs. 6-13.

Description & Remarks: The characteristic features of *Pseudotextularia* genus is distinguished in side view of the test. Chambers gradually increase in size in the early portion of the test of *Pseudotextularia elegans*. In later part, chambers laterally compressed (width of the chamber much more than the hight). Overall shape of the test is triangular in side view.

It differs from *Pseudotextularia nuttalli* by having thich wall and laterally compressed chambers rather than reniform chambers

Local Stratigraphic Range: Identified only within the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone in the Belen section (Figure 2.8)

Pseudotextularia intermedia De KLASZ, 1953

Pl. 9, figs. 13-15

1953. *Pseudotextularia intermedia* De KLASZ, p. 231-232, pl. 5, figs. 2a-c.

2004. *Pseudotextularia intermedia* De KLASZ; PREMOLI SILVA and VERGA, p. 185, pl. 115, figs. 4-5, p.186 pl.116, figs. 1-2.

Description & Remarks: Test resembles to *Pseudotextularia nuttalli* in terms of the general test shape. It is characterized by two smaller chamberlets developed on the last chambers.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

Pseudotextularia nuttalli (VOORWIJK, 1937)

Pl. 9, figs. 11, 12

1937. *Guembelina nuttalli* VOORWIJK; p. 192, pl. 2, figs. 1-9.

1991. *Pseudotextularia nuttalli* (VOORWIJK); NEDERBRAGT, p. 363, pl. 10, figs. 4, 6.

2004. *Pseudotextularia nuttalli* (VOORWIJK); PREMOLI SILVA and VERGA, p. 186, pl. 116, figs. 3-5; p. 264, pl. 34, fig. 14.

Description & Remarks: Early portion of the test (first 3-4 chambers) increase gradually in size. The most characteristic feature is the reniform last two or three chambers rapidly enlarged (width much more than height), test wall is thin.

Local Stratigraphic Range: Identified only within the *Abathomphalus mayaroensis* Zone in the Toylar section (Figure 2.10).

HETEROHELIX (EHRENBERG, 1843, genus)

Type species: *Textularia americana* EHRENBERG, 1843

Heterohelix globulosa (EHRENBERG, 1840)

Pl. 10, fig. 1

1840. *Textularia globulosa* EHRENBERG; p. 135, pl. 4, fig. 2b, 4b, 5b, 7b, 8b.
1991. *Heterohelix globulosa* EHRENBERG; NEDERBRAGT, p. 347, pl. 2, figs. 1,2.
2004. *Heterohelix globulosa* EHRENBERG; PREMOLI SILVA and VERGA, p. 140, pl. 70, figs. 5-7; p. 252, pl. 22, figs. 13, 14.

Description & Remarks: Test biserial, very characteristic by globular chambers inreasing gradually in size, wall is thin.

Local Stratigraphic Range: Identified only within the *Abathomphalus mayaroensis* Zone in the Toylar section (Figure 2.10).

Heterohelix punctulata (CUSHMAN, 1938)

Pl. 10, fig. 2

1938. *Guembelina punctulata* CUSHMAN; p. 13, pl. 2, figs. 15, 16.
1988. *Pseudoguembelina punctulata* CUSHMAN; KELLER, p. 252, pl. 2, fig. 10.
1991. *Heterohelix punctulata* CUSHMAN; NEDERBRAGT, p. 349, pl. 3, fig. 6.
2004. *Heterohelix punctulata* CUSHMAN; PREMOLI SILVA and VERGA, p. 143, pl. 73, figs. 1-5; p. 253, pl. 23, fig. 5.

Description & Remarks: This species is very characteristic by having large and robust, biserial, thick walled test and very rapidly enlarging chambers.

Local Stratigraphic Range: Identified only within the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone in the Toylar section (Figures 2.9 and 2.10).

PLANOGLOBULINA (CUSHMAN, 1927, genus)

Type species: *Guembelina acervulinoides* EGGER, 1900

Planoglobulina acervulinoides (EGGER, 1900)

Pl. 10, figs. 4, 5

1900. *Guembelina acervulinoides* EGGER, p. 36, pl. 14, figs. 14-18, 20-22.
1972. *Planoglobulina acervulinoides* EGGER; MARTIN, p. 81, pl. 3, figs. 3-6.
2004. *Planoglobulina acervulinoides* EGGER; PREMOLI SILVA and VERGA, p. 171, pl. 101, figs. 1-7; p. 261, pl. 31, figs. 6-11.

Description & Remarks: Early portion of the test biserial, later part multiserial, flabelliform (remarkably triangular shaped). Chambers increase rapidly in size in biserial portion but they often smaller than last series of the biserial portion. Chambers globular-subglobular.

It differs from *Planoglobulina brazoensis* by having almost symmetrical, triangular and thinner walled test and generally smaller chambers in the mutiserial portion.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

Planoglobulina brazoensis MARTIN,1972

Pl. 10, figs. 6, 7

1972. *Planoglobulina brazoensis* MARTIN, p. 82, 83, pl. 3, figs. 7a-c.

2004. *Planoglobulina brazoensis* MARTIN, PREMOLI SILVA and VERGA, p.172, pl. 102, figs.1-4.

Description & Remarks: Early portion of the test biserial, later part multiserial, flabelliform. Chambers globular-subglobular. Chambers increase rapidly in size in the biserial portion, nearly equal in size in the multiserial portion**.**

It differs *Planoglobulina acervulinoides* by having laterally inflated and less symmetrical test, larger chambers in the multiserial portion.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

RACEMIGUEMBELINA (MONTANARO GALLITELLI, 1957, genus)

Type species: *Guembelina fructicosa* EGGER, 1902 p.35 (as Gümbelina)

Racemiguembelina fructicosa (EGGER, 1899)

Pl. 10, figs. 8-11

1899. *Guembelina fructicosa* EGGER; p. 35, pl. 14, figs. 8, 9, 24-26.

1988. *Racemiguembelina fructicosa* (EGGER); KELLER, p. 250, pl. 1, fig. 15.

1999. *Racemiguembelina fructicosa* (EGGER); ÖZKAN-ALTINER and ÖZCAN, p. 294, fig. 4/10.

2004. *Racemiguembelina fructicosa* (EGGER); PREMOLI SILVA and VERGA, p. 187, pl. 117, figs. 1-6; p. 265, pl. 35, figs. 1-3.

2010 *Racemiguembelina fructicosa* (EGGER); HAKYEMEZ and ÖZKAN

ALTINER, pl. 2, fig. 27.

Description & Remarks: Multiple chambers in the last series of the test easily visible in the transverse sections. Chambers globular, umbilicus wide.

Local Stratigraphic Range: Identified in the *Contusotruncana contusa/ Racemiguembelina fructicosa* Zone and in the *Abathomphalus mayaroensis* Zone.

ROTALLIPORACEA (SIGAL, 1958, superfamilia)

HEDBERGELLIDAE (LOEBLICH and TAPPAN, 1961, familia)

GLOBANOMALINA (HAQUE, 1956, genus)

Type species: *Globanomalina ovalis*, HAQUE, 1956

Globanomalina chapmani (PARR, 1938)

Pl. 11, fig.11

1938. *Globorotalia chapmani* PARR, p. 87, pl. 3, figs. 8, 9a, b

198r. *Planorotalites chapmani* (PARR); NEDERBRAGT and VAN HINTE, (*partim*),p. 586, pl. 2, figs. 3-10, pl. 3, figs. 4-6.

1987. *Planorotalites chapmani* (PARR); TOUMARKINE and LUTERBACHER, p.108, text fig.12.5-8.

2003. *Globanomalina chapmani* (PLUMMER); PREMOLI SILVA , RETTORI, VERGA, pl.17, figs. 1a-d, figs. 2a-d.

Description & Remarks: Test large, low trochospiral, biconvex, chambers inflated but less compressed along the margin. Umbilicus wide.

It differs from *Globanomalina pseudomenardii* by having periphery lacking keel; from *Globanomalina compressa* by having large and somewhat compressed chambers in the last whorl; from *Globanomalina ehrenbergi* by nearly equally biconvex periphery.

Local Stratigraphic Range: Ranged from the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c) to the *Globanomalina pseudomenardii* Zone (P4).

Globanomalina compressa (PLUMMER, 1926)

Pl. 11, figs. 8-10

1926. *Globigerina compressa* PLUMMER; p. 135, pl. 8, figs. 11a-c.

1957. *Globorotalia compressa* (PLUMMER); BOLLI, p. 77, pl. 20, figs. 21-23.

1957. *Turborotalia compressa* (PLUMMER); PANDEY and RAVINDRAM, p. 164, pl. 7, figs. 5-9.

1971. *Globorotalia compressa* (PLUMMER); POSTUMA, p. 186, 187.

1985. *Planorotalites compressa* (PLUMMER); TOUMARKINE and LUTERBACHER, p.107, text figs. 12.1-2.

1997. *Globanomalina compressa* (PLUMMER); BERGGREN and NORRIS, p. 85, pl. 7, figs. 15-21.

2003. *Globanomalina compressa* (PLUMMER); PREMOLI SILVA , RETTORI, VERGA, pl. 17, figs. 1a-d, figs. 2a-d.

Description & Remarks: Test small, very low trochospiral, almost biconvex or spiral side flat, umbilikal side inflated, chambers subglobular-oval and increase rapidly in size in the last whorl, umbilicus wide.

It differs from *Globanomalina pseudomenardii* by having periphery lacking keel; from *Globanomalina ehrenbergii* and *Globanomalina chapmani* by having oval (not compressed) chambers.

Local Stratigraphic Range: Ranged from the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c) to the *Globanomalina pseudomenardii* Zone (P4).

Globanomalina ehrenbergi (BOLLI, 1957)

Pl. 11, fig. 12

1957. *Globorotalia ehrenbergi* BOLLI, p. 77, pl. 20, figs. 18-20.

1971. *Globorotalia ehrenbergi* BOLLI; POSTUMA, p. 188, 189.

1988. *Planorotalites ehrenbergi* (BOLLI); HUNTER, ARNOLD, PARKER p. 182, pl. 1, fig. 508.

1997. *Globanomalina ehrenbergi* (BOLLI); BERGGREN and NORRIS, p. 87, pl. 8, figs. 1-5.

2003. *Globanomalina ehrenbergi* (BOLLI); PREMOLI SILVA , RETTORI, VERGA, pl. 17, figs. 1a-d, figs. 2a-d.

Description & Remarks: Test low trochospiral, chambers inflated but compressed along the margin, increase rapidly in size, last chamber often with a faint pseudokeel, umbilicus wide.

It differs from *Globanomalina pseudomenardii* by having periphery lacking a true keel.

Local Stratigraphic Range: Identified in the *Morozovella angulata/Igorina pusilla* Zone (P3) and in the *Globanomalina pseudomenardii* Zone (P4).

Globanomalina pseudomenardii (BOLLI, 1957)

Pl. 11, figs. 13, 14

1957. *Globorotalia pseudomenardii* BOLLI, p. 77, pl. 20, figs. 14-16.
1971. *Globorotalia pseudomenardii* BOLLI; POSTUMA, p. 204, 205.
1971. *Planorotalites pseudomenardii* (BOLLI); LUTERBACHER, p. 726, pl. 1, fig. 4b.
1985. *Planorotalites pseudomenardii* (PLUMMER); TOUMARKINE and LUTERBACHER, p.108, text figs. 12.3-4.
1987. *Planorotalites pseudomenardii* (BOLLI); NEDERBRAGT and VAN HINTE, p. 587, pl. 1, figs. 1-16.
1997. *Globanomalina pseudomenardii* (BOLLI); BERGGREN and NORRIS, p. 87, pl. 8, figs. 1-5.
2003. *Globanomalina pseudomenardii* (BOLLI); PREMOLI SILVA , RETTORI, VERGA, pl. 19, figs. 1a-f.

Description & Remarks: Test low trochospiral, lenticular, nearly biconvex, chambers compressed, increase rapidly in size, axial periphery acute, with a distinct keel, umbilicus narrow.

It is easily distinguished from the other species of *Globanomalina* by having keeled periphery.

Local Stratigraphic Range: Identified only within the *Globanomalina pseudomenardii* Zone (P4).

GLOBOROTALIACEA (CUSHMAN, 1927, superfamilia)

GUEMBELITRIIDAE (MONTANARO GALLITELLI, 1957, familia)

GUEMBELITRIA (CUSHMAN, 1933, genus)

Type species: *Guembelitria cretacea*, CUSHMAN, 1933

Guembelitria* cf. *cretacea CUSHMAN, 1933

Pl. 11, figs. 1-3

1933. *Guembelitria cretacea* CUSHMAN; p. 37, pl. 4, figs. 12 a, b.

2004. *Guembelitria cretacea* CUSHMAN; PREMOLI SILVA and VERGA, p. 252, pl. 2, fig.1.

Description & Remarks: Test very small (>100 μm), triserial, chambers globular.

Local Stratigraphic Range: Identified in the *Guembelitria cretacea* Zone (P0) + *Parvulaglobigerina eugubina* Zone (Pα) and in the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c).

WOODRINGINA (LOEBLICH and TAPPAN, 1957, genus)

Type species: *Woodringina claytonensis*, LOEBLICH and TAPPAN, 1957

Woodringina* cf. *hornerstownensis OLSSON, 1960

Pl. 11, figs. 4, 5

1960. *Woodringina hornerstownensis* OLSSON; p. 29, pl. 4, figs. 18, 19.

2004. *Woodringina hornerstownensis* OLSSON; PREMOLI SILVA, RETTORI, VERGA, pl. 54, fig. 4.

Description & Remarks: Test small and elongate. Later portion of the test is distinctly twisted. Chambers increase more rapidly in width than height.

Local Stratigraphic Range: Identified only within the *Guembelitria cretacea* Zone (P0) + *Parvulaglobigerina eugubina* Zone (Pα).

GLOBOCONUSA (KHALILOV, 1959, genus)

Type species: *Globoconusa conusa*, KHALILOV, 1956

Globoconusa daubjergensis (BRONNIMANN, 1953)

Pl. 11, figs. 15-17

1953. *Globigerina daubjergensis* BRONNIMANN; p. 340, text fig. 1.

1957. *Globigerinoides daubjergensis* (BRONNIMANN); LOEBLICH and TAPPAN, p. 184, pl. 40, figs. 1a-c.

1970. *Globoconusa daubjergensis* (BRONNIMANN); OLSSON, p. 601, pl. 92, figs. 2a-b.

1971. *Globigerina daubjergensis* BRONNIMANN; POSTUMA, p. 148, 149.

1979. *Globastica daubjergensis* (BRONNIMANN); BLOW, p.1235, pl. 74, figs. 7-9.

2003. *Globoconusa daubjergensis* (BRONNIMANN); PREMOLI SILVA, RETTORI, VERGA, pl. 24, figs. 1a-g.

Description & Remarks: Test small (100-125 µm), medium to heigh trochospiral, initial whorls is more elevated than the last whorl. Chambers in the inner whorls is distinctly smaller than those of the final whorl. Umbilicus is very small.

Local Stratigraphic Range: Identified in the *Guembelitria cretacea* Zone (P0) + *Parvulaglobigerina eugubina* Zone (Pα) and in the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c).

PARVULARUGOGLOBIGERINA (HOFKER, 1978, genus)

Type species: *Globigerina eugubina* LUTERBACHER and PREMOLI SILVA, 1964

Parvularugoglobigerina* cf. *eugubina (LUTERBACHER and PREMOLI SILVA, 1964)

Pl. 11, figs. 6, 7

1964. *Globigerina eugubina* LUTERBACHER and PREMOLI SILVA; p. 105, pl. 2, figs. 8a-c.

1991. *Parvularugoglobigerina eugubina* (LUTERBACHER and PREMOLI SILVA); D'HONDT and KELLER, p. 96, pl.4, figs. 4-6.

2003. *Parvularugoglobigerina eugubina* (LUTERBACHER and PREMOLI SILVA); PREMOLI SILVA, RETTORI, VERGA, pl.39, figs 4a-c, 5a-d, pl.40,figs.1a-d.

Description & Remarks: Test very small, low trochospiral, spiral side flat, umbilical side inflated, last chamber is large, umbilicus small. Only 2 specimens were recognized in Toylar section (Figure 2.10).

Local Stratigraphic Range: Identified only within the *Guembelitria cretacea* Zone (P0) + *Parvulaglobigerina eugubina* Zone (Pα).

GLOBIGERINIDAE (CARPENTER, PARKER and JONES, 1862, familia)

PARASUBBOTINA (OLSSON, HEMLEBEN, BERGGREN and LIU, 1992, genus)

Type species: *Globigerina pseudobulloides*, PLUMMER, 1926

Parasubbotina pseudobulloides (PLUMMER, 1926)

Pl. 11, figs.18-21

1926. *Globigerina pseudo-bulloides* PLUMMER; p. 133, pl. 8, figs. 9a-c.

1957. *Globorotalia pseudobulloides* (PLUMMER); BOLLI, p. 72, pl. 17, figs. 19-21.

1971. *Globorotalia pseudobulloides* (PLUMMER); POSTUMA, p. 202, 203.

1985. *Morozovella pseudobulloides* (PLUMMER); TOURMAKINE and LUTERBACHER, p. 111, figs. 14.1-2.

1992. *Subbotina pseudobulloides* (PLUMMER); BERGGREN, p. 563, pl. 1, figs.7-8.

1992. *Parasubbotina pseudobulloides* (PLUMMER); OLSSON, HEMBLEN, BERGGREN, LIU, p. 197, pl. 3, figs. 1-7.

1997. *Parasubbotina pseudobulloides* (PLUMMER); BERGGREN and NORRIS, p.81, pl.5, figs. 12-16.

2003. *Parasubbotina pseudobulloides* (PLUMMER); PREMOLI SILVA, RETTORI, VERGA, pl. 38, figs. 3a-g.

Description & Remarks: Test very low trochospiral, chambers in the inner whorls are distinctly smaller than those of last whorls, last chamber is very large and occupies nearly ½ of the test. Chambers are globular-subglobular, umbilicus moderately wide.

It differs from *Praemurica pseudoinconstans* and *Praemurica inconstans* by having chambers increasing vey rapidly in size.

Local Stratigraphic Range: Ranged from the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c) to the *Morozovella angulata/Igorina pusilla* Zone (P3).

SUBBOTINA (BROTZEN and POŻARYSKA, 1961, genus)

Type species: *Globigerina triloculinoides*, PLUMMER, 1927

Subbotina triangularis (WHITE, 1928)

Pl. 12, figs. 1, 2

1928. *Globigerina triangularis* WHITE, p. 195, pl. 28, figs. 1a-c

1979. *Subbotina triangularis triangularis* (WHITE); BLOW, p.1281, pl. 91, figs.7-9.

1997. *Subbotina triangularis* (WHITE); BERGGREN and NORRIS, p. 81, pl. 5, figs.1, 5, 9.

2003. *Subbotina triangularis* (WHITE); PREMOLI SILVA, RETTORI, VERGA, pl. 46, figs. 2a-d.

Description & Remarks: The most characteristic feature of this species is the last whorl consisting of 3.5 chambers (It was differentiated from transverse section in thin section analysis). Chambers globular, umbilicus narrow, surface spinose.

Local Stratigraphic Range: Ranged from the *Praemurica uncinata* Zone (P2) to the *Globanomalina pseudomenardii* Zone (P4).

Subbotina triloculinoides (PLUMMER, 1926)

Pl. 12, figs.3-7

1926. *Globigerina triloculinoides* PLUMMER; p. 134, pl. 8, figs. 10a-b.
1961. *Subbotina triloculinoides* (PLUMMER); BROTZEN and POARYSKA, p. 160, pl. 4, fig. 4; p. 160, text-fig. 2.
1971. *Globigerina triloculinoides* PLUMMER; POSTUMA, p. 160, 161
1997. *Subbotina triloculinoides* (PLUMMER); BROTZEN and POARYSKA, p.160, pl. 4, fig. 4, p.160, text-fig 2.
1997. *Subbotina triloculinoides* (PLUMMER); BERGGREN and NORRIS, p.79, pl. 4, figs. 1-3, 5-7, 9, 10, 19, 21, 22.
2003. *Subbotina triloculinoides* (PLUMMER); PREMOLI SILVA, RETTORI, VERGA, pl. 46, figs. 3a-d.

Description & Remarks: Test low trochospiral, chambers globular-subglobular, Last chamber nearly occupies nearly half of the test, umbilicus moderately wide. Surface of the chambers spinose.

It differs from *Subbotina velascoensis* by its globular last chamber, from *Subbotina triangularis* by having chambers increasing very rapidly in size and larger last chamber.

Local Stratigraphic Range: Ranged from the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c) to the *Globanomalina pseudomenardii* Zone (P4).

Subbotina velascoensis (CUSHMAN, 1925)

Pl. 12, figs. 8-10

1925. *Globigerina velascoensis* CUSHMAN ,p. 19, pl. 3, figs. 6a-c.
1997. *Subbotina velascoensis* (CUSHMAN); BERGGREN and NORRIS, p.81, pl. 5, figs. 2, 6, 1, 11.
2003. *Subbotina velascoensis* (CUSHMAN); PREMOLI SILVA, RETTORI, VERGA, pl. 47, figs. 2a-f.

Description & Remarks: Test low trochospiral, early chamber subglobular, last chamber compressed, laterally elongated, occupies about half of the test, umbilicus narrow.

It easily differentiated from *Subbotina triloculinoides* and *Subbotina tria*ngularis by its compressed and laterally elongated, oval shaped last chamber.

Local Stratigraphic Range: Ranged from the *Praemurica uncinata* Zone (P2) to the *Globanomalina pseudomenardii* Zone (P4).

TRUNCOROTALOIDIDAE (LOELICH and TAPPAN, 1961, familia)

ACARININA (SUBBOTINA, 1953, genus)

Type species: *Acarinina acarinata*, SUBBOTINA, 1953
(= *Globigerina nitida*, MARTIN, 1943)

Acarinina soldadoensis (BRONNIMANN, 1952)
Pl. 12, fig. 11

1952. *Globigerina soldadoensis* BRONNIMANN, p. 7, 9, pl. 1, figs. 1-9.
1962. *Globorotalia (Acarinina) soldadoensis* (BRONNIMANN); HILLEBRANDT, p. 142, pl. 14, figs. 5, 6.
1971. *Acarinina soldadoensis* (BRONNIMANN); BERGGREN, p. 76, pl. 5, figs.1-3.
1979. *Muricoglobigerina soldadoensis soldadoensis* (BRONNIMANN); BLOW, p. 1120, pl. 98, figs. 1-3.
1997. *Acarinina soldadoensis* (BRONNIMANN); BERGGREN and NORRIS, p.95, pl. 12, figs. 6, 8-15, 21.
2003. *Acarinina soldadoensis* (BRONNIMANN); PREMOLI SILVA, RETTORI, VERGA, pl. 9, figs. 2a-d, figs. 3a-d.

Description & Remarks: Test low trochospiral, spiral side slightly convex, umbilical side inflated, chambers subglobular, increase moderately in size, axial periphery subrounded, surface of the test muricate, umbilicus moderately wide.

Local Stratigraphic Range: Identified only within the *Globanomalina pseudomenardii* Zone (P4) in the Toylar section (Figure 2.9).

Acarinina subsphaerica (SUBBOTINA, 1947)
Pl. 12, figs. 12, 13

1947. *Globigerina subsphaerica* SUBBOTINA; p.108, pl.5, figs. 26-28.

1958. *Acarinina subsphaerica* (SUBBOTINA); SHUTSKAYA, p.89, pl.2, figs.12-14.

1997. *Acarinina subsphaerica* (SUBBOTINA); BERGGREN and NORRIS, p.93, pl.11, figs. 15, 18-23, pl.12, fig. 4.

2003. *Acarinina subsphaerica* (SUBBOTINA); PREMOLI SILVA, RETTORI, VERGA, pl.11, figs. 1a-d.

Description & Remarks: Test small, high trochospiral, inner whorls more elevated in respect to the last whorl, axial periphery subrounded, surface of the chambers distinctly muricate, umbillicus very narrow, nearly closed.

It differs from *Acarinina mckannai* (White 1928) by its higher spired and small test.

Local Stratigraphic Range: Identified in the *Praemurica uncinata* Zone (P2) + *Morozovella angulata/Igorina pusilla* Zone (P3) of the Toylar section and in the *Globanomalina pseudomenardii* Zone (P4).

MOROZOVELLA (McGOWRAN, 1968, genus)

Type species: *Pulvinulina velascoensis*, CUSHMAN, 1925

Morozovella aequa (CUSHMAN and RENZ, 1942)

Pl. 13, figs. 1, 2

1942. *Globorotalia crassata* var. *aequa* CUSHMAN and RENZ; p.12, pl.3, figs 3a-c.

1957. *Globorotalia aequa* (CUSHMAN and RENZ); BOLLI, p.74, pl.17, fig 1-3, pl.18, figs. 13-15.

1963. *Truncorotalia aequa* (CUSHMAN and RENZ); GOHRBANDT, p.58-59, pl. 4, figs. 10-12.

1971 *Globorotalia aequa* (CUSHMAN and RENZ); POSTUMA, p. 168, 169.

1971. *Morozovella aequa* (CUSHMAN and RENZ); BERGGREN, p.76, pl. 5, fig. 6.

1997. *Morozovella aequa* (CUSHMAN and RENZ); BERGGREN and NORRIS, p.103, pl.16, figs. 22-24.

2003. *Morozovella aequa* (CUSHMAN and RENZ); PREMOLI SILVA, RETTORI, VERGA, pl. 30, figs. 1a-e, 2a-d.

Description & Remarks: Test low trochospiral, umbilico-convex, spiral side almost flat to slightly convex, umbilical side strongly convex, umbilicus narrow, chambers conical, axial periphery acute, last chamber is longer than opposite chamber, chamber surface muricate except the last chamber that is generally smooth.

It differs from *Morozovella angulata* by having larger test, more acute periphery and larger last chamber, from *Morozovella velascoensis* by its unequal size of the chambers in the last whorl and narrower umbilicus.

Local Stratigraphic Range: Identified only within the *Globanomalina pseudomenardii* Zone (P4).

Morozovella angulata (WHITE, 1928)

Pl. 13, figs. 3, 4

1928. *Globigerina angulata* WHITE; p.27, fig.13.
1937. *Globorotalia angulata* (WHITE); GLAESSNER p.383, pl.4, figs. 35a-c.
1955. *Truncorotalia angulata* (WHITE); DALBIEZ, GLINTZBOECKEL p.533, pl.2, figs.6a-c.
1958. *Acarinina angulata* (WHITE); MOROZOVA p.33, pl.2, fig.2.
1971. *Globorotalia angulata* (WHITE); POSTUMA, p. 170, 171.
1977. *Morozovella angulata* (WHITE); BERGGREN p.230, pl.5.
1997. *Morozovella angulata* (WHITE); BERGGREN and NORRIS, p.99 , pl.14, fig.2, 3, 9, 14, 18, 20-23.
2003. *Morozovella angulata* (WHITE); PREMOLI SILVA, RETTORI, VERGA pl.30, figs. 3a-e.

Description & Remarks: Test low trochospiral, spiral side almost flat (inner whorls somewhat elevated), umbilical side convex, axial periphery acute, chambers subangular, increase slowly in size, surface of the chambers muricate, umbilicus narrow aand deep.

It differs from *Morozovella praeangulata* by having acute axial periphery.

Local Stratigraphic Range: Identified in the *Morozovella angulata/Igorina pusilla* Zone (P3) and in the *Globanomalina pseudomenardii* Zone (P4).

Morozovella conicotruncata (SUBBOTINA, 1953)

Pl. 13, fig. 5

1953. *Globorotalia conicotruncata* SUBBOTINA; p.220, pl. 20, figs. 5a-b.
1971. *Morozovella conicotruncata* (SUBBOTINA); BERGGREN, p.74, pl.4, figs.7,8.
1997. *Morozovella conicotruncata* (SUBBOTINA); BERGGREN and NORRIS, p.101, pl.15, fig.1-9.

2004. *Morozovella conicotruncata* (SUBBOTINA); PREMOLI SILVA, RETTORI, VERGA; pl. 31, figs. 4a-d, pl. 32, figs. 1a-d.

Description & Remarks: Test low trochospiral, umbilico-convex, spiral side flat, umbilical side convex, periphery acute, chambers conical, umbilicus narrow, umbilical shoulders rounded, chambers increase slowly in size, two chambers in the last whorl nearly equal in size.

The most characteristic feature differs from the other *Morozovella* species of this species that its chambers margins joining with spiral side at narrow angle.

Local Stratigraphic Range: Identified only within the *Morozovella angulata/Igorina pusilla* Zone (P3)

Morozovella occlusa (LOEBLICH and TAPPAN 1957)

Pl. 13, figs. 6-8

1957. *Globorotalia occlusa* LOEBLICH and TAPPAN; p.191, pl. 55, figs. 3a-c.

1977. *Morozovella occlusa* (LOEBLICH and TAPPAN); BERGGREN, p.234, pl. 7.

1997. *Morozovella occlusa* (LOEBLICH and TAPPAN); BERGGREN and NORRIS, p.103, pl.16, figs. 9-15, 17.

2004. *Morozovella occlusa* (LOEBLICH and TAPPAN); PREMOLI SILVA, RETTORI, VERGA; pl. 35, figs. 2a-d, fig. 3a-d.

Description & Remarks: Test low trochospiral, nearly biconvex, inner whorls inflated in spiral side, umbilical side convex, axial periphery acute, umbilicus narrow, umbilical shoulders rounded.

It differs from *Morozovella velascoensis* by its smaller test, less thickness and smaller umbilicus.

Local Stratigraphic Range: Identified only within the *Globanomalina pseudomenardii* Zone (P4).

Morozovella praeangulata (BLOW, 1979)

Pl. 13, fig. 9

1979. *Globorotalia* (*Acarinina*) *praeangulata* BLOW; p.942-944, pl. 82, fig. 5-6.

1997. *Morozovella praeangulata* BLOW; BERGGREN and NORRIS; p.99, pl.14,

fig. 1, 4-6.

2004. *Morozovella praeangulata* BLOW; PREMOLI SILVA, RETTORI, VERGA; pl. 56, fig. 3a-d.

Description & Remarks: Test low trochospiral, spiral side flat, umbilical side convex, axial periphery subacute, umbilicus narrow, last chamber conical, but opposite chamber subconical that resembles that of *Praemurica uncinata*.

It differs from *Morozovella angulata* by its less acute peripheral margin; from *Praemurica uncinata* by its more acute peripheral margin with conical last chamber

Local Stratigraphic Range: Identified only within the *Praemurica uncinata* Zone (P2), in the Belen section (Figure 2.7).

Morozovella velascoensis (CUSHMAN, 1925)

Pl. 13, fig. 10

1925. *Pulvulina velascoensis* CUSHMAN; p.19, pl. 3, figs. 5a-c.

1928. *Globorotalia velascoensis* (CUSHMAN); WHITE, p.281, pl. 398, figs.2a-c.

1961. *Pseudogloborotalia velascoensis* (CUSHMAN); BERMUDEZ, p.1349, pl.16, figs.11a-b.

1968. *Truncorotaloides* (*Morozovella*) *velascoensis* (CUSHMAN); McGOWRAN, pl. 2, fig.1.

1971. *Globorotalia velascoensis* (CUSHMAN); POSTUMA, p. 218, 219

1977. *Morozovella velascoensis* (CUSHMAN); BERGGREN, p.232, pl. 6

1997. *Morozovella velascoensis* (CUSHMAN); BERGGREN and NORRIS, p.101, pl.15, figs.10-15, 16-18, 22.

2004. *Morozovella velascoensis* (CUSHMAN); PREMOLI SILVA, RETTORI, VERGA; pl. 37, figs. 3a-d, 4a-d.

Description & Remarks: Test large, umbilico-convex, spiral side flat, umbilicsl side strongly convex, axial periphery acute with conical chambers, umbilicus very large, the conjuction of chamber margin and spiral surface and around the umbilicus (adumbilical ridges) densely pustulose.

İt differs from *Morozovella aequa* by its large umbilicus with pustule bunches and nearly equal size of two chambers in the last whorls (last and opposite chambers in the axial section).

Local Stratigraphic Range: Identified only within the *Globanomalina pseudomenardii* Zone (P4).

IGORINA (DAVIDZON, 1978, genus)

Type species: *Globorotalia tadjikistanensis*, BYKOVA, 1953

Igorina* cf. *albeari (CUSHMAN and BERMUDEZ, 1949)

Pl. 13, figs. 11, 12

1949. *Globorotalia albeari* CUSHMAN and BERMUDEZ; p.33, pl.6, fig 13-15
1977. *Morozovella albeari* (CUSHMAN and BERMUDEZ); BERGGREN, p.226-7, pl.3.
1979. *Globorotalia albeari* CUSHMAN and BERMUDEZ; BLOW, p. 883-5, pl. 92, fig. 4, 8, 9, pl. 93, fig. 1-4.
1997. *Igorına albeari* (CUSHMAN and BERMUDEZ); BERGGREN and NORRIS, p.91, pl.10, fig 10, 14, 15, 18, 19, 21-23.
2003. *Igorına albeari* (CUSHMAN and BERMUDEZ); PREMOLI SILVA, RETTORI, VERGA, pl. 27, fig 2a-e, fig 3a-d.

Description & Remarks: Test small, biconvex, chambers in the inner whorls distinctly smaller than last whorl, axial periphery acute, umbilicus narrow.

It is distinguished from *Igorina pusilla* by its more acute periphery and more enlarging of the last whorl.

Local Stratigraphic Range: Identified only within the *Praemurica uncinata* Zone (P2) + *Morozovella angulata/Igorina pusilla* Zone (P3) of the Toylar section (Figure 2.9).

Igorina pusilla (BOLLI, 1957)

Pl. 13, fig. 13

1957. *Globorotalia pusilla pusilla* BOLLI; p.78, pl.20, fig 8-10
1971. *Globorotalia pusilla* (BOLLI); POSTUMA, p. 206, 207
1977. *Morozovella pusila* (BOLLI); BERGGREN, p.226, pl.3
1985. *Planorotalites pusilla pusilla* (BOLLI); TOUMARKINE and LUTHERBACHER, p.108, text figs.12, 13a-c.
1997. *Igorına pusilla* (BOLLI); BERGGREN and NORRIS, p.91, pl.10, fig 1, 2, 5-6, 11.
2003. *Igorına pusilla* (BOLLI); PREMOLI SILVA, RETTORI, VERGA, pl. 28, fig

4a-f.

Description & Remarks: Test small, moderately high trochospiral, biconvex, axial periphery subacute, chambers moderately increase in size, umbilicus narrow.

It differs from *Igorina albeari* by having subacute periphery and generally smaller test.

Local Stratigraphic Range: Identified only within the*Morozovella angulata/Igorina pusilla* Zone (P3).

PRAEMURICA (HAQUE 1956, genus)

Type species: *Globigerina (Eoglobigerina) taurica*, MOROZOVA, 1961

Praemurica inconstans (SUBBOTINA, 1953)

Pl. 13 figs. 14, 15

1953. *Globigerina inconstans* SUBBOTINA, p.58, pl. 3, figs. 1, 2.
1961. *Globorotalia* (*Acarinina*) *inconstans* (SUBBOTINA); LEONOV and ALIMARINA, pl. 3, figs. 1-3; 5-8.
1964. *Globorotalia inconstans* (SUBBOTINA); LUTERBACHER, p.650, figs.19-23.
1979. (*Turborotalia*) *inconstans* (SUBBOTINA); BLOW, p. 1080, pl. 71, figs. 6, 7.
1985. *Morozovella inconstans* (SUBBOTINA); TOUMARKINE and LUTERBACHER, p.109, text figs.13.1-2.
1997. *Preamurica inconstans* (SUBBOTINA); BERGGREN and NORRIS, p. 97, pl.13, figs.1-6.
2003. *Preamurica inconstans* (SUBBOTINA); PREMOLI SILVA, RETTORI, VERGA, pl. 40, figs. 4a-c, pl. 41, figs. 1a-d, 2a-c.

Description & Remarks: Test low trochospiral, spiral side almost flat, inner whorl considerably smaller in relation to the last whorl, umbilical side inflated. Chambers globular-subglobular and increase gradually in size. Surface of early chambers muricate, last chamber smooth. Umbilicus small and deep.

It differs from *Praemurica pseudoinconstans* by having generally larger test and chambers; from *Parasubbotina pseudobulloides* by having chambers gradually increase in size size visible in the axial profile.

Local Stratigraphic Range: Identified in the *Globanomalina compressa*/ *Praemurica inconstans* Subzone (P1c) and the *Praemurica uncinata* Zone (P2) + *Morozovella angulata/Igorina pusilla* Zone (P3) of the Toylar section.

Praemurica pseudoinconstans (BLOW, 1979)

Pl. 13, figs. 16-18

1979. *Globorotalia (Turborotalia) pseudoinconstans* BLOW, p. 1105, pl. 67, fig. 4.
1992. *Praemurica pseudoinconstans* (BLOW); OLSSON, HEMLEBEN, BERGGREN and LIU, p. 202. pl. 6, figs. 1, 4.
1997. *Praemurica pseudoinconstans* (BLOW), BERGGREN and NORRIS, p.89, pl. 9, figs. 16-24.
2003. *Praemurica pseudoinconstans* (BLOW), PREMOLI SILVA, RETTORI, VERGA, pl. 41, figs. 5a-d.

Description & Remarks: Test relatively small, low trochospiral, nearly equally biconvex, chambers subglobular, increase slowly in size, umbilicus wide**.**

It differs from *Parasubbotina pseudobulloides* by having less inflated chambers and distinctly increase slowly in size; differs from *Praemurica inconstans* by having smaller test and chambers, wider umbilicus.

Local Stratigraphic Range: Ranged from the *Guembelitria cretacea* Zone (P0) + *Parvulaglobigerina eugubina* Zone (Pα) to the *Praemurica uncinata* Zone (P2).

Praemurica uncinata (BOLLI, 1957)

Pl. 13, figs. 19-22

1957. *Globorotalia uncinata* BOLLI; p. 74, pl. 17, fig. 13-15.
1970. *Acarinina inconstans uncinata* (BOLLI); SHUTSKAYA, p. 110, pl. 6, fig. 1a-c (holotype refigured); figs. 2a-c.
1971. *Globorotalia uncinata* (BOLLI); POSTUMA, p. 216, 217.
1977. *Morozovella uncinata* (BOLLI); BERGGREN, p. 225, pl. 1.
1997. *Praemurica uncinata* (BOLLI); BERGGREN and NORRIS, p.97, pl. 13 figs. 7-19.
2003. *Praemurica uncinata* (BOLLI); PREMOLI SILVA, RETTORI, VERGA, pl. 41, figs. 5 a-d.

Description & Remarks: Test low trochospiral, spiral side almost flat, umbilical side inflated, axial periphery subangular, early chamber in the last whorl subangular,

last chamber somewhat compressed, oval, increasing moderately in size, umbilicus narrow, deep.

It differs from *Morozovella praeangulata* by having compressed but not subangular/angular last chamber.

Local Stratigraphic Range: Identified only within the *Praemurica uncinata* Zone (P2).

4. CONCLUSION

Within this thesis, Upper Cretaceous and Palaeocene planktonic foraminiferal fauna is evaluated and the assumed conformable relationships of Upper Cretaceous (Campanian and Maastrichtian) and Palaeocene units in the Kocaeli Peninsula, NW Turkey is tested. Besides the palaeontologic analysis and biostratigraphic approaches, some comments also have been done on the sedimentary features around the Cretaceous-Palaeogene boundary.

The studied portion of Akveren Formation, which consisted of pelagic carbonates, has been divided into 9 biozones, including *Gansserina gansseri* Zone, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone and *Abathomphalus mayaroensis* Zone which represents Late Campanian-Maastrichtian, *Guembelitria cretacea* (P0) Zone, *Parvularugoglobigerina eugubina* (Pα) Zone, *Globanomalina compressa*/*Praemurica inconstans* (P1c) Subzone (As a subzone of *Parasubbotina pseudobulloides* (P1) Zone), *Praemurica uncinata* (P2) Zone, *Morozovella angulata/Igorina pusilla* (P3) Zone and *Globanomalina pseudomenardii* (P4) Zones which represents Palaeocene. For the biozonation, 70 species belonging to 25 genera are identified (See Systematics section).

Within the two sections, Nasuhlar-Bulduk and Belen, some early diagenetic events, including hardground, concretions of derived carbonate pebbles and the ferroginous material, which is clearly visible both in micro- and macro-scale. The palaeontologic time gap between *Contusotruncana contusa/Racemiguembelina fructicosa* Zone and *Globanomalina compressa*/*Praemurica inconstans* (P1c) Subzone coincides with the hardground formation and concretion of derived carbonate pebbles in Nasuhlar-Bulduk section, where another gap between *Abathomphalus mayaroensis* Zone and *Globanomalina compressa*/*Praemurica inconstans* (P1c) Subzone coincides with another hardground formation in Belen section. In the other hand, at Toylar section, a continous sedimentary sequence where an identifiable compact biozone of *Guembelitria cretacea* (P0) Zone + *Parvularugoglobigerina eugubina* (Pα) Zone, is recognizable and in conformable contact with the Upper Maastrichtian representative

Abathomphalus mayaroensis Zone. Since the vertical extent of this section has not been available for a more detailed sampling for Palaeocene strata, a conformable Palaeocene sequence is assumable.

The data gathered from the Nasuhlar-Bulduk and Belen sections represents a hiatus between Upper Cretaceous and Lower Palaeocene beds and the K-Pg boundary in Kocaeli Peninsula is not completely conformable, as the earlier studies have shown. A non depositional period, caused by a rapid sea-level rise at the K-Pg boundary (Macleod and Keller, 1991), and the shelf-drawdown model is hypotesized to explain the present situation. Although the unconformable sequences, there are still conformable sections of Upper Cretaceous and Lower Palaeocene, as represented in Toylar section. The relation of these two different “regimes”, needs more and detailed studies are recommended in order to understand the Late Cretaceous-Early Palaeocene evolution of the area .

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APPENDIX

PLATE 1

Figure 1: ***Contusotruncana contusa***, (CUSHMAN, 1926), Belen section, sample A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 2: ***Contusotruncana contusa***, (CUSHMAN, 1926), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 3: ***Contusotruncana contusa***, (CUSHMAN, 1926), Nasuhlar-Bulduk section, sample no 2, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 4: ***Contusotruncana contusa***, (CUSHMAN, 1926), Toylar section, sample no 24, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 5: ***Contusotruncana fornicata***, (PLUMMER, 1931), Toylar section, sample no 6, Undefined zone

Figure 6: ***Contusotruncana fornicata***, (PLUMMER, 1931), Toylar section, sample no D2, *Abathomphalus mayaroensis* Zone

Figure 7: ***Contusotruncana patelliformis***, (GANDOLFI, 1955), Belen section, sample no B, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

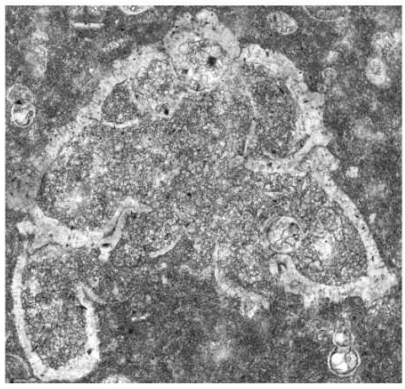
Figure 8: ***Contusotruncana patelliformis***, (GANDOLFI, 1955), Nasuhlar-Bulduk section, sample no D, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 9: ***Contusotruncana patelliformis***, (GANDOLFI, 1955), Belen section, sample no 14-1, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 10: ***Contusotruncana patelliformis***, (GANDOLFI, 1955), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 11: ***Contusotruncana patelliformis***, (GANDOLFI, 1955), Toylar section, sample no D2, *Abathomphalus mayaroensis* Zone

PLATE 1



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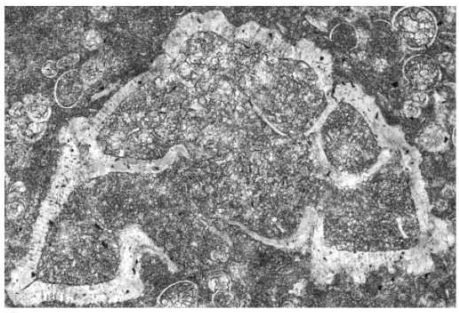

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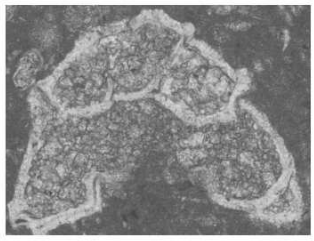

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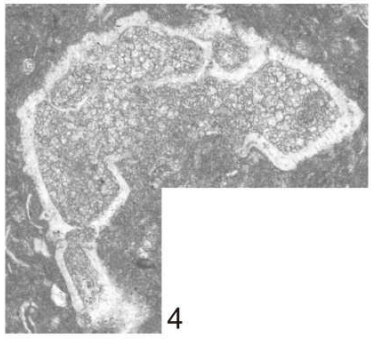

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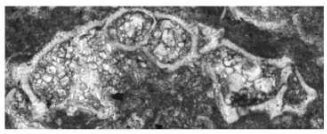

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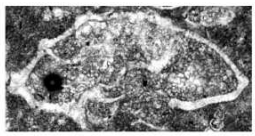

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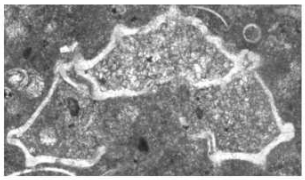

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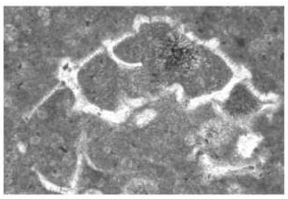

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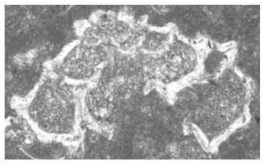

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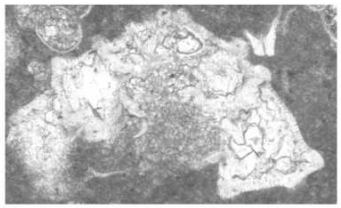

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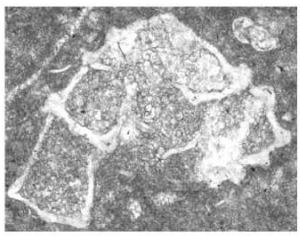

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PLATE 2

Figure 1: ***Contusotruncana plicata***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 2: ***Contusotruncana plicata***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 3: ***Contusotruncana plicata***, (WHITE, 1928), Toylar section, sample no 18, *Gansserina gansseri* Zone

Figure 4: ***Contusotruncana plicata***, (WHITE, 1928), Toylar section, sample no D, *Abathomphalus mayaroensis* Zone

Figure 5: ***Contusotruncana plicata***, (WHITE, 1928), Toylar section, sample no A, *Abathomphalus mayaroensis* Zone

Figure 6: ***Contusotruncana walfishensis***, (TODD, 1970), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 7: ***Contusotruncana walfishensis***, (TODD, 1970), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 8: ***Contusotruncana walfishensis***, (TODD, 1970), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 9: ***Contusotruncana walfishensis***, (TODD, 1970), Nasuhlar-Bulduk section, sample no 7, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

PLATE 2

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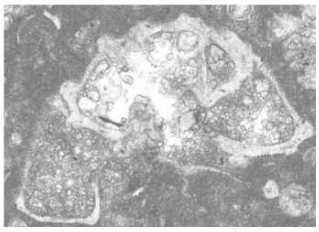

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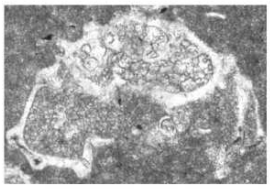

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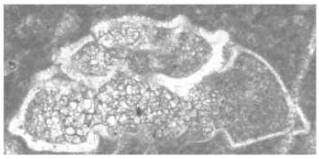

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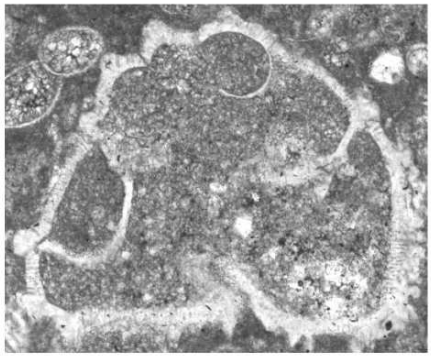

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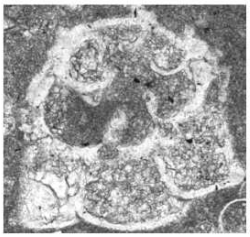

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PLATE 3

Figure 1: ***Abathomphalus mayaroensis***, (BOLLI, 1951), Toylar section, sample no A, *Abathomphalus mayaroensis* Zone

Figure 2: ***Abathomphalus mayaroensis***, (BOLLI, 1951), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 3: ***Abathomphalus mayaroensis***, (BOLLI, 1951), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 4: ***Gansserina gansseri***, (BOLLI, 1951), Toylar section, sample no 20, *Gansserina gansseri* Zone

Figure 5: ***Gansserina gansseri***, (BOLLI, 1951), Belen section, sample no 12, *Gansserina gansseri* Zone

Figure 6: ***Globotruncana arca***, (CUSHMAN, 1926), Nasuhlar-Bulduk section, sample no 6, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 7: ***Globotruncana arca***, (CUSHMAN, 1926), Belen section, sample no 11, *Gansserina gansseri* Zone

Figure 8: ***Globotruncana arca***, (CUSHMAN, 1926), Belen section, sample no 12, *Gansserina gansseri* Zone

Figure 9: ***Globotruncana arca***, (CUSHMAN, 1926), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 10: ***Globotruncana arca***, (CUSHMAN, 1926), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 11: ***Globotruncana bulloides***, VOGLER, 1941, Belen section, sample no 10, *Gansserina gansseri* Zone

Figure 12: ***Globotruncana bulloides***, (VOGLER, 1941), Toylar section, sample no 9, *Gansserina gansseri* Zone

Figure 13: ***Globotruncana bulloides***, VOGLER, 1941, Toylar section, sample no 13, *Gansserina gansseri* Zone

Figure 14: ***Globotruncana bulloides***, VOGLER, 1941, Toylar section, sample no 14, *Gansserina gansseri* Zone

Figure 15: ***Globotruncana dupeublei***, CARON *et al.*, 1984, Belen section, sample no 9, *Gansserina gansseri* Zone

Figure 16: ***Globotruncana dupeublei***, CARON *et al.*, 1984, Belen section, sample no 14-1, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

PLATE 3

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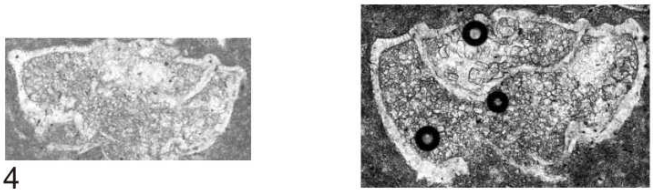

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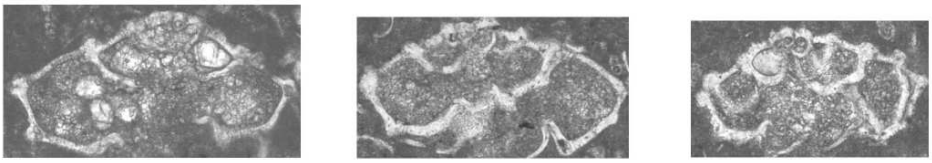

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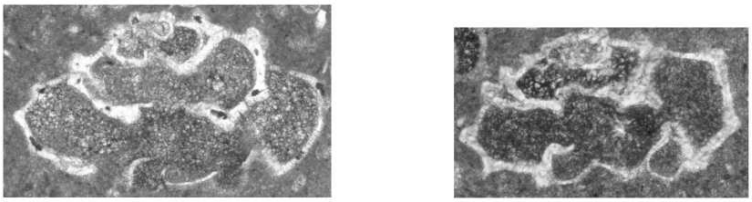

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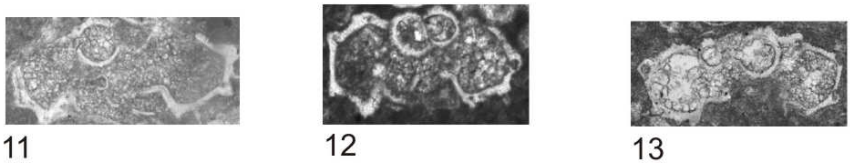

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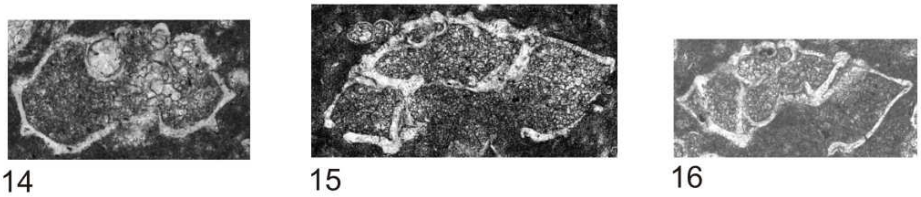

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PLATE 4

Figure 1: ***Globotruncana esnehensis***, NAKKADY, 1950, Toylar section, sample no 18, *Gansserina gansseri* Zone

Figure 2: ***Globotruncana esnehensis***, NAKKADY, 1950, Toylar section, sample no A, *Abathomphalus mayaroensis* Zone

Figure 3: ***Globotruncana falsostuarti***, SIGAL, 1952, Toylar section, sample no 20, *Gansserina gansseri* Zone

Figure 4: ***Globotruncana falsostuarti***, SIGAL, 1952, Nasuhlar-Bulduk section, sample no 5, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 5: ***Globotruncana hilli***, PESSAGNO, 1967, Belen section, sample no 6, *Gansserina gansseri* Zone

Figure 6: ***Globotruncana hilli***, PESSAGNO, 1967, Toylar section, sample no 9, *Gansserina gansseri* Zone

Figure 7: ***Globotruncana hilli***, PESSAGNO, 1967, Toylar section, sample no 13, *Gansserina gansseri* Zone

Figure 8: ***Globotruncana insignis***, (GANDOLFI, 1955), Nasuhlar-Bulduk section, sample no 6, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 9: ***Globotruncana insignis***, GANDOLFI, 1955, Nasuhlar-Bulduk section, sample no 7, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 10: ***Globotruncana insignis***, GANDOLFI, 1955, Belen section, sample no 12, *Gansserina gansseri* Zone

Figure 11: ***Globotruncana lapparenti***, BROTZEN, 1936, Toylar section, sample no 16, *Gansserina gansseri* Zone

Figure 12: ***Globotruncana lapparenti***, BROTZEN, 1936, Belen section, sample no 6, *Gansserina gansseri* Zone

Figure 13: ***Globotruncana linneiana***, (D'ORBIGNY, 1839), Toylar section, sample no 5, Undefined zone

Figure 14: ***Globotruncana linneiana***, (D'ORBIGNY, 1839), Toylar section, sample no 11, *Gansserina gansseri* Zone

Figure 15: ***Globotruncana mariei***, (BANNER and BLOW, 1960), Toylar section, sample no 1, Undefined zone

Figure 16: ***Globotruncana mariei***, (BANNER and BLOW, 1960), Nasuhlar-Bulduk section, sample no C, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 17: ***Globotruncana mariei***, (BANNER and BLOW, 1960), Nasuhlar-Bulduk section, sample no E, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 18: ***Globotruncana mariei***, (BANNER and BLOW, 1960), Belen section, sample no D, *Abathomphalus mayaroensis* Zone

PLATE 4

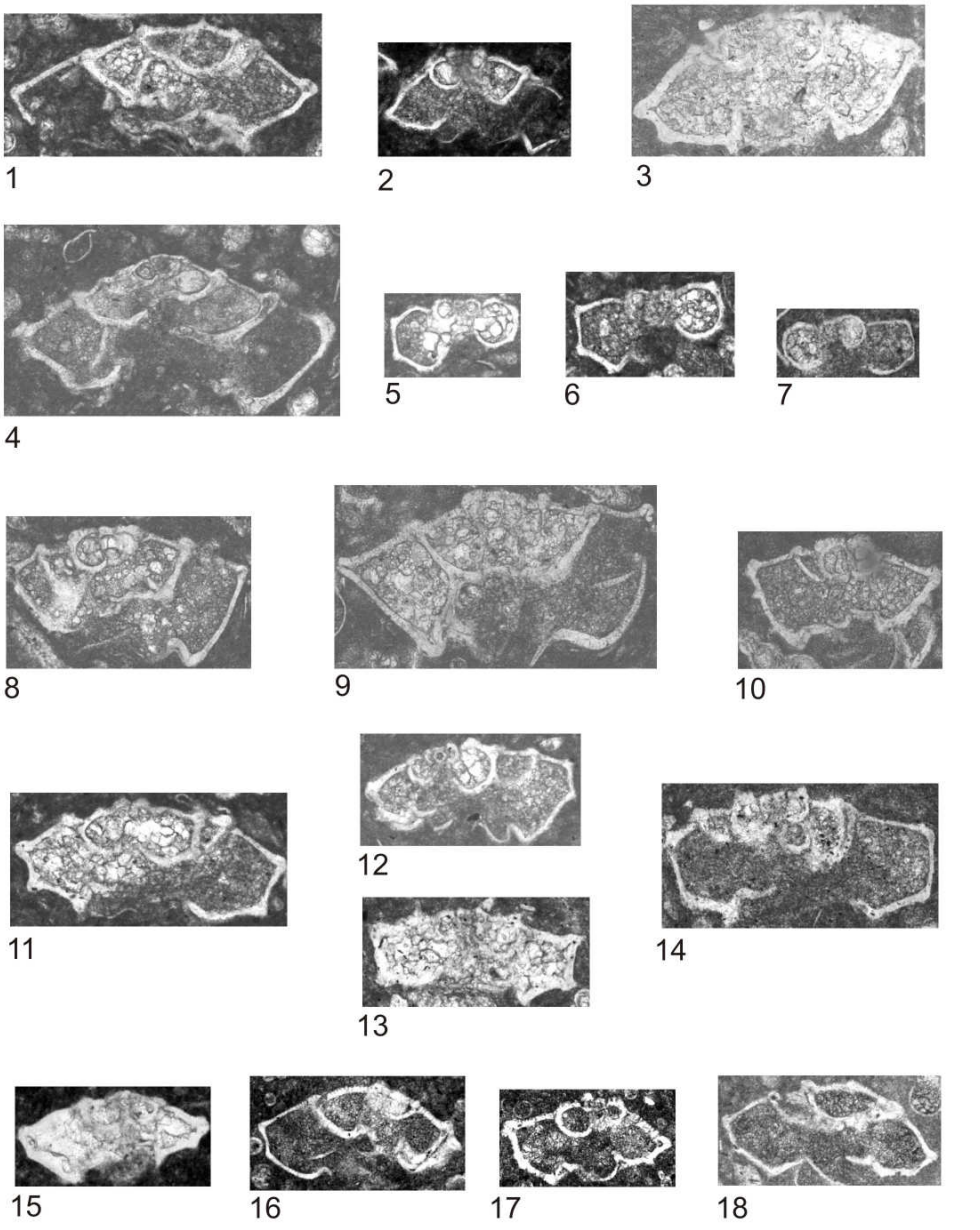


PLATE 5

Figure 1: ***Globotruncana orientalis***, EL NAGGAR, 1960, Toylar section, sample no 9, *Gansserina gansseri* Zone

Figure 2: ***Globotruncana orientalis***, EL NAGGAR, 1960, Belen section, sample no 12, *Gansserina gansseri* Zone

Figure 3: ***Globotruncana orientalis***, EL NAGGAR, 1960, Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 4: ***Globotruncana rosetta***, (CARSEY, 1926), Toylar section, sample no 2, Undefined zone

Figure 5: ***Globotruncana rosetta***, (CARSEY, 1926), Belen section, sample no C , *Abathomphalus mayaroensis* Zone

Figure 6: ***Globotruncana rosetta***, (CARSEY, 1926), Nasuhlar-Bulduk section, sample no D , *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 7: ***Globotruncanita angulata***, (TILEV, 1951), Belen section, sample no A , *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 8: ***Globotruncanita angulata***, (TILEV, 1951), Belen section, sample no C , *Abathomphalus mayaroensis* Zone

Figure 9: ***Globotruncanita conica***, (WHITE, 1928), Belen section, sample no 10 , *Gansserina gansseri* Zone

Figure 10: ***Globotruncanita conica***, (WHITE, 1928), Belen section, sample no B , *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 11: ***Globotruncanita conica***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no 3 , *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

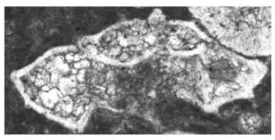
Figure 12: ***Globotruncanita conica***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no 8 , *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 13: ***Globotruncanita pettersi***, (GANDOLFI, 1955), Nasuhlar-Bulduk section, sample no 5, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 14: ***Globotruncanita pettersi***, (GANDOLFI, 1955), Nasuhlar-Bulduk section, sample no E, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 15: ***Globotruncanita pettersi***, (GANDOLFI, 1955), Toylar section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

PLATE 5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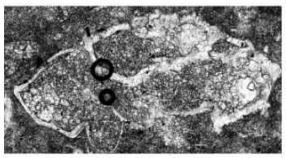
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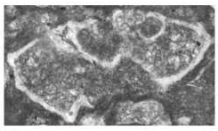
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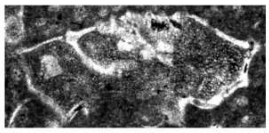
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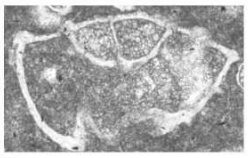
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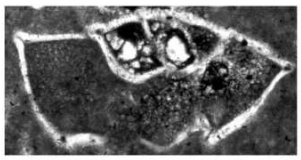
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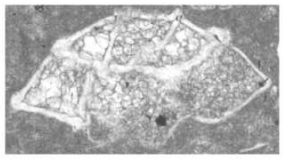
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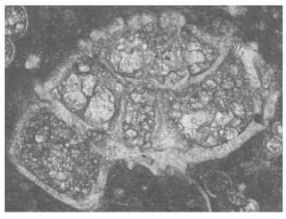
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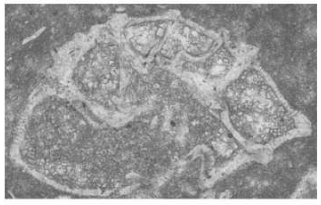
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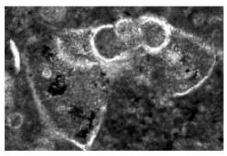
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PLATE 6

Figure 1: ***Globotruncanita stuarti***, (De LAPPARENT, 1918), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 2: ***Globotruncanita stuarti***, (De LAPPARENT, 1918), Toylar section, sample no B, *Abathomphalus mayaroensis* Zone

Figure 3: ***Globotruncanita stuarti***, (De LAPPARENT, 1918), Nasuhlar-Bulduk section, sample no 7, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 4: ***Globotruncanita stuarti***, (De LAPPARENT, 1918), Nasuhlar-Bulduk section, sample no 6, *Abathomphalus mayaroensis* Zone

Figure 5: ***Globotruncanita stuartiformis***, (DALBIEZ, 1955), Belen section, sample no 11, *Gansserina gansseri* Zone

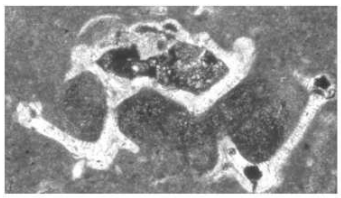
Figure 6: ***Globotruncanita stuartiformis***, (DALBIEZ, 1955), Belen section, sample no D, *Abathomphalus mayaroensis* Zone

Figure 7: ***Globotruncanita stuartiformis***, (DALBIEZ, 1955), Toylar section, sample no B, *Abathomphalus mayaroensis* Zone

Figure 8: ***Globotruncanita stuartiformis***, (DALBIEZ, 1955), Toylar section, sample no 27, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 9: ***Globotruncanita stuartiformis***, (DALBIEZ, 1955), Belen section, sample no A *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

PLATE 6



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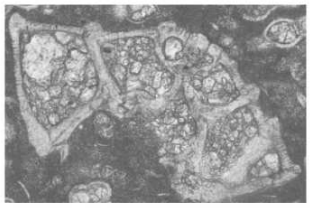

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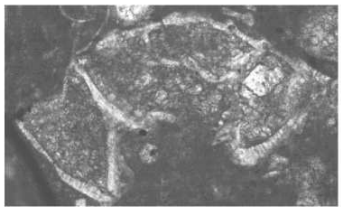

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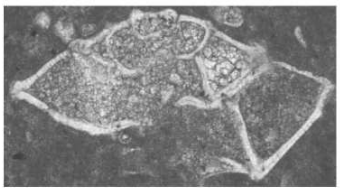

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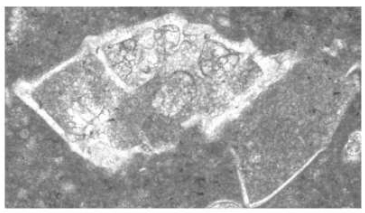

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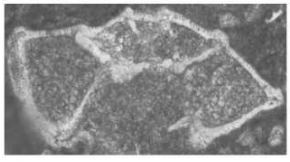

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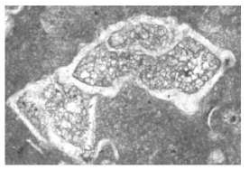

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PLATE 7

Figure 1: ***Globotruncanella havanensis***, (VOORWIJK, 1937), Belen section, sample no 14, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 2: ***Globotruncanella havanensis***, (VOORWIJK, 1937), Toylar section, sample no 22, *Gansserina gansseri* Zone

Figure 3: ***Globotruncanella havanensis***, (VOORWIJK, 1937), Toylar section, sample no A, *Abathomphalus mayaroensis* Zone

Figure 4: ***Globotruncanella petaloidea***, (GANDOLFI, 1955), Nasuhlar-Bulduk section, sample no 4, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 5: ***Globotruncanella petaloidea***, (GANDOLFI, 1955), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 6: ***Globotruncanella minuta***, (CARON and GONZALEZ DONOSO, 1937), Belen section, sample no 14, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 7: ***Globotruncanella minuta***, (CARON and GONZALEZ DONOSO, 1937), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 8: ***Globotruncanella pschadae***, (KELLER, 1946), Belen section, sample no 7, *Gansserina gansseri* Zone

Figure 9: ***Globotruncanella pschadae***, (KELLER, 1946), Toylar section, sample no 21, *Gansserina gansseri* Zone

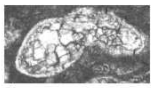
Figure 10: ***Globotruncanella pschadae***, (KELLER, 1946), Nasuhlar-Bulduk section, sample no C, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 11: ***Kuglerina rotundata***, (BRONNIMAN, 1952), Toylar section, sample no 9, *Gansserina gansseri* Zone

Figure 12: ***Kuglerina rotundata***, (BRONNIMAN, 1952), Toylar section, sample no 12, *Gansserina gansseri* Zone

Figure 13: ***Kuglerina rotundata***, (BRONNIMAN, 1952), Toylar section, sample no 15, *Gansserina gansseri* Zone

PLATE 7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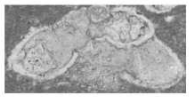
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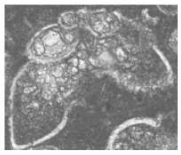
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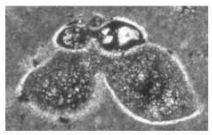
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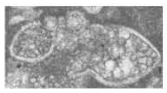
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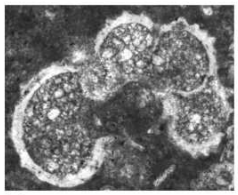
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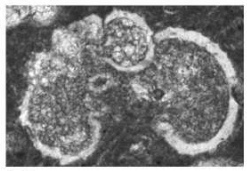
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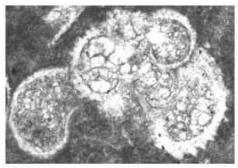
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PLATE 8

Figure 1: ***Rugoglobigerina hexacamerata***, BRONNIMAN, 1952, Toylar section, sample no 24, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 2: ***Rugoglobigerina macrocephala***, BRONNIMAN, 1952, Belen section, sample no 14, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 3: ***Rugoglobigerina milamensis***, SMITH and PESSAGNO, 1973, Belen section, sample no 9, *Gansserina gansseri* Zone

Figure 4: ***Rugoglobigerina milamensis***, SMITH and PESSAGNO, 1973, Toylar section, sample no B, *Abathomphalus mayaroensis* Zone

Figure 5: ***Rugoglobigerina milamensis***, SMITH and PESSAGNO, 1973, Toylar section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 6: ***Rugoglobigerina pennyi***, BRONNIMAN, 1952, Nasuhlar-Bulduk section, sample no 4, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 7: ***Rugoglobigerina pennyi***, BRONNIMAN, 1952, Nasuhlar-Bulduk section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 8: ***Rugoglobigerina pennyi***, BRONNIMAN, 1952, Toylar section, sample no 16, *Gansserina gansseri* Zone

Figure 9: ***Rugoglobigerina rugosa***, (PLUMMER, 1926), Toylar section, sample no 23, *Gansserina gansseri* Zone

Figure 10: ***Rugoglobigerina rugosa***, (PLUMMER, 1926), Toylar section, sample no 26, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

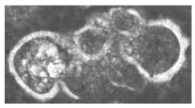
Figure 11: ***Rugoglobigerina rugosa***, (PLUMMER, 1926), Toylar section, sample no 27, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 12: ***Rugoglobigerina rugosa***, (PLUMMER, 1926), Belen section, sample no 14-1, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 13: ***Rugoglobigerina rugosa***, (PLUMMER, 1926), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 14: ***Rugoglobigerina rugosa***, (PLUMMER, 1926), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

PLATE 8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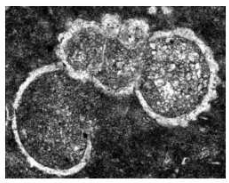
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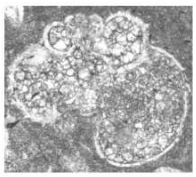
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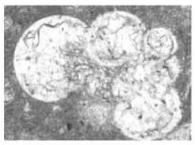
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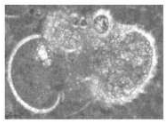
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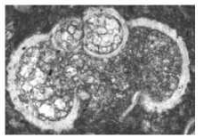
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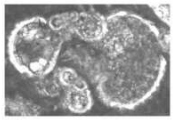
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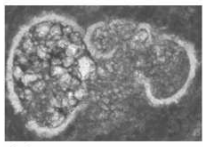
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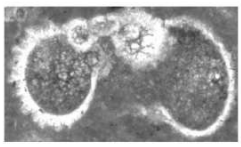
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PLATE 9

Figure 1: ***Trinitella scotti***, BRONNIMAN, 1952, Belen section, sample no 14-1, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 2: ***Trinitella scotti***, BRONNIMAN, 1952, Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 3: ***Trinitella scotti***, BRONNIMAN, 1952, Belen section, sample no D, *Abathomphalus mayaroensis* Zone

Figure 4: ***Trinitella scotti***, BRONNIMAN, 1952, Toylar section, sample no 26, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 5: ***Macroglobigerinelloides prairiehillensis***, (PESSAGNO, 1967), Belen section, sample no 5, *Gansserina gansseri* Zone

Figure 6: ***Macroglobigerinelloides prairiehillensis***, (PESSAGNO, 1967), Toylar section, sample no 22, *Gansserina gansseri* Zone

Figure 7: ***Macroglobigerinelloides subcarinatus***, (BRONNIMAN, 1952), Nasuhlar-Bulduk section, sample no E, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 8: ***Macroglobigerinelloides subcarinatus***, (BRONNIMAN, 1952), Belen section, sample no 14, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 9: ***Macroglobigerinelloides subcarinatus***, (BRONNIMAN, 1952), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 10: ***Pseudotextularia elegans***, (RZEHAK, 1891), Belen section, sample no A, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 11: ***Pseudotextularia nutalli***, (VOORWIJK, 1937), Belen section, sample no D, *Abathomphalus mayaroensis* Zone

Figure 12: ***Pseudotextularia nutalli***, (VOORWIJK, 1937), Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 13: ***Pseudotextularia intermedia***, De KLASZ, 1891, Belen section, sample no C, *Abathomphalus mayaroensis* Zone

Figure 14: ***Pseudotextularia intermedia***, De KLASZ, 1891, Nasuhlar-Bulduk section, sample no C, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 15: ***Pseudotextularia intermedia***, De KLASZ, 1891, Toylar section, sample no A, *Abathomphalus mayaroensis* Zone

PLATE 9


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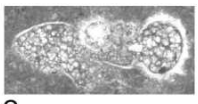
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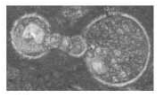
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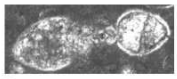
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PLATE 10

Figure 1: ***Heterohelix globulosa***, (EHRENBERG, 1840), Toylar section, sample no A, *Abathomphalus mayaroensis* Zone

Figure 2: ***Heterohelix punctulata***, (CUSHMAN, 1938), Toylar section, sample no 27, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 3: ***Heterohelix* sp.**, Toylar section, sample no 27, *Contusotruncana contusa /Racemiguembelina fructicosa* Zone

Figure 4: ***Planoglobulina acervulinoides***, (EGGER, 1900), Belen section, sample no 13, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 5: ***Planoglobulina acervulinoides***, (EGGER, 1900), Toylar section, sample no D1, *Abathomphalus mayaroensis* Zone

Figure 6: ***Planoglobulina brazoensis***, MARTIN, 1972, Nasuhlar-Bulduk section, sample no E, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

Figure 7: ***Planoglobulina brazoensis***, MARTIN, 1972, Belen section, sample no D, *Abathomphalus mayaroensis* Zone

Figure 8: ***Racemiguembelina fructicosa***, (EGGER, 1899), Nasuhlar-Bulduk section, sample no E, *Abathomphalus mayaroensis* Zone

Figure 9: ***Racemiguembelina fructicosa***, (EGGER, 1899), Belen section, sample no 14-2, *Abathomphalus mayaroensis* Zone

Figure 10: ***Racemiguembelina fructicosa***, (EGGER, 1899), Nasuhlar-Bulduk section, sample no E, *Abathomphalus mayaroensis* Zone

Figure 11: ***Racemiguembelina fructicosa***, (EGGER, 1899), Toylar section, sample no 24, *Contusotruncana contusa/Racemiguembelina fructicosa* Zone

PLATE 10

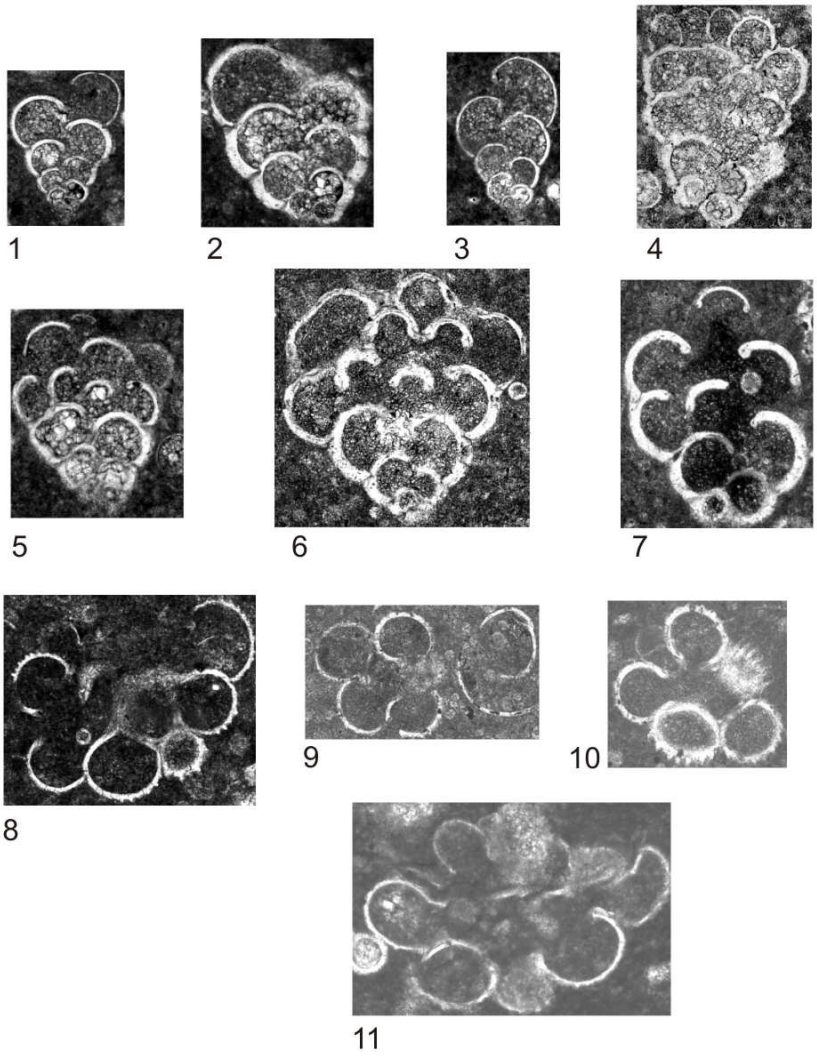

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PLATE 11

Figure 1: ***Guembelitria* cf. *cretacea***, CUSHMAN, 1933, Toylar section, sample no E, *Guembelitria cretacea* (P0) + *Parvularugoglobigerina eugubina* (Pα) Zone

Figure 2: ***Guembelitria* cf. *cretacea***, CUSHMAN, 1933, Belen section, sample no F, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 3: ***Guembelitria* cf. *cretacea***, CUSHMAN, 1933, Nasuhlar-Bulduk section, sample no F, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 4: ***Woodringina* cf. *hornertownensis***, OLSSON, 1960, Toylar section, sample no F, *Guembelitria cretacea* (P0) + *Parvularugoglobigerina eugubina* (Pα) Zone

Figure 5: ***Woodringina* cf. *hornertownensis***, OLSSON, 1960, Toylar section, sample no G, *Guembelitria cretacea* (P0) + *Parvularugoglobigerina eugubina* (Pα) Zone

Figure 6: ***Parvularugoglobigerina* cf. *eugubina***, (LUTERBACHER and PREMOLI SILVA, 1964), Toylar section, sample no E, *Guembelitria cretacea* (P0) + *Parvularugoglobigerina eugubina* (Pα) Zone

Figure 7: ***Parvularugoglobigerina* cf. *eugubina***, (LUTERBACHER and PREMOLI SILVA, 1964), Toylar section, sample no E, *Guembelitria cretacea* (P0) + *Parvularugoglobigerina eugubina* (Pα) Zone

Figure 8: ***Globanomalina compressa***, (PLUMMER, 1926), Belen section, sample no H, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 9: ***Globanomalina compressa***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no F, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 10: ***Globanomalina compressa***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no F, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 11: ***Globanomalina chapmani***, (PARR, 1938), Belen section, sample no 15, *Globanomalina pseudomenardii* (P4) Zone

Figure 12: ***Globanomalina ehrenbergi***, (BOLLI, 1957), Belen section, sample no 15, *Globanomalina pseudomenardii* (P4) Zone

Figure 13: ***Globanomalina pseudomenardii***, (BOLLI, 1957), Belen section, sample no 18, *Globanomalina pseudomenardii* (P4) Zone

Figure 14: ***Globanomalina pseudomenardii***, (BOLLI, 1957), Belen section, sample no 18, *Globanomalina pseudomenardii* (P4) Zone

Figure 15: ***Globoconusa daubjergensis***, (BRONNIMANN, 1953), Nasuhlar-Bulduk section, sample no B, *Contusotruncana contusa – Racemiguembelina fructicosa* Zone infilling

Figure 16: ***Globoconusa daubjergensis***, (BRONNIMANN, 1953), Nasuhlar-Bulduk section, sample no E, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 17: ***Globoconusa daubjergensis***, (BRONNIMANN, 1953), Nasuhlar-Bulduk section, sample no F, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

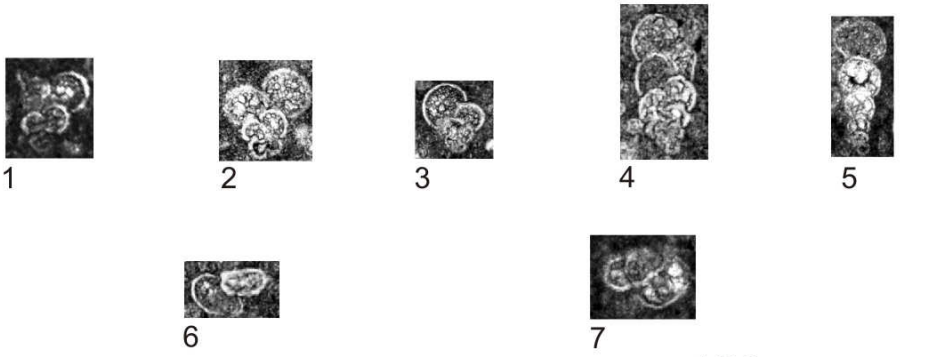
Figure 18: ***Parasubbotina pseudobulloides***, (PLUMMER, 1926), Belen section, sample no 14-5, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 19: ***Parasubbotina pseudobulloides***, (PLUMMER, 1926), Toylar section, sample no 32, *Praemurica uncinata* (P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 20: ***Parasubbotina pseudobulloides***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no F, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 21: ***Parasubbotina pseudobulloides***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no G, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

PLATE 11



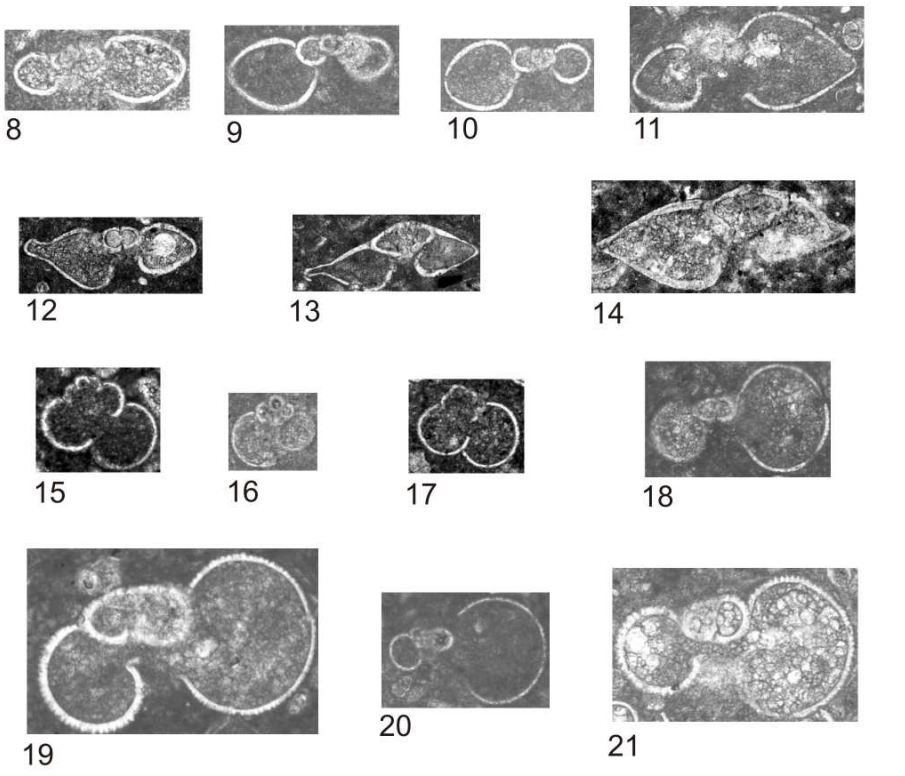


PLATE 12

Figure 1: ***Subbotina triangularis***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no 17 , *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 2: ***Subbotina triangularis***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no 19 , *Globanomalina pseudomenardii* (P4) Zone

Figure 3: ***Subbotina triloculinoides***, (PLUMMER, 1926), Toylar section, sample no 32, *Globanomalina pseudomenardii* (P4) Zone

Figure 4: ***Subbotina triloculinoides***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no 19, *Globanomalina pseudomenardii* (P4) Zone

Figure 5: ***Subbotina triloculinoides***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no G, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 6: ***Subbotina triloculinoides***, (PLUMMER, 1926), Nasuhlar-Bulduk section, sample no H, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 7: ***Subbotina triloculinoides***, (PLUMMER, 1926), Belen section, sample no 14-4, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 8: ***Subbotina velascoensis***, (CUSHMAN, 1928), Belen section, sample no 14-10, *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 9: ***Subbotina velascoensis***, (CUSHMAN, 1928), Belen section, sample no 14-10, *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 10: ***Subbotina velascoensis***, (CUSHMAN, 1928), Toylar section, sample no 36, *Praemurica uncinata*(P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 11: ***Acarinina soldadoensis***, (BRONNIMANN, 1952), Toylar section, sample no 39B, *Globanomalina pseudomenardii* (P4) Zone

Figure 12: ***Acarinina subsphaerica***, (SUBBOTINA, 1947), Toylar section, sample no 36, *Praemurica uncinata*(P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 13: ***Acarinina subsphaerica***, (SUBBOTINA, 1947), Toylar section, sample no 37, *Globanomalina pseudomenardii* (P4) Zone

PLATE 12

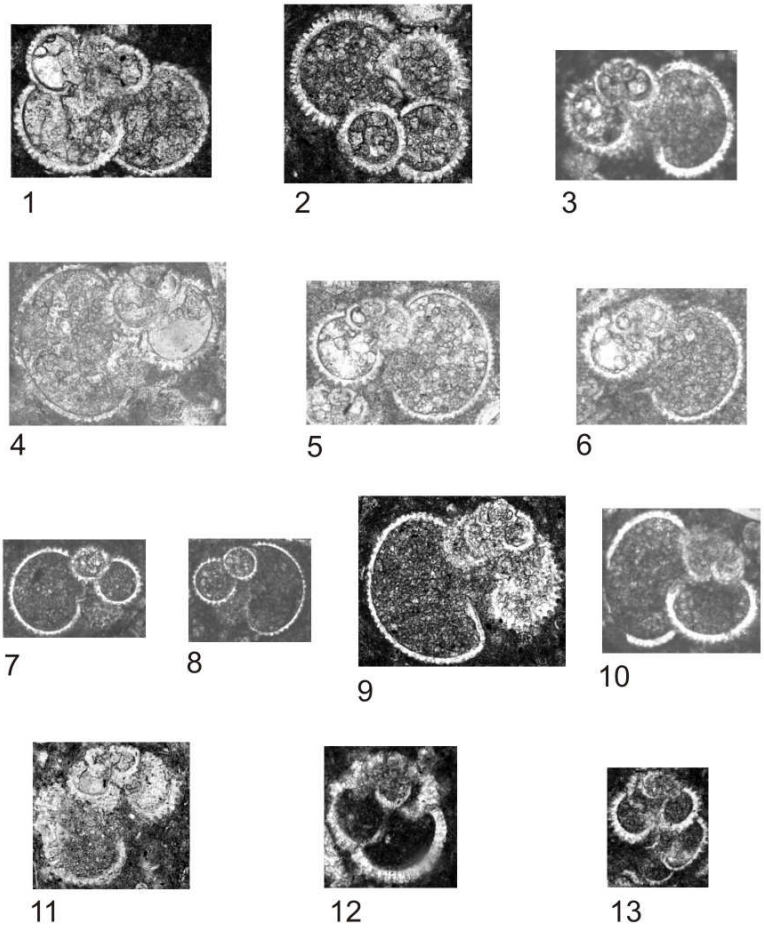


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PLATE 13

Figure 1: ***Morozovella aequa***, (CUSHMAN and RENZ, 1942), Nasuhlar-Bulduk section, sample no 23, *Globanomalina pseudomenardii* (P4) Zone

Figure 2: ***Morozovella aequa***, (CUSHMAN and RENZ, 1942), Toylar section, sample no 39B, *Globanomalina pseudomenardii* (P4) Zone

Figure 3: ***Morozovella angulata***, (WHITE, 1928), Nasuhlar-Bulduk section, sample no 17, *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 4: ***Morozovella angulata***, (WHITE, 1928), Belen section, sample no 15, *Globanomalina pseudomenardii*(P4) Zone

Figure 5: ***Morozovella conicotruncata***, (SUBBOTINA, 1953), Toylar section, sample no 33, *Praemurica uncinata* (P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 6: ***Morozovella occlusa***, (LOEBLICH and TAPPAN, 1957), Belen section, sample no 15, *Globanomalina pseudomenardii* (P4) Zone

Figure 7: ***Morozovella occlusa***, (LOEBLICH and TAPPAN, 1957), Toylar section, sample no 37, *Globanomalina pseudomenardii* (P4) Zone

Figure 8: ***Morozovella occlusa***, (LOEBLICH and TAPPAN, 1957), Toylar section, sample no 39B, *Globanomalina pseudomenardii* (P4) Zone

Figure 9: ***Morozovella praeangulata***, (BLOW, 1979), Belen section, sample no 15, *Globanomalina pseudomenardii* (P4) Zone

Figure 10: ***Morozovella velascoensis***, (CUSHMAN, 1925), Toylar section, sample no 39B, *Globanomalina pseudomenardii* (P4) Zone

Figure 11: ***Igorina* cf. *albeari***, (CUSHMAN and BERMUDEZ, 1949), Toylar section, sample no 33, *Praemurica uncinata* (P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 12: ***Igorina* cf. *albeari***, (CUSHMAN and BERMUDEZ, 1949), Toylar section, sample no 33, *Praemurica uncinata* (P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 13: ***Igorina pusilla***, (BOLLI, 1957), Belen section, sample no 14-11, *Morozovella angulata/ Igorina pusilla* (P3) Zone

Figure 14: ***Preamurica inconstans***, (SUBBOTINA, 1953), Toylar section, sample no 33, *Praemurica uncinata* (P2) – *Morozovella angulata/Igorina pusilla* (P3) Zone

Figure 15: ***Preamurica inconstans***, (SUBBOTINA, 1953), Nasuhlar-Bulduk section, sample no G, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 16: ***Preamurica pseudoinconstans***, (BLOW, 1979), Belen section, sample no G, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 17: ***Preamurica pseudoinconstans***, (BLOW, 1979), Belen section, sample no G, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 18: ***Preamurica pseudoinconstans***, (BLOW, 1979), Belen section, sample no G, *Globanomalina compressa-Preamurica inconstans* (P1c) Zone

Figure 19: ***Preamurica uncinata***, (BOLLI, 1957), Nasuhlar-Bulduk section, sample no 13, *Praemurica uncinata* (P2) Zone

Figure 20: ***Preamurica uncinata***, (BOLLI, 1957), Nasuhlar-Bulduk section, sample no 14, *Praemurica uncinata* (P2) Zone

Figure 21: ***Preamurica uncinata***, (BOLLI, 1957), Nasuhlar-Bulduk section, sample no 14, *Praemurica uncinata* (P2) Zone

Figure 22: ***Preamurica uncinata***, (BOLLI, 1957), Belen section, sample no 14-8, *Praemurica uncinata* (P2) Zone

PLATE 13

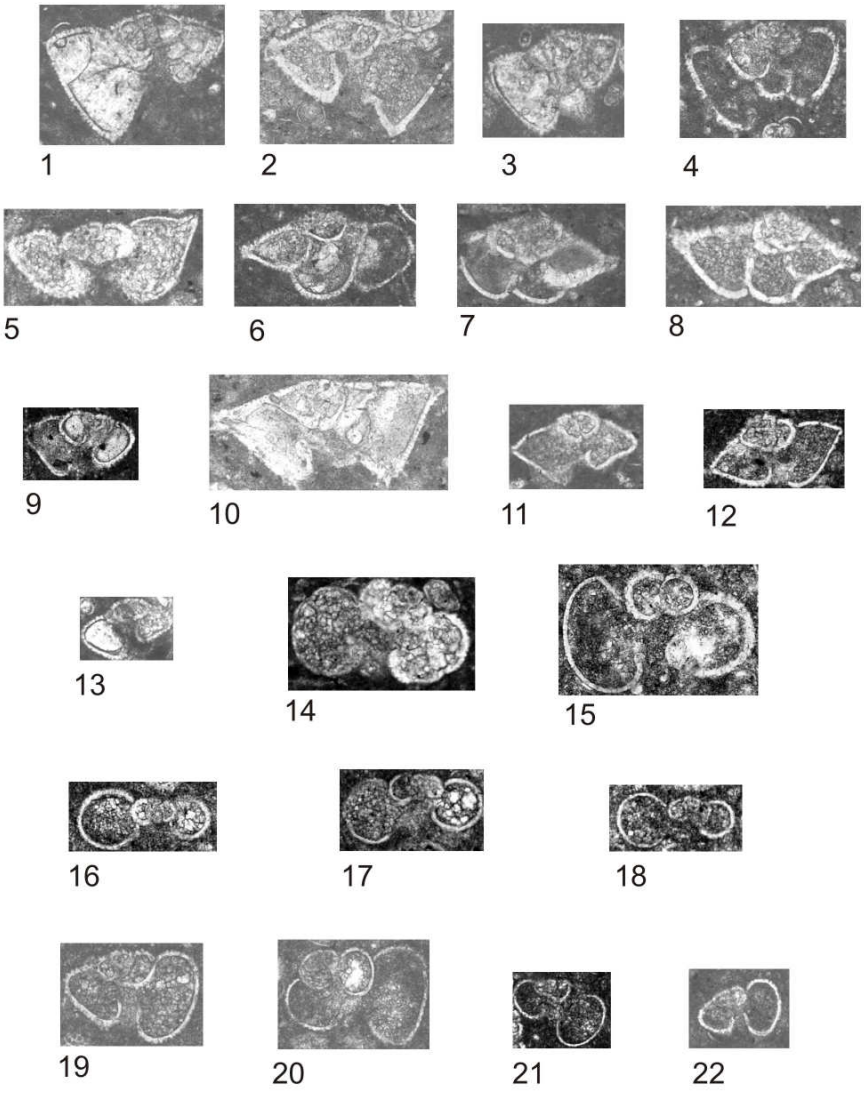

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PLATE 14

Figure 1: ***Discocyclina seunesi*** (DOUVILLÉ) **cf. *karabuekensis***, LESS and ÖZCAN, 2007, Belen section, sample no 18B

Figure 2: ***Discocyclina seunesi*** (DOUVILLÉ) **cf. *karabuekensis***, LESS and ÖZCAN, 2007, Belen section, sample no 18B

Figure 3: ***Orbitoclypeus multiplicatus*** (GUMBEL) ***haymanaensis***, ÖZCAN *et al.*, 2001, Belen section, sample no 18B

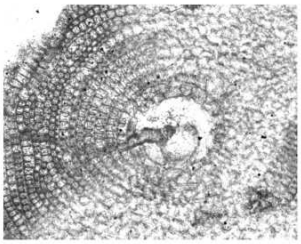
Figure 4: ***Orbitoclypeus multiplicatus*** (GUMBEL) ***haymanaensis***, ÖZCAN *et al.*, 2001, Belen section, sample no 18B

Figure 5: ***Orbitoclypeus multiplicatus*** (GUMBEL) ***haymanaensis***, ÖZCAN *et al.*, 2001, Belen section, sample no 18B

Figure 6: ***Orbitoclypeus multiplicatus*** (GUMBEL) ***haymanaensis***, ÖZCAN *et al.*, 2001, Belen section, sample no 18B

Figure 7: ***Assilina*** **gr.** ***yvettae*** (SCHAUB 1981) **–** ***aziliensis*** (TAMBAREAU 1966), Belen section, sample no 26

PLATE 14



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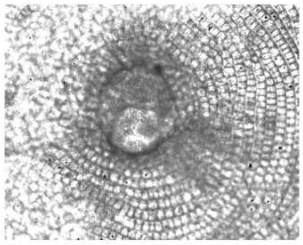

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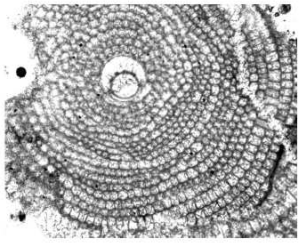

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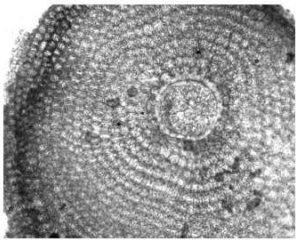

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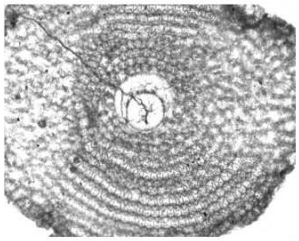

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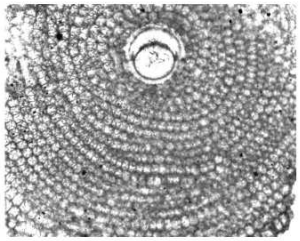

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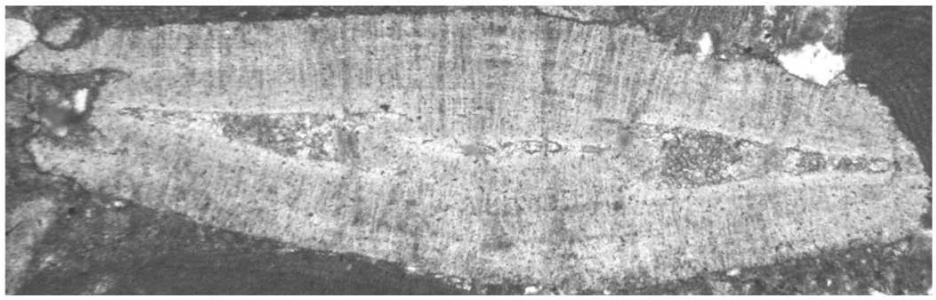

7

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CURRICULUM VITAE

Candidate's full name: VOLKAN SARIGÜL

Place and date of birth: ANKARA, SEPTEMBER 10, 1987

Education:

- M.Sc., Istanbul Technical University, Enstitute of Eurasian Earth Sciences, 2011.
- B.S., Istanbul Technical University, Department of Geological Engineering, 2009.
- Ankara Private Tevfik Fikret High School, Ankara, Turkey, 2004.

B.Sc. Graduation Project:

"Geology of Near Karahamzalı Village, South Polatlı"

Project supervisor: Prof. Dr. Naci GÖRÜR.

M.Sc. Graduation Project:

"Planktonic foraminiferal events and biostratigraphy of Upper Cretaceous and Lower Palaeocene carbonates (Akveren Formation) of Kocaeli Peninsula, NW Turkey".

Project supervisors: Prof. Dr. Ercan ÖZCAN and Dr. Aynur HAKYEMEZ.

Research experience:

1. Summer intership at Istanbul Technical University (ITU), in palaeontology section (summer 2007).
   Supervisor: Prof. Dr. Ercan ÖZCAN

   Studied early ontogenic parameters of large benthonic radial foraminiferas (esp. Miogypsinidae, Lepidocyclinidae, Orthophragminae and Cycloclypei) and their stratigraphic distributions at Şamlar (Istanbul) and Adilcevaz (Bitlis) regions, between Middle-Upper Eocene, Lower Miocene.

2. Summer Intership at Turkish Petroleum Company (TPAO), at petroleum search department in sedimentology section (summer 2006).
   Supervisor: Assoc. Prof. Dr. Ahmet Sami DERMAN

Studied how the petroleum forms, moves, accumulates and gets trapped. Basin types, reservoir geology, stratigraphy and sediment relations. Logged comments, geophysics methods on wells.

Explanation of Haymana Basin (southwest of Ankara) as the intership project, and its stratigraphy, tectonics and potential for petroleum.

3. Volunteer assistantship at Istanbul Technical University (ITU), in palaeontology section (2005 – 2006).

   Examination of the classification of brachiopods, pelecypods, cephalopods and echinoderms.

Presentations:

- Özcan, E., Less, G. ve **Sarıgül, V.,** 2008, Burdigalian Migration of Larger Foraminifera From Indo-Pacific to Western Tethys Based on The Data from Eastern Turkey: Paleobiogeographic Implications, *Procedings of 61th Geological Congress of Turkey*, 444–446.

Short courses and conferences:

- International School on Foraminifera, 3rd Course, 7-16 April 2010, Urbino/ITALY.

Computer skills:

Microsoft Office Tools (Word, Excel, Powerpoint etc…), Coreldraw, Photoshop.

Foreign Languages:

Fluent in Turkish, English and French, basic knowledge of Arabic.

References are available upon request.