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MAASTRICHTIAN - SELANDIAN PLANKTONIC FORAMINIFERA BIOSTRATIGRAPHY AND PALAEOECOLOGICAL INTERPRETATION OF AKVEREN FORMATION IN BARTIN AREA (WESTERN BLACK SEA, TURKEY)

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Research Article

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ABSTRACT

The changes in planktonic foraminifera assemblages were studied in two sections composed of clayey limestone, limestone, claystone and marl in the Akveren Formation in the Bartın Province. *Pseudoguembelina palpebra*, *Racemiguembelina fructicosa*, *Abathomphalus mayaroensis* and *Pseudoguembelina hariaensis* biozones in the Maastrichtian and *Parvularugoglobigerina eugubina*, *Glomobanomalina compressa*/*Praemurica uncinata*, *Praemurica uncinata* and *Morozovella angulata* biozones in the Paloecene were determined using planktonic genus and species identified in these sections. Paleoecological interpretations in this study were completed by using the relative abundances of paleoecological species identified in these biozones. The abundance of *Rugoglobigerina* spp., *Heterohelix globulosa*, *Pseudoguembelina* spp., species that tolerated changes in sea water temperature and nutrition, increased in the Maastrichtian. In the uppermost Maastrichtian, high abundance of *Racemiguembelina fructicosa*, *Heterohelix globulosa* and *Rugoglobigerina* spp. show oligotrophic and warmer environmental conditions in this study. The abundance of globotruncanids are unstable due to environmental changes. The new species have smaller sizes and globular chambers emerged in the Paleocene. High abundance of *Subbotina triloculinoides* and *Parasubbotina pseudobulloides* show mesotrophic and cooler environmental conditions in the Danian. Morozovellid taxa started to dominate in the Selandian and environmental conditions changed from mesotrophic to oligotrophic.

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1. Introduction

The temperature in the Late Cretaceous from Cenomanian to Maastrichtian was higher than today as determined by stable isotope studies and global climate models (Huber et al., 1995, 2002; Clarke and Jenkyns, 1999; DeConto et al., 1999; Wilson and Norris, 2001; Norris et al., 2002; Wilson et al., 2002; Bice et al., 2006; Forster et al., 2007; Bornemann et al., 2008; Friedrich et al., 2008; Shirazi et al., 2013; Kaya-Özer, 2014).

The Cretaceous climate started to cool in the Campanian and Maastrichtian (Huber et al., 1995, 2002). While the decrease reached a maximum level in the Maastrichtian (Clarke and Jenkyns, 1999; Huber et al., 2002; Miller et al., 2005), a sudden increase in temperature occurred at the end of this period (Li and Keller, 1998*a,b*) and surface water temperatures increased by 2-3 °C between ~65.45 and 65.1 Ma before the Cretaceous–Paleogene boundary (K–Pg) (Li and Keller 1998*a,b*; Barrera and Savin, 1999). Global cooling continued in the last 100 kyr of the Maastrichtian and sea surface water temperatures decreased (Thibault and Gardin, 2007).

Climatic changes caused variations in the biota of planktonic foraminifera together with most fauna (Abramovich and Keller, 2003). An important biotic event that occurred in this period is a decrease in planktonic foraminifera species richness at about 66 Ma in the South Atlantic and Tethys basins, coincident with the end-Maastrichtian global warming (Li and Keller, 1998*a, b*). This was also proven by oxygen isotope studies carried out on deep-sea drillings in the Atlantic, Pacific and Indian Oceans (Zachos et al., 1985, 1989; D'Hondt and Lindinger, 1994; Corfield and Norris, 1996; Barrera et al., 1997; Li and Keller, 1998*a,b*; Abramovich and Keller, 2003; Friedrich et al., 2012) and in the Boreal Realm (Friedrich et al., 2008).

Keller et al. (2002) noticed the faunal decline crested at the K/Pg boundary with the mass extinction

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of tropical-subtropical planktonic foraminiferal species whereas the cosmopolitan and ecologically generalist species survived into the Danian. At first, tropical species with complex, large and ornamental shells (*globotruncanids, racemiguembelinids, planoglobulinids*) and then smaller subtropical species (*pseudotextularids, rugoglobigerinids*) were affected during the extinction at the K/Pg boundary (Keller, 1996)

There are lots of paleoecological studies based on stable oxygen and carbon isotopes and changes in planktonic foraminifera assemblages in Maastrichtian and Paleocene sediments which were collected from deep sea drillings and several locations worldwide (Huber et al., 1995; Li and Keller, 1998*a*). The aim of this study is to identify planktonic foraminifera biostratigraphy in the Akveren Formation and determine the paleoecological conditions based on changes in planktonic foraminifera assemblages between Maastrichtian and lower Paleocene period using samples from Bartın Province (Western Black Sea) in Turkey. The biostratigraphic and paleoenvironmental interpretations of the composition of the planktonic foraminifers were also discussed.

2. Geological Setting and Previous Studies

The study area is in the Western Black Sea Basin in the Pontides, one of the tectonic plates in Turkey, which is a part of the Alpine Belt. There are several geological studies about Bartın province and its surrounding. The first studies in the region were about its petroleum potential (Badgley, 1959; Saner, 1981; Gedik and Korkmaz, 1984; Robinson et al., 1996; Görür and Tüysüz, 1997). There are also several studies investigating its geological and tectonic characteristics. The geological map of Cide-Kurucaşile area was drawn by Akyol et al. (1974). Geological structure, tectonic, petrographical and petrological characteristics of the region from Jurassic to Quaternary were investigated by Saner (1980), Gedik et al. (1983), Barka et al. (1983), Aydın et al. (1986), Derman et al. (1995), Derman (2002) and Tüysüz et al. (2012).

Şengör (1982) suggested that the Western Black Sea basin was opened as a back arc basin in relation to closure of the Tethys Ocean. Görür (1988) mentioned the Western Black Sea Basin as related to post rift thermal subsidence (Görür, 1988). Özçelik and Çaptuğ (1990) examined the tectonic characteristics of the region and emphasized that sedimentation was continuous in upper Cretaceous/Tertiary units. In addition, they pointed out that the Akveren Formation is of Maastrichtian-early Paleocene age, comprises marls, calciturbiditic limestones, micrites and shale.

Akman (1992) studied the stratigraphic units between Lutetian and Permian, and named the various sediments, volcano-sedimentary, and volcanic rocks that outcrop in the region. Tüysüz (1993) investigated the Pontides in detail, classified its tectonic sections and suggested a geological evolution model. Sunal and Tüysüz (2001) studied the stratigraphy and tectonics of the region. Tüysüz (2002) stated that deposition was accompanied by strong volcanism in the Cenomanian-Maastrichtian period and this volcanism that was common on the Black Sea coast began at the end of the Campanian and ended in the Maastrichtian.

Paleontological studies completed in the study area and its surrounding are important. Dizer and Meriç (1981) defined the planktonic foraminifera zones from the upper Cretaceous to Paleocene in Gebze, Akçakoca, Devrek and Bartın areas in Northwest Anatolia. They stated that the sea had a deep sea characteristic in Bartın in the upper Cretaceous and Paleocene. Varol (1983) discussed the late Cretaceous-Paleocene calcareous nanofossils from the Kokaksu Section. Sirel (1991) defined a new species (*Cideina* n.gen.) in his study in the Cide region. Özkan-Altıner and Özcan (1999) examined the benthic and planktonic foraminifera in the units from late Cretaceous to early Tertiary in the forearc basins located in north, northwest and central Anatolia.

Şener (2007) identified *Neotrocholinid* and *Orbitolinid* species that were benthic foraminifera in the İnaltı Formation outcropping in Amasra. Three new *Neotrocholina species* (*Neotrocholina amasraensis, N. sireli, N. bartinensis*) were identified, the age of the formation in the study area was defined as Cimmerian-Aptian based on these identified species.

3. Stratigraphy

The oldest unit in the area consists of Amasra Group rocks, belonging to the Yemişliçay Upper Group (Tüysüz et al., 2004). The Amasra Group, deposited in the late Santonian and Campanian, begins with a marine succession that overlaps the older units (Tüysüz et al., 2004). At the beginning of this period, pelagic limestones were deposited and then volcanics and pyroclastics (Kazpınar Formation) developed (Tüysüz et al., 2004).

3.1. Kazpınar Formation

The name of the formation was first used by Tokay (1954/1955). This unit was studied as the Yemişliçay formation (Ketin and Gümüş, 1963), Kurucaşile formation (Akyol et al., 1974), Lümeran formation (Kaya et al., 1982/1983), Cambu formation (Şahintürk and Özçelik, 1983; Tüysüz et al., 1997) and Dinlence formation (Akman, 1992) in previous studies. Kazpınar formation widely consists of andesitic lavas, pyroclastics, volcanic sandstones, siltstones, marls and lava blocks (Tüysüz et al., 2004).

Kazpınar formation indicates volcanic activity in the deep sea environment (Akman, 1992). Turbiditic units were deposited when the volcanism lost its effect (Akman, 1992). The age of the formation was defined as Campanian according to its stratigraphic position (Tüysüz et al., 2004). In another study, it was dated as early Campanian due to genus and species of planktonic foraminifera and nanofossils that were identified in carbonate levels in this formation (Kaya-Özer, 2009).

3.2. Akveren Formation

Akveren Formation overlaps the Yemişliçay group rocks consisting of volcanic and volcaniclastic rocks (Gedik et al., 2005). The Akveren Formation was first described by Gayle (1959) as layers of clayey limestone then formally defined by Ketin and Gümüş (1963) as widespread along the western Black Sea coast.

Akveren Formation was the subject of several studies. Dobrucalı (1985) and Sarıca (1993) examined planktonic foraminifera fauna and stratigraphic position of the Akveren Formation. Kırcı (1998) stated that the Akveren Formation includes a rich foraminifera assemblage that consists of planktonic foraminifera, small benthic foraminifera and large benthic foraminifera in Maastrichtian and dated it as late Cretaceous-Paleocene. In addition, she pointed out that it was dominated by deepening intensity flows and represented a calciturbiditic succession that reflected deposition in the open shelf environment.

Aydın (2005) studied nanoplankton biostratigraphy in detail in the units of Cretaceous-Paleogene age including the Akveren Formation northwest of İzmit. In this study, the Cretaceous-Tertiary boundary was determined to be continuous. Güray (2006) determined the Campanian-Maastrichtian boundary by using planktonic foraminifera. While the Campanian-Maastrichtian boundary was determined as the boundary of zones of *Pseudotextularia elegans* and *Planoglobulina acervuloinides* in her study, the Cretaceous/Tertiary boundary was determined by the extinction of upper Cretaceous fossils.

The Akveren Formation is initially characterized at the base by white-gray, medium to thickly bedded sandstones and greenish-gray marls that change to white-cream, thinly bedded micritic limestones and clayey limestones in the upper levels. The formation ends with white-beige, locally siliceous, thin to medium bedded limestones, claystones, and marl alternations and gradually passes into the Atbaşı Formation consisting of calcareous mudstones (Akman, 1992, Figure 1).

Thickness of the Akveren Formation was indicated as 390 m by Akyol et al. (1974) and 590 m by Akman (1992). The age of the formation was indicated as Campanian-Maastrichtian by Akman (1992), Maastrichtian by Ketin and Gümüş (1963) and Maastrichtian-Paleocene by Gedik and Korkmaz (1984). Kaya-Özer (2009), Kaya-Özer and Toker (2012) pointed out that the age of the Akveren Formation age is Campanian-Selandian based on planktonic foraminifera and nannofossil biostratigraphy.

3.3. Atbaşı Formation

The Atbaşı formation was first named by Ketin and Gümüş (1963) and different names have been used in some studies (Akyol et al., 1974; Akman, 1992). The unit consists of green and purple thin bedded, conchoidal fracture, fossiliferous siltstones, claystones and marls. Thin to medium bedded, green, greenish, gray sandstone layers and rarely white colored, thin bedded limestones are found in the unit. According to Gedik and Korkmaz (1984), its thickness is 537 m Akyol et al. (1974) named this unit the Akgüney Formation and indicated its thickness as 260 m. The age of the unit was determined as Paleocene-Early Eocene (Ketin and Gümüş, 1963), Paleocene (Akyol et al., 1974), early Eocene (Gedik and Korkmaz, 1984) and Paleocene (Tüysüz et al., 1997), in various studies. Kaya-Özer and Çakır (2015) pointed out the age of the formation was Selandian-Ypresian according to detailed planktonic foraminifera biostratigraphy.

4. Material and Method

This study is based on 37 samples from two sections in the Akveren Formation. The study area lies in the Bartın area on the Black Sea coast and is shown on the 1:25000 Zonguldak E28-c2 map (Figure 1).

The samples of planktonic foraminifera were disaggregated in 10% concentrated hydrogen peroxide soaked with water and washed through >63 µm sieve until clean foraminiferal residues were recovered. The washed samples were dried at room temperature. From each Cretaceous sample, about 300 planktonic foraminifera were picked from random sample splits (Abramovich and Keller, 2003). All Paleocene planktonic foraminifera species were picked from the samples, because they are rare. The planktonic foraminifera species were identified under a stereo microscope (Leica zoom 2000). The important species were photographed with a scanning electron microscope (SEM-JEOL JSM-6490LV)) at the Turkish Petroleum Company (TPAO) and are presented in the plate.

Mesozoic taxonomic concepts for planktonic foraminifera identification were applied in this study according to Robaszynski et al. (1984), Caron (1985), Robaszynski and Caron (1995), Huber et al. (2008), Petrizzo et al. (2011). Cenozoic taxonomic concepts for planktonic foraminifera identification were used according to Toumarkine and Luterbacher (1985), Berggren and Norris (1997) and Olsson et al. (1999).

The percentages of planktonic foraminifera species were calculated for paleoecological interpretation and these percentages were counted according to the

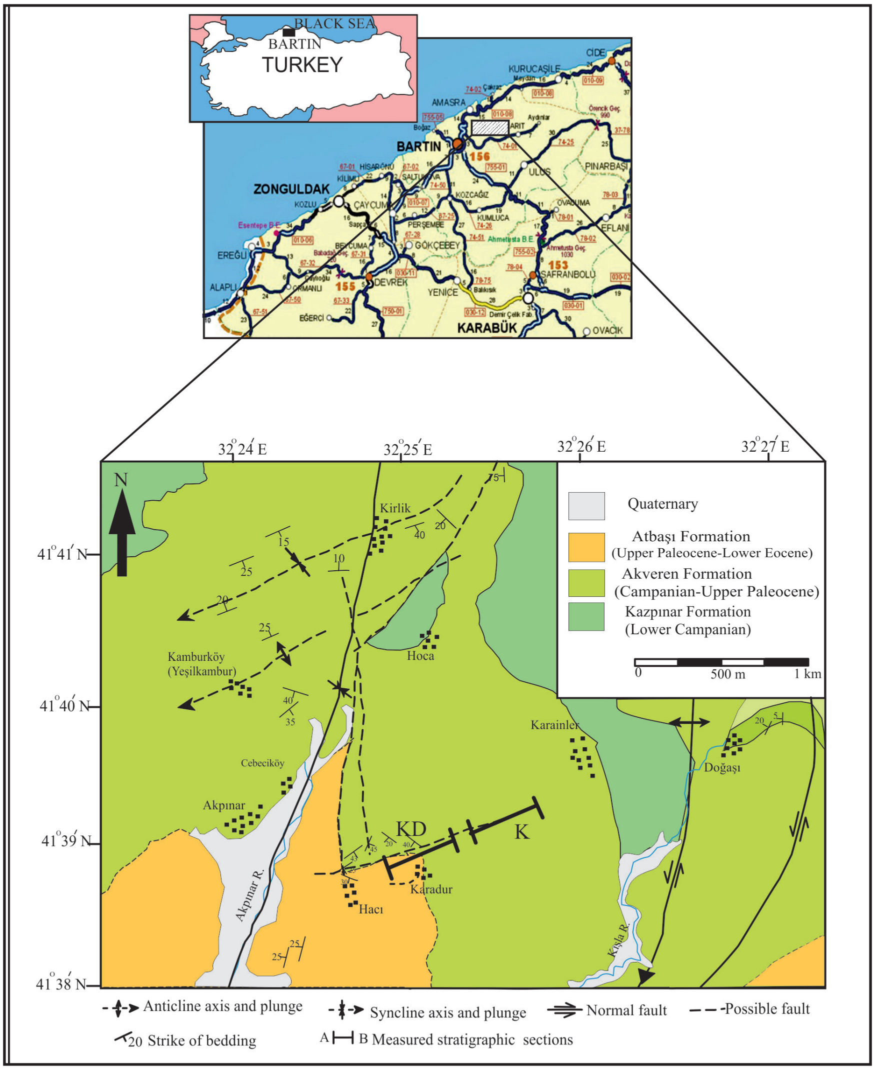

Figure 1- Location and geological map of the study area with locations of the measured sections (modified from Akman, 1992).

relative abundance of each species in the samples. The percentage abundances (%) of planktonic foraminifera are listed in table 1 and table 2.

5. Results

5.1. Stratigraphic Section

The detailed planktonic foraminiferal biostratigraphy were studied in the Karainler and Karadur areas around Bartın (Figure 1).

Karainler stratigraphic section

Measured in west of Karainler Village in the Akveren Formation, the Karainler section begins at the coordinates 41^{o}39’25”- 32^{o}25’80” and ends at 41^{o}39’15”- 32^{o}25’50”. It consists of an alternation of pink, cream-colored, thin to medium bedded clayey limestones, cream-colored, thin-bedded claystones and gray conchoidal marl at the base of the Akveren Formation (Figure 2). It passes into an alternation of gray, beige, thin to medium bedded, clayey limestones, white, thin bedded claystones and gray, green laminated marl in the upper level of the Akveren Formation. The section ends with an alternation of gray marl and thin to medium bedded limestones that include hard, partly silicified and echinoid fossils (Figure 2, 3). Total thickness of the section measured in the Akveren Formation is 140 m and the sampling intervals varied every 3-10 m in this section (Figure 3).

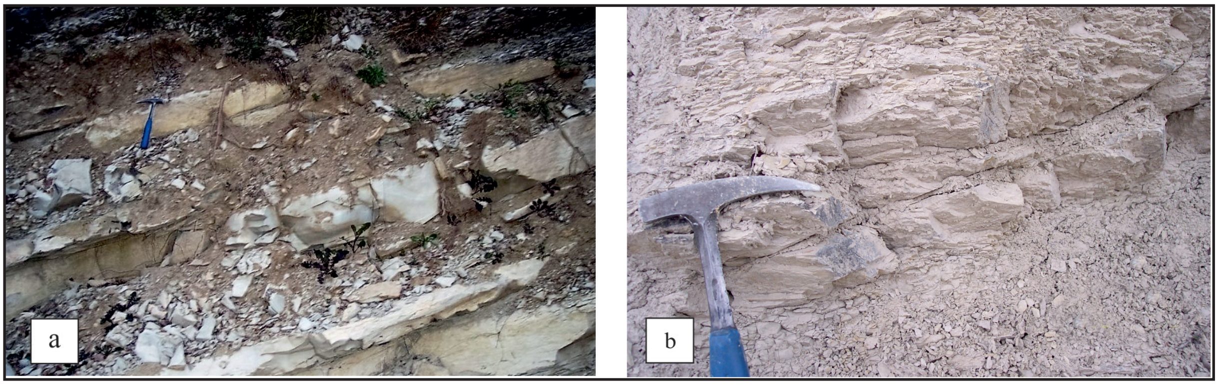

Figure 2- Field photographs of the sedimentary rocks of the Karainler stratigraphic section. (a). Alternating silicified limestones and marl in the upper Maastrichtian of the Akveren Formation, (b). interbedded gray green marls and cream clayey limestone in the lower Maastrichtian of the Akveren Formation.

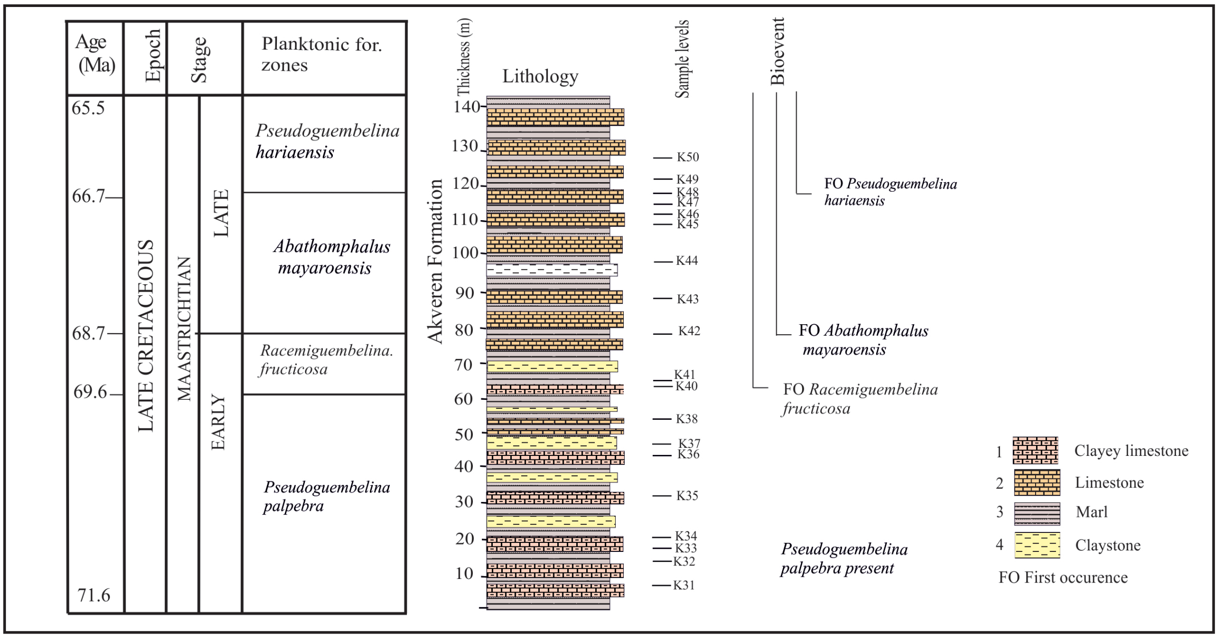

Figure 3- Karainler measured stratigraphic section showing lithostratigraphy, biostratigraphy and main planktonic foraminiferal bioevents from the Bartın area.

Karadur stratigraphic section

Measured around Karadur Village, the Karadur section begins at the coordinates 41°39'15"- 32°25'45" and ends at 41°38'80"- 32°24'95". It consists of an alternation of cream-colored, thin to medium bedded limestones, claystones and green, beige marl at the base in the Akveren Formation (Figure 4). The section continues as an alternation of partly silicified, thin to medium bedded limestones and laminated marl in the upper level of the Akveren Formation (Figure 4), it gradually passes into the Atbaşı Formation consisting of purple, green, thin to medium bedded conchoidal fracture marl in the uppermost levels (Figure 5). Total thickness of Karadur section is 23 m and the sampling intervals varied from 1-5 m in this section (Figure 5).

In the study area, the K/Pg boundary is located within the Akveren Formation. However, during the sampling process, this boundary was missed and could not be identified.

5.2. Biostratigraphy

The standard upper Cretaceous biozonation scheme of Huber et al. (2008) and standard Paleocene biozonation scheme of Wade et al. (2011) were applied to the planktonic foraminifera data (Figure 3, 5). The important planktonic foraminifera species were shown in the plate I, II.

5.2.1. Maastrichtian Planktonic Foraminifera Zones

Pseudoguembelina palpebra Partial-range Zone: Biostratigraphic interval from the first occurence (FO) of *Pseudoguembelina palpebra* to the FO of *Racemiguembelina fructicosa*.

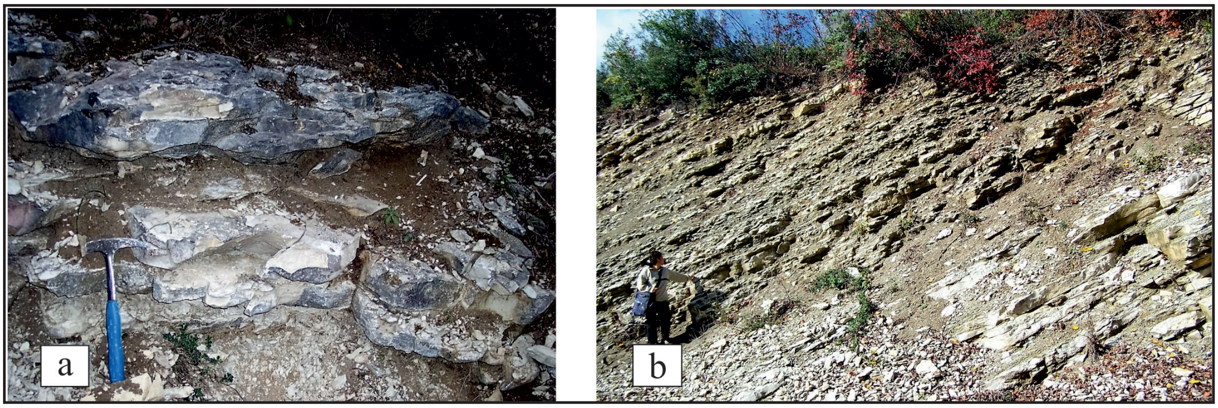

Figure 4- Field photographs of the sedimentary rocks of the Karadur stratigraphic section. (a). interbedded graygreen marls and cream silicified micritic limestones in the upper Maastrichtian of the Akveren Formation, (b). field view of Karadur stratigraphic section.

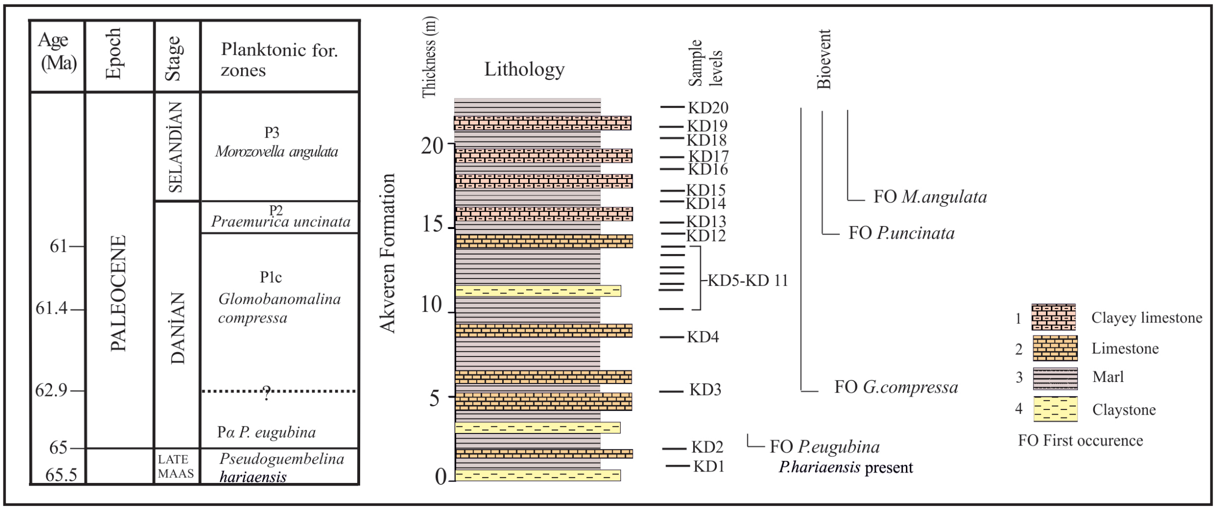

Figure 5- Karadur measured stratigraphic section showing lithostratigraphy, biostratigraphy and main planktonic foraminiferal bioevents from the Bartın area.

Author: Huber et al., 2008

Age: late Campanian-early Maastrichtian (Base 71.64 Ma, top 69.62 Ma; Huber et al. 2008).

The dominant planktonic foraminiferal species recorded in this zone include *Contusotruncana contusa, C. fornicata*, *C. patelliformis, C. plicata, C. plummerea, C. walfischensis, Gansserina gansseri*, *Globigerinelloides ultramicrus*, *Globotruncana arca*, *G. aegyptiaca*, *G. bulloides*, *G. falsostuarti*, *G. insignis*, *G. linneiana*, *G. mariei, Globotruncanella havanensis*, *G. minuta*, *G. petaloidea, Globotruncanita stuarti, G. stuartiformis*, *Heterohelix globulosa, Planoglobulina acervulinoides, P. multicamerata*, *Pseudoguembelina costulata*, *P. palpebra, Pseudotextularia elegans*, *Rugoglobigerina hexacamerata, R. macrocephala, R. rugosa*, *R. rotundata* (Table 1).

This zone has been identified in samples K31–K38 from the base of the Karainler stratigraphic section of the Akveren Formation (Table 1, Figure 3).

Racemiguembelina fructicosa Partial-range Zone: Biostratigraphic interval from the FO of *Racemiguembelina fructicosa* to the FO of *Abathomphalus mayaroensis*.

Author: Huber et al., 2008 (modified by Robaszynski and Caron 1995; Li and Keller 1998*a, b*).

Age: early Maastrichtian (Base 69.62 Ma, top 68.72 Ma; Huber et al., 2008).

The dominant planktonic foraminiferal species recorded in this zone include *Contusotruncana contusa, C. plicata, C. plummerea, C. walfischensis, Gansserina gansseri*, *Globigerinelloides ultramicrus*, *Globotruncana arca*, *G. aegyptiaca*, *G. falsostuarti*, *G. insignis*, *G. mariei, Globotruncanella havanensis*, *G. petaloidea, Globotruncanita falsocalcarata, G. stuarti, G. stuartiformis*, *Heterohelix globulosa, Planoglobulina acervulinoides, P. multicamerata*, *Pseudoguembelina costulata*, *P. palpebra, Pseudotextularia elegans*, *Racemiguembelina fructicosa, Rugoglobigerina hexacamerata, R. macrocephala, R. rugosa*, *R. Rotundata*.

This zone has been identified in samples K40 and K41 of the Karainler section (Table 1, Figure 3).

Abathomphalus mayaroensis Partial-range Zone: Biostratigraphic interval from the FO of *Abathomphalus mayaroensis* to the FO of *Pseudoguembelina hariaensis*.

Author: Huber et al., 2008, modified by Robaszynski and Caron (1995).

Age: late Maastrichtian (Base 68.72 Ma, top 66.78 Ma; Huber et al., 2008).

The dominant planktonic foraminiferal species recorded in this zone include *Abathomphalus mayaroensis, Contusotruncana contusa, C. patelliformis, C. plicata, C. plummerea, C. walfischensis, Gansserina gansseri*, *Globigerinelloides ultramicrus*, *Globotruncana arca*, *G. aegyptiaca*, *G. bulloides, G. falsostuarti*, *G. insignis*, *G. mariei, Globotruncanella havanensis*, *G. minuta*, *G. petaloidea, Globotruncanita falsocalcarata, G. stuarti, G. stuartiformis*, *Heterohelix globulosa, Planoglobulina acervulinoides, P. multicamerata*, *Pseudoguembelina costulata*, *P. palpebra, Pseudotextularia elegans*, *Racemiguembelina fructicosa, Rugoglobigerina hexacamerata, R. macrocephala, R. rugosa*, *R. rotundata*.

This zone has been identified in samples K42–K47 of the Karainler section of the Akveren Formation (Table 1, Figure 3).

Pseudoguembelina hariaensis Partial-range Zone: Biostratigraphic interval from the FO of the nominate species to the extinction of most Cretaceous planktonic foraminifera at the Cretaceous-Paleogene boundary.

Author: Robaszynski and Caron (1995).

Age: latest Maastrichtian (Base 66.78 Ma, top 65.50 Ma; Huber et al., 2008).

Toward the end of the Maastrichtian, globotruncanids decreased and high abundances of biserial heterohelicids, pseudoguembelinids, and rugoglobigerinids are recorded. The most characteristic elements recorded in this zone are *Abathomphalus mayaroensis, Contusotruncana contusa, C. plicata, C. plummerea, C. walfischensis, Gansserina gansseri*, *Globigerinelloides ultramicrus*, *Globotruncana arca*, *G. aegyptiaca*, *G. falsostuarti*, *G. mariei, Globotruncanella havanensis*, *G. petaloidea,*

Table 1- Percentage abundances (%) of planktonic foraminifera are represented against sample position of the Karainler stratigraphic section in the Maastrichtian.

Maastrichtian																		Stage
P.palpebra						*R.fructicosa*		*A.mayaroensis*						*P.hariaensis*				*Planktonic Foraminifera Zones*
K31	K33	K34	K35	K36	K38	K40	K41	K42	K43	K44	K45	K46	K47	K48	K49	K50		SAMPLES
0	0	0	0	0	0	0	0	0.1	0	0.1	0.1	0.2	0.1	0	0	0		*Abathomphalus mayaroensis*
0	0.4	0.3	0.3	0.1	3.5	0.1	0.3	1.1	0	0.2	0.3	0.2	0.2	0.2	0.1	0		*Contusotruncana contusa*
17	5.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		*Contusotruncana fornicata*
0.6	0	0.1	0	0	0	0	0	0.1	0	0.1	0.1	0.1	0.1	0	0	0		*Contusotruncana patelliformis*
2.1	0.9	0.1	0	0.4	0	0.1	0.2	0.4	0.5	0.5	0.2	0.2	0.1	0.1	0.1	0.1		*Contusotruncana plicata*
0	0	0.6	0	0.7	5.6	0.1	0.6	0.6	0	0.1	0.5	0.3	0.2	0.3	0.1	0.1		*Contusotruncana plummerea*
0	0	0.2	0	0	1.4	0	0.3	0.2	0	0.3	0.3	0.2	0.2	0.1	0.1	0		*Contusotruncana walfischensis*
0.6	1.1	0.3	0	0.1	2.1	0.7	0.2	0.3	0	0.2	0.2	0.1	0.2	0.2	0.1	0.1		*Gansserina gansseri*
2.5	0.7	0	0	2.1	0	0	5	0.9	1.1	1.1	3.5	1.1	1.5	0	0	0		*Globigerinelloides ultramicrus*
3.2	1.4	0.5	0.3	0.1	9.2	0.5	0	0.3	0.1	0.3	0.1	0.1	0.1	0.2	0.1	0.1		*Globotruncana aegyptiaca*
13	8.8	1.5	1.4	1.2	7	0.4	1.7	1.5	1.2	0	1.3	1.2	1.5	0.8	0.6	0.5		*Globotruncana arca*
0	0	0	0.1	0	0	0	0	0.1	0.1	0	0	0.1	0	0	0	0		*Globotruncana bulloides*
0	0	0.1	0.3	0.2	1.4	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1		*Globotruncana falsostuarti*
0	0.4	0	0	0.1	0	0.5	0.2	0.3	0	0.5	0.1	0.1	0	0	0	0		*Globotruncana insignis*
16	3.5	1.2	2.5	3.6	0	0	0	0	0	0	0	0	0	0	0	0		*Globotruncana linneiana*
2.5	1.6	0	0.3	0.3	3.5	0.3	0	0	0	0	0	0.4	0.3	0.5	0.2	0.2		*Globotruncana mariei*
0	5.3	0.5	8	17	0	2.9	3.1	2.2	2.7	4.9	1.9	2.2	0.2	0.1	0.2	0.1		*Globotruncanella havanensis*
4.8	2.7	1.2	1.5	1.7	0	0	0	0	0	0	0	0.1	0.1	0	0	0		*Globotruncanella minuta*
3	1.6	1.5	2.3	19	0	3.8	12	13	14	11	11	10	9	16	17	16		*Globotruncanella petaloidea*
0	0	0	0	0	0	0.1	0.8	0	0	0.6	0.1	0.1	0.1	0.6	0.3	0.5		*Globotruncanita falsocalcarata*
0.4	0	0.1	0	0.1	0	0.2	0.6	0.4	0.3	0.2	0.4	0.6	1.2	0.1	0.1	0.1		*Globotruncanita stuarti*
1.3	0.5	0.4	1.1	0.2	0	1.1	0.8	0.8	0.5	0.4	0.8	0.4	0	0.1	0.2	0.1		*Globotruncanita stuartiformis*
4.7	2.1	14	10	16	4.2	6.1	6.7	6.7	7.3	6.5	6	4.5	9.4	13	13	16		*Heterohelix globulosa*
0.6	0.2	0.1	0	0.3	0	2.3	1.1	0.9	0	1.6	1	1.5	2.5	3.4	3.9	2.7		*Planoglobulina acervulinoides*
0.2	0	0.1	0	0	0	0.5	0.9	0.5	0.6	0.9	0.7	0.5	0.2	1.3	0.8	1.3		*Planoglobulina multicamerata*
4.6	4	13.5	10	3.5	4.3	12	16.6	16	18	17.2	17.6	19	19	7	5	4		*Pseudoguembelina costulata.*
0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.5	2,2	8		*Pseudoguembelina hariaensis*
3	1.8	1.5	2	2.5	2	8	5.4	10	11	9.8	6.4	8	3	7.5	5.3	4		*Pseudoguembelina palpebra*
1.3	1.8	4	2.6	1.2	2.8	3.8	6.9	6	9.4	4.8	6.7	8	3.5	1.8	1	2.1		*Pseudutextularia elegans*
0	0	0	0	0	0	0.3	12	14	8	11	14	16	12	8.3	11	10		*Racemiguembelina fructicosa*
5.5	2.1	16	14	3.9	0	29	9.7	14	13	12	13	14	16	11	8.9	9.6		*Ruguglobigerina hexacamerata*
0.6	0	6.9	7.5	5.1	0	3.4	4.2	4.3	4.8	5.5	2.1	2.8	5.1	5.3	5.6	5.5		*Ruguglobigerina macrocephala*
9.7	8.8	20	17	9	18	23	9	5.1	6.7	8.2	7.9	6.4	13	16	22	19		*Ruguglobigerina rugosa*
1.9	45	15	19	12	35	0.6	0.8	0.9	1.2	1.6	1.3	1	1.5	2	0.4	1.6		*Rugoglobigerina rotundata*

Globotruncanita falsocalcarata, G. stuarti, G. stuartiformis, *Heterohelix globulosa, Planoglobulina acervulinoides, P. multicamerata*, *Pseudoguembelina palpebra, P. costulata*, *P. palpebra, Pseudotextularia elegans*, *Racemiguembelina fructicosa, Rugoglobigerina hexacamerata, R. macrocephala, R. rugosa*, *R. rotundata*.

This zone has been identified in the Akveren Formation in samples K48–K50 of the Karainler section (Table 1, Figure 3), as well as in sample KD1 from the lowermost levels of the Karadur section (Table 2, Figure 5).

Plummerita hantkeninoides Zone is absent from all the Bartın sites which evolved within the last 300 k.y. of the Maastrichtian (Abramovich and Keller, 2002). The markers species of this zone is apparently preferred to live in eutrophic shelfal to upper-slope continental margin environments (e.g., Abramovich et al. 1998; Abramovich and Keller, 2002; MacLeod et al., 2007) and has not been reported from open-ocean pelagic carbonate sediments (Huber et al., 2008).

The Cretaceous-Paleogene transition is within the Akveren Formation. Any lithological changes were not seen in this region. Consequently, this boundary was estimated with changes of planktonic foraminifera species of this area.

K/Pg boundary are defined planktonic foraminiferal zone *Guembelitria cretacea* (P0) followed by the *Parvularugoglobigerina eugubina* Zone (Pla) (Smit, 1982). Abramovich et al. (2010) studied the distribution of the *Guembelitria* genera in detail in the uppermost Maastrichtian. They mentioned that whereas *Guembelitria* genera bloomed in the uppermost surface water primarily above shelf and slope environments, it appears to have failed to reach the open ocean.

5.2.2 Paleocene Planktonic Foraminifera Zones

Parvularugoglobigerina eugubina Taxon-range Zone (Pα): Biostratigraphic interval characterized by the total range of the nominate taxon *Parvularugoglobigerina eugubina*.

Author: Luterbacher and Premoli Silva, 1964.

Age: 64.97–64.8 Ma; Danian (early Paleocene).

The most characteristic assemblage recorded in this zone includes *Eoglobigerina eobulloides*, *Globoconusa conusa* and *Parvularugoglobigerina eugubina*.

This zone has been identified in sample KD2 of the Karadur section of the Akveren Formation (Table 2, Figure 5).

Parasubbotina pseudobulloides Partial-range Subzone (P1a) and *Subbotina triloculinoides* Lowest Occurrence Subzone (P1b) were not determined in this study area (Table 2, Figure 5).

Glomobanomalina compressa/*Praemurica uncinata* Lowest Occurrence Subzone (P1c): Biostratigraphic interval between the FO of *Glomobanomalina compressa* and/or *Praemurica inconstans* and the FO of *Praemurica uncinata*.

Author: Berggren and Miller, 1988.

Age: 62.87–61.37 Ma; early Paleocene (mid-late Danian).

The characteristic assemblage recorded in this zone includes *Globoconusa conusa, Parasubbotina pseudobulloides*, *Eoglobigerina eobulloides*, *Subbotina triloculinoides, Praemurica inconstans, Morozovella trinidadensis* and *Glomobanomalina compressa*.

This zone has been identified in sample KD3-KD11 of the Karadur section (Table 2, Figure 5).

Praemurica uncinata Lowest Occurrence Zone (P2): Biostratigraphic interval between the FO of *Praemurica uncinata* and the FO of *Morozovella angulata*.

Author: Berggren and Miller, 1988.

Age: 61.37–61.0 Ma; late early Paleocene (late Danian).

Associated species of the nominate taxon are *Globoconusa conusa, Parasubbotina pseudobulloides*, *Subbotina triloculinoides, Praemurica inconstans, Morozovella trinidadensis, Glomobanomalina compressa* and *Praemurica uncinata*.

This zone has been identified in sample KD12-

Table 2- Percentage abundances (%) of planktonic foraminifera are represented against sample position of the Karadur stratigraphic section from Maastrichtian to Selandian.

Stage	Maastr.	Danian											Selandian				
Planktonic Foraminifera Zones	*P.hariaensis*	*P.eugubina*	*G.compressa*								*P.uncinata*		*M.angulata*				
Samples	KD1	KD2	KD3	KD4	KD5	KD6	KD8	KD9	KD10	KD11	KD12	KD13	KD14	KD15	KD17	KD19	KD20
Abathomphalus mayaroensis	0.5	K/Pg sınırı															
Contusotruncana contusa	2.1																
Contusotruncana plummerea	0.6																
Contusotruncana walfischensis	0.3																
Gansserina gansseri	0.5																
Globigerinelloides ultramicrus	2.2																
Globotruncana aegyptiaca	0.7																
Globotruncana arca	1.3																
Globotruncana falsostuarti	0.6																
Globotruncanella havanensis	0.3																
Globotruncanella petaloidea	4.2																
Globotruncanita stuarti	0.2																
Globotruncanita stuartiformis	0.7																
Heterohelix globulosa	4.5																
Planoglobulina acervulinoides	3.2																
Pseudoguembelina costulata.	1.0																
Pseudoguembelina hariaensis	3.4																
Pseudoguembelina palpebra	1.1																
Racemiguembelina fructicosa	47																
Ruguglobigerina hexacamerata	2.6																
Ruguglobigerina macrocephala	4.2																
Ruguglobigerina rugosa	4.7																
Parvularugoglobigerina eugubina		50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eoglobigerina eobulloides		36	25	0	0	3.4	24	0	0	0	0	0	0	0	0	0	0
Globoconusa conusa		14	4.2	2.4	4.1	7.2	0	0	7.2	3	3.7	2.3	5.6	0	0	0	0
Parasubbotina pseudobulloides		0	10	14	38	43	19	18	21	27	12	11	7.5	20	0	0	0
Subbotina triloculinoides		0	52	43	35	37	48	71	34	55	79	61	75	61	34	53	57
Glomobanomalina compressa		0	4.2	4.2	3.8	4.3	4.8	2.9	6	3.2	1.9	4.5	2.5	9	14	9.5	0
Praemucira inconstans		0	4.2	2.8	3.5	4.9	4.8	8.8	7.7	1.2	1.5	14	4.3	4.9	21	4.8	0
Morozovella trinidadensis		0	0	0	0	0	0	0	8.9	3.2	1.1	3.4	1.2	0	0	0	0
Praemurica uncinata		0	0	0	0	0	0	0	0	0	0.7	3.4	2.5	3.7	14	0	0
Morozovella angulata		0	0	0	0	0	0	0	0	0	0	0	1.9	2	6.9	14	4.1
Morozovella conicotruncana		0	0	0	0	0	0	0	0	0	0	0	0	0	10	11	29
Igorina pusilla		0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2
Morozovella velascoensis		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.1
Acarinina primitiva		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0.8
Planorotalites chapmani		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	2.3

KD13 of the Karadur section (Table 2, Figure 5) of the Akveren Formation.

Morozovella angulata Lowest Occurrence Zone (P3): Biostratigraphic interval between the FO of *Morozovella angulata* and the FO of *Globanomalina pseudomenardii*.

Author: Berggren and Miller, 1988.

Age: 61.0–59.4 Ma; early late Paleocene (Selandian).

Associated species of the nominate taxon in the studied section are *Globoconusa conusa, Parasubbotina pseudobulloides*, *Subbotina triloculinoides, Praemurica inconstans, Morozovella trinidadensis, M. angulata, M. conicotruncana, M. velascoensis, Glomobanomalina compressa, Praemurica uncinata, Acarinina primitiva, Igorina pusilla* and *Planorotalites chapmani*.

This zone has been identified samples KD14–KD20 of the Akveren Formation (Table 2, Figure 5).

5.3. Planktonic Foraminifera Assemblages

5.3.1. Composition of the Planktonic Foraminifera Assemblages in the Maastrichtian

The Maastrichtian is represented by small-sized biserial and low trochospiral spired planktonic foraminifera in the study area. The most dominant species in the Maastrichtian is small-sized *Rugoglobigerina* (*Rugoglobigerina rugosa, R. hexacamerata, R. macrocephala*) with low trochospiral shell. Within the foraminifera assemblages, *Rugoglobigerina* spp. is the most dominant species with 10-55% enrichment (Table 1, Figure 6). *Rugoglobigerina rotundata* with higher trochospiral shell is the only dominant species in the lower Maastrichtian with abundance of 45% in sample K33 and 35% in sample K38. Although it has abundance between 2% and 45% in the lower Maastrichtian, the species is rare in the upper Maastrichtian (0.4-2%). *Pseudoguembelina* spp. is the second most dominant species (6-27%) (Table 1, Figure 6).

The third dominant species is *Heterohelix globulosa* with abundance of 2-16%. The other small-sized and low trochospiral shell species *Globotruncanella petaloidea* is another dominant species (2-17%). *Pseudotextularia elegans* is observed as a less common species (1-7%). In the upper Maastrichtian, *Racemiguembelina fructicosa* is the second common species (8-14%) together with *Rugoglobigerina* spp, with the exception of sample K40 (Table 1, Figure 6).

5.3.2. Composition of the Planktonic Foraminifera Assemblages in the Paleocene

Planktonic foraminifera species appearing just after the K/Pg boundary are small sized with globular chambers. The first Danian genera are *Parvularugoglobigerina eugubina*, *Eoglobigerina eobulloides* and *Subbotina triloculinoides*. In the lower Danian, *Globoconusa conusa*, *Parasubbotina pseudobulloides*, *Glomobanomalina compressa* and *Praemurica inconstans* are also observed together with *P. eugubina*, *E. eobulloides* and *S. triloculinoides* (Table 2, Figure 7).

Beginning from upper Danian, *Morozovella* spp. species appear (Table 2, Figure 7). The life time of *P. eugubina* and *E. eobulloides*, which are the initial species appearing in the Danian, is short. They are observed only in a few samples (Figure 7). The most dominant species of the Danian is *S. triloculinoides*

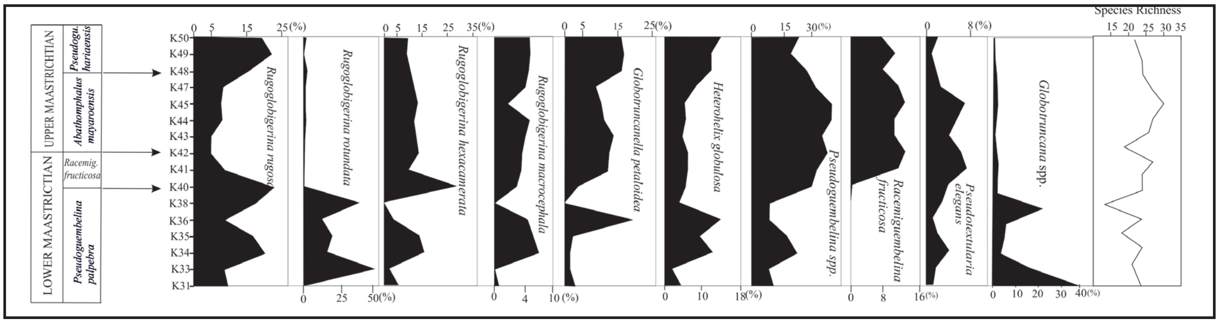

Figure 6- Species richness, percentage distributions of selected planktonic foraminifera of the Karainler stratigraphic section in the Maastrichtian.

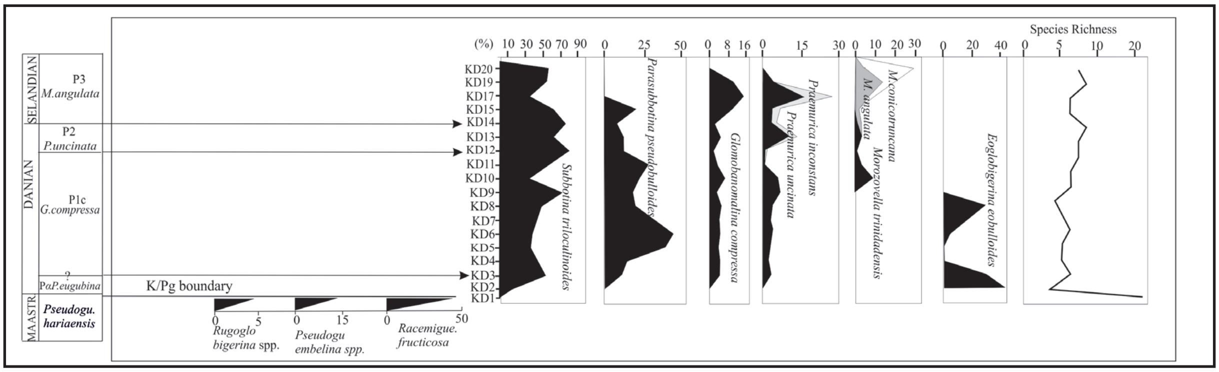

Figure 7- Species richness, percentage distributions of selected planktonic foraminifera of the Karadur stratigraphic section from Maastrichtian to Selandian.

with 14-79% abundance. *P. pseudobulloides* is the other dominant species with 8-43% abundance (Table 2, Figure 7).

Less dominant species are *G. compressa* (2-14%), *P. inconstans* (3-21%), *G. conusa* (2-7%), *Morozovella trinidadensis* (1-9%), *Praemurica uncinata* (1-14%), *Morozovella angulata* (2-7%) and *Morozovella conicotruncana* (10-15%). In the Selandian, *S. triloculinoides* (53-57%) and *Morozovella* species are dominant (Table 2, Figure 7).

5.4. The Paleoecology of Planktonic Foraminifera in the Maastrichtian

Planktonic foraminifera are defined as sensitive recorders of the upper part of the water column, reflecting changes in primary productivity, sea surface water temperature and the degree of water column stratification (Leckie, 1987; Schiebel and Hemleben, 2000). In the Bartın area, abundance of *Globotruncana* spp. (*Globotruncana arca*, *G. linneiana*, *G. aegyptiaca*, *G. mariei*, *G. bulloides*, *G. falsostuarti*, *G. ventricosa* and *G. insignis*) is rare and shows a decrease in the Maastrichtian (Table 1, Figure 6). Abramovich and Keller (2003) indicated that the abundance of globotruncanids decreased under biotic stress in the Maastrichtian. In this study area, decrease in the abundance of globotruncanids may reflect the changes in environmental conditions.

In the lower Maastrichtian, the abundance of *Rugoglobigerina* taxa increased when abundances of globotruncanids decreased. Genus *Rugoglobigerina* are widely observed from lower Maastrichtian to upper Maastrichtian (Table 1, Figure 6). This genus was proposed to live in tropical-mid latitudes and warm climates in previous studies and the abundance of *Rugoglobigerinids* arrive at maximum levels in climatic warming periods (Malmgren, 1991; Nederbragt, 1991, 1998; Li and Keller, 1998*a*). Abramovich and Keller (2003) stated that decreases in the relative abundance of tropical-subtropical *Pseudoguembelina costulata*, *Rugoglobigerina rugosa* and several keeled globotruncanids (including *Contusotruncana* species) coincide with the warm event and their decline suggests unfavorable environmental conditions.

Pseudoguembelina and *Heterohelix globulosa* are dominant in the upper Maastrichtian fauna in the study area (Table 1, figure 6). Abramovich et al. (2003) and Keller (2004) suggest that the domination of small biserial ecological species and low trochospiral species (*Rugoglobigerina*, *H. globulosa*, *Pseudoguembelina*, *Pseudotextularia*) and also the low diversity of the species indicates the presence of highly stressed environmental conditions.

Heterohelix globulosa is evaluated as tolerant of the changes in salinity, temperature, oxygen and the amount of nutrition (Keller, 2004). *Heterohelix globulosa* continued to live without being affected by changes in environmental conditions. Ashckenazi-Polivoda et al. (2011) stated that Heterohelicids display high abundance in a variety of marine environments, indicate unsuitable environmental conditions and an ability to adjust to a wide range of water column conditions. In this study, increasing abundance of *Heterohelix globulosa* and *Pseudoguembelina* spp. shows that they are resistant and tolerant of the changes in environmental conditions such as nutrition and temperature, exhibiting compatibility with global climate changes before the K/Pg boundary.

Racemiguembelina, which is common in the upper Maastrichtian assemblages, were defined as photosymbiotic (Houston and Huber, 1998; D'Hondt and Zachos, 1998; Houston et al., 1999). *Racemiguembelina* is defined as an oligotrophic genus in the open ocean (Abramovich et al., 2010). In the uppermost Maastrichtian, high abundance of *Racemiguembelina fructicosa*, *Heterohelix globulosa* and *Rugoglobigerina* spp. can be interpreted as the presence of oligotrophic and warmer environmental conditions in this study (Table 1-2, Figure 6-7).

Kaya-Özer (2014) investigated nanofossil assemblages, carbon and oxygen stable isotope data in this stratigraphic section and suggested that environmental conditions changed from eutrophic to oligotrophic during the Maastrichtian. Diversification of planktonic foraminifera species indicate the same environmental conditions in this study.

In the upper Maastrichtian in the Bartın area, the increasing abundance of *Globotruncanella petaloidea* is coherent with increasing abundance of the species which are tolerant of changes in nutrition and temperature (Table 1, Figure 6). It is possible that these species are able to live in similar environments.

5.5. The Paleoecology of Planktonic Foraminifera in the Paleocene

Small, unornamental and primitive Paleogene species began to be seen just above K/Pg boundary in this study area. *Parasubbotina pseudobulloides* and *Subbotina triloculinoides* are the dominant species in the Danian (Table 2, Figure 7). In the upper Danian, together with these species, the abundance of *Praemurica* species also increased. However, in the Selandian, *Morozovella* species start to dominate (Table 2, Figure 7).

Quillevere and Norris (2003) suggested that different depth habitats played an important role in the diversification of planktonic foraminifera, related to the initiation of photosymbiosis as a trophic strategy. Subbotinids lived within or below the thermocline whereas morozovellids and igorinids dwelled in the surface mixed-layer (Shackleton et al., 1985; Pearson et al., 1993; D´Hondt et al., 1994; Van Eijden, 1995; Lu et al., 1998; Quillevere and Norris, 2003).

Subbotina and *Parasubbotina* preferred cold water, asymbiotic living and mesotrophic environmental conditions (Boersma and Premoli-Silva, 1991; Pearson et al., 1993; Norris, 1996; Berggren and Norris, 1997; Guasti et al., 2005). Also, *Parasubbotina* and *Subbotina* taxa shared a similar trophic strategy and living position within the thermocline (Guasti et al., 2005). Guasti et al. (2005) stated that increased productivity through enhanced input of nutrients from land may favor the thermocline dweller *Parasubbotina*. In the study area, during the Danian, high abundance of *Parasubbotina and Subbotina* can be considered as indicating mesotrophic and cooler environmental conditions.

Stable isotope values indicate that subbotinids lived in cooler, deeper waters than morozovellids (Boersma and Premoli Silva, 1991; Norris, 1996). Positive $\delta^{18}O$ values show *Morozovella* and later *Acarinina* species have a deeper habitat (Berggren and Norris, 1997; Quillevere et al., 2000; Quillevere and Norris, 2003). Most morozovellids, acarininids and igorinids were accepted as photosymbiotic species (D'Hondt et al., 1994; Norris, 1996; Berggren and Norris, 1997; Quillevere and Norris, 2003). Acarininids and morozovellids thrive in low-nutrient water masses in the global ocean during the late Paleocene (Norris, 1996; Quillevere and Norris, 2003). *Praemurica inconstans* was accepted as a photosymbiotic species (Kelly et al., 1996).

Morozovella adapted to warm water and oligotrophic environmental conditions (Pearson et al., 1993; Norris, 1996; Berggren and Norris, 1997; Quillevere and Norris, 2003). In this study, in the Selandian, *Morozovella* started with common taxa with *Subbotina* and *Parasubbotina* (Table 2, Figure 7). Increasing abundance of *Morozovella* taxa which lived in low nutrition waters, indicates mesotrophic-oligotrophic and warmer environmental conditions in the Selandian. Kaya-Özer (2014) suggested similar environmental conditions in the Paleocene based on $\delta^{13}C$ values.

6. Conclusion

The Akveren Formation represents open sea characteristics in the Maastrichtian-Selandian period based on planktonic foraminifera species. In the Maastrichtian, planktonic foraminifera assemblages in the study area are dominated by small, simple morphotypes, opportunists, generalists and high-stress specialist morphologies. Increased abundance of small-sized, biserial and low trochospiral planktonic foraminifera species (*Rugoglobigerina* spp., *Heterohelix globulosa*, *Pseudoguembelina* spp., *Pseudotextularia elegans*) show variable and unstable environmental conditions in the Western Black Sea basin during the Maastrichtian. In the uppermost Maastrichtian, high abundance of *Racemiguembelina fructicosa*, *Heterohelix globulosa* and *Rugoglobigerina* spp. indicates oligotrophic and warmer environmental conditions.

In the lower Paleocene, high abundance of *Parasubbotina* and *Subbotina* shows mesotrophic and cooler environmental conditions. In the Selandian, increasing abundance of *Morozovella* taxa indicates mesotrophic- oligotrophic and warmer environmental conditions.

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PLATES

PLATE I

Figure 1- *Abathomphalus mayaroensis* (Bolli), Spiral view, Sample K41.

Figure 2- *Abathomphalus mayaroensis* (Bolli), Umbilical view, Sample K41.

Figure 3- *Contusotruncana contusa* (Cushman), Spiral view, Sample K41.

Figure 4- *Gansserina gansseri* (Bolli), Side view, Sample K39.

Figure 5- *Rugoglobigerina rugosa* (Plummer), Spiral view, Sample K48.

Figure 6- *Heterohelix globulosa* (Ehrenberg), Side view, Sample K32.

Figure 7- *Planoglobulina multicamerata* (De Klasz), Side view, Sample K48.

Figure 8- *Pseudoguembelina hariaensis* Nederbragt, Side view, Sample K48.

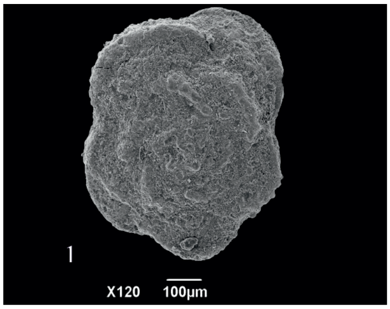
Figure 9- *Pseudoguembelina hariaensis* Nederbragt, Side view, Sample K48.

Figure 10- *Pseudoguembelina palpebra* Bronnimann and Brown, Sample K36.

Figure 11- *Racemiguembelina fructicosa* (Egger), Side view, Sample K42.

Figure 12- *Pseudotextularia elegans* (Rzehak), Side view, Sample K48.

PLATE I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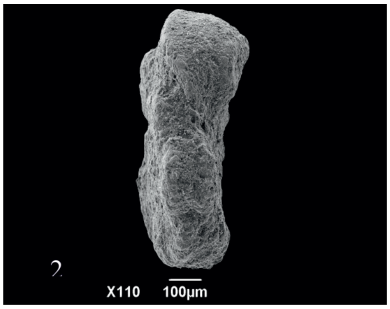
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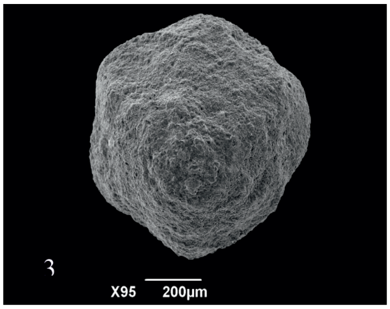
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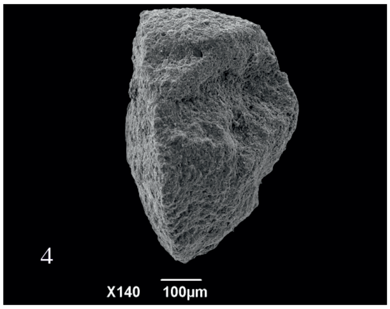
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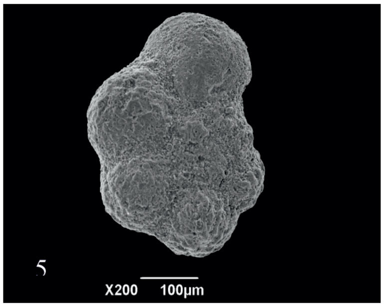
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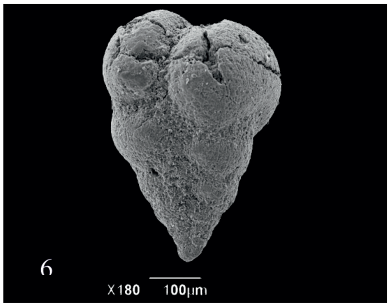
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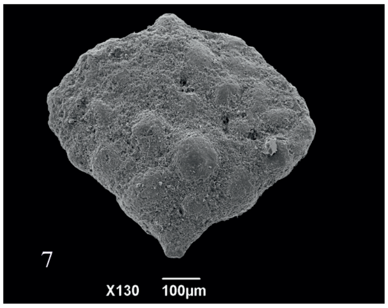
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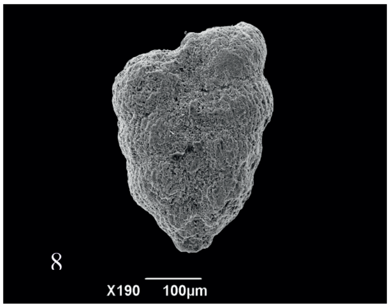
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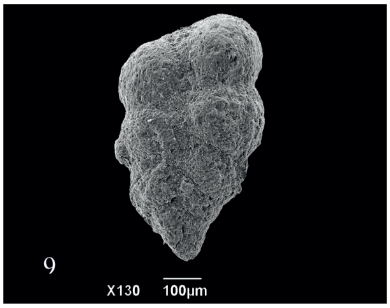
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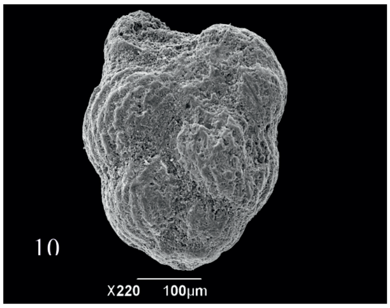
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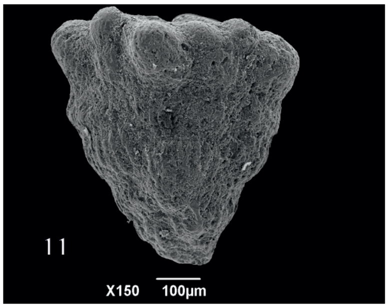
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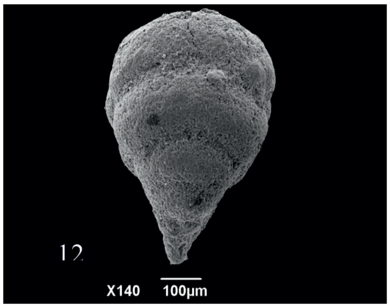
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PLATE II

Figure 13- *Parvularugoglobigerina eugubina* (Luterbacher and Premoli Silva), Umbilical view, Sample KD3.

Figure 14- *Parasubbotina pseudobulloides* (Plummer), Spiral view, Sample KD6.

Figure 15- *Parasubbotina pseudobulloides* (Plummer), Side view, Sample KD15.

Figure 16- *Igorina pusilla* (Bolli), Spiral view, Sample KD20.

Figure 17- *Subbotina triloculinoides* (Plummer), Spiral view, Sample KD16.

Figure 18- *Subbotina triloculinoides* (Plummer), Umbilical view, Sample KD20.

Figure 19- *Praemurica uncinata* (Bolli), Spiral view, Sample KD13.

Figure 20- *Morozovella angulata* (White), Side view, Sample KD19.

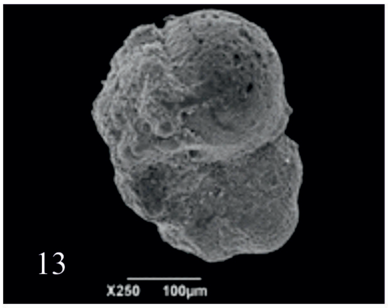
Figure 21- *Globanomalina compressa* (Plummer), Side view, Sample KD12.

Figure 22- *Globoconusa conusa* Khalilov, Spiral view, Sample KD6.

Figure 23- *Morozovella velascoensis* (Cushman), Umbilical view, Sample KD19.

Figure 24- *Morozovella conicotruncana* (Subbotina), Spiral view, Sample KD19.

PLATE II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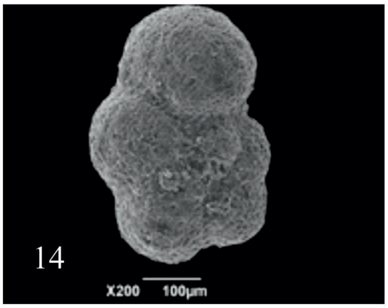
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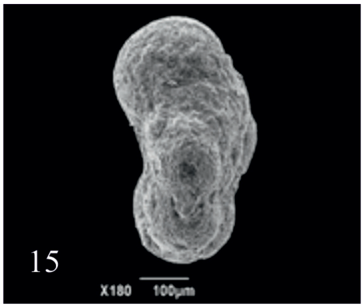
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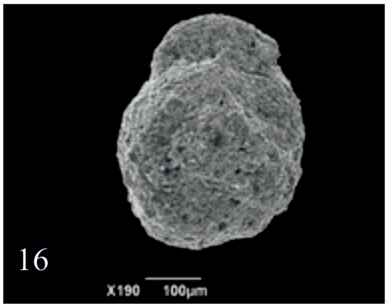
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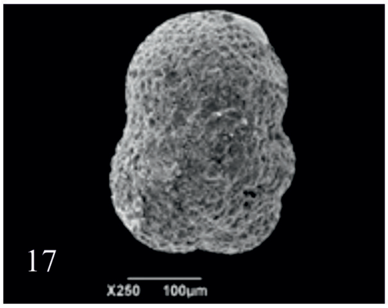
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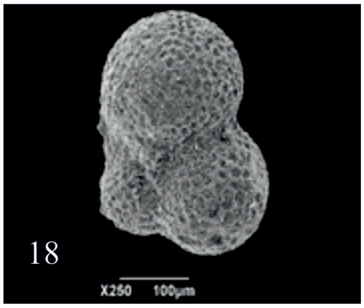
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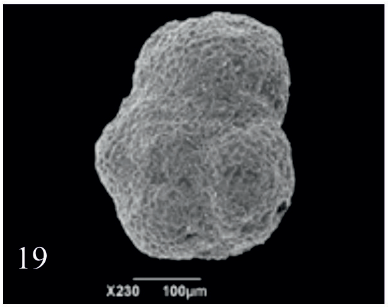
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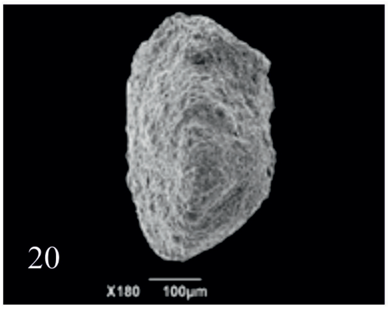
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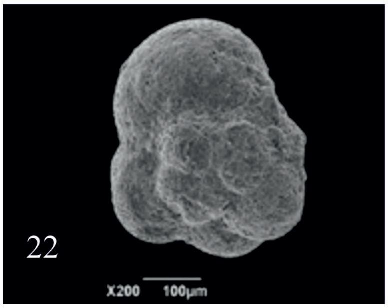
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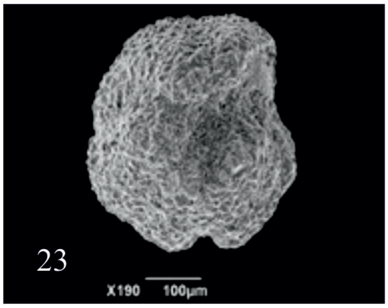
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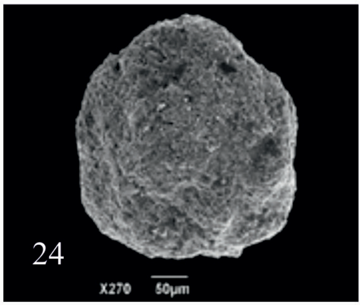
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