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TECTONOSTRATIGRAPHIC EVOLUTION OF THE CRETACEOUS DYNAMIC BASINS ON ACCRETIONARY OPHIOLITIC MELANGE PRISM, SW OF ANKARA REGION

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ABSTRACT

The collision tectonics in the Ankara region is marked by the İzmir-Ankara-Erzincan suture belt. Most of the ophiolites and Jurassic-Cretaceous units of the ophiolitic melanges and the remnant sequences of associated Cretaceous arc-trench basins display strong similarities along this belt. To the SW of Ankara region, the Cretaceous ophiolitic melange (North Anatolian Ophiolitic Melange) is characterized by ophiolitic and Jurassic-Cretaceous limestone blocks embedded in a brecciated and sheared ophiolitic matrix with pelagic sequences. The Cenomanian-Turonian sequences that were accumulated on an accretionary ophiolitic melange prism consist of alternating pelagic, argillaceous carbonates and clastics with Malm-Lower Cretaceous limestone olistoliths. These are all unconformably overlain by Maastrichtian continental red clastics.

The Cenomanian-Turonian sequences are developed on top of a dynamic accretionary melange prism along active subduction zone in northern branch of Neotethys. The Cretaceous ophiolitic melange emerged with various contemporaneous dynamic arc-trench basins and progressively comixed since Cenomanian.

Key words: Cenomanian-Turonian, Cretaceous ophiolitic melange, İzmir-Ankara-Erzincan suture, Central Anatolia.

ÖZ

Ankara bölgesinde çarpışma tektoniği İzmir-Ankara-Erzincan kenet kuşağı ile tanımlanır. Bu kuşak boyunca, ofiyolitik melanj içinde yeralan ofiyolitler, Jura-Kretase yaşlı birimler ve bu melanja ait birimler ile gelişmiş yakın ilişkili Kretase yay-hendek havzalarının kalıntı istifleri büyük benzerlikler sunarlar. GB Ankara bölgesinde, Kretase yaşlı ofiyolitik melanj (Kuzey Anadolu Ofiyolitik Melanjı), breşleşmiş ve makaslanmış ofiyolitli hamur içinde yeralan ofiyolitik ve Jura-Kretase yaşlı kireçtaşı bloklarından oluşur. Eklenir ofiyolitli melanj kaması üzerinde gelişen Senomaniyen-Turoniyen istifi, Malm-Kretase yaşlı kireçtaşı olistolitleri içeren pelajik killi karbonat ve klastik ardalanmasından oluşur. Bu kaya topluluklarının tümü ise Mastriştiyen yaşlı karasal kırmızı klastikler tarafından uyumsuz bir dokanak ile üzerlenir.

Senomaniyen-Turoniyen istifleri Neotetis'in kuzey kolundaki aktif dalma-batma zonu boyunca sürekli devinim geçirmekte olan eklenir melanj kaması üzerinde gelişmiştir. Kretase ofiyolitik melanjı yaşıt aktif yay-hendek havzaları ile birlikte yükselmiş ve Senomaniyen'den itibaren sürekli olarak birlikte karışmışlardır.

Anahtar Kelimeler: Senomaniyen-Turoniyen, Kretase ofiyolitli melanjı, İzmir-Ankara-Erzincan kenedi, Orta Anadolu.

INTRODUCTION

Ankara region (Central Anatolia) is one of the key region in Turkey where all of the evolutionary events of the Tethys are documented as imbricated piles (Fig.1). One of the tectonic slice of this imbricated tectonic belt is the slightly metamorphosed Triassic Karakaya Complex (Fig. 2). This Complex is characterized by blocks of intensely deformed, dismembered pre-Mesozoic low-grade metamorphics, Carboniferous to Permian carbonates and Triassic sequences that are all partially set in a matrix of graywackes (Akyürek et al., 1984; Koçyiğit, 1987; Yılmazer, 1994).

The Jurassic-Cretaceous sequences, that are unconformably overlying the Triassic Complex, are characterized by typical Atlantic type continental margin clastics and carbonates of Liassic-Aptian age (Fig. 2) (Akyürek et al., 1984; Koçyiğit, 1987). However, most of the Jurassic-Cretaceous sequences cropped out as blocks in Cretaceous ophiolitic melanges and as olistoliths in Cretaceous basins.

The well-known, so-called "Ankara melange" Belt, which was erroneously interpreted as a frag-

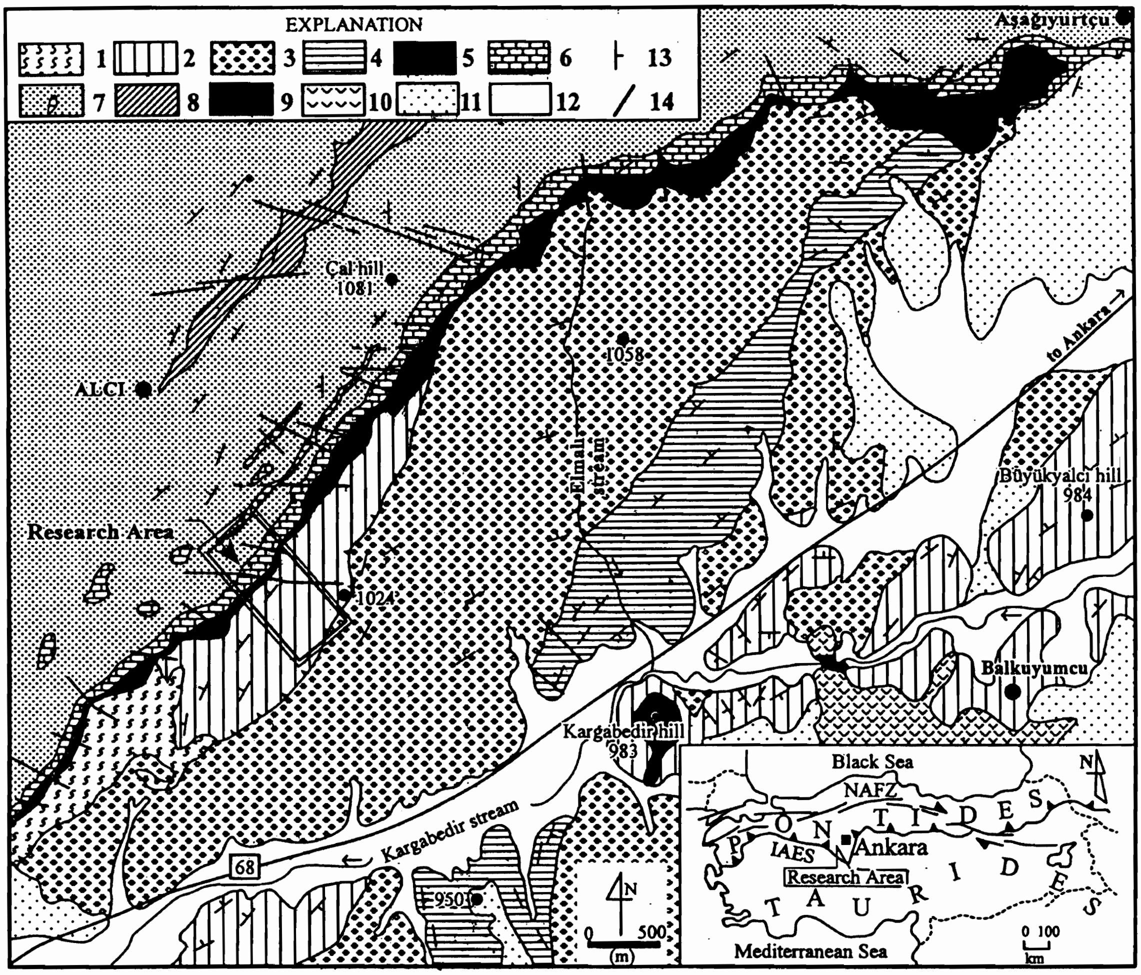

Figure 1. Simplified geologic map of the SW Ankara region. 1. Cretaceous ophiolitic melange, 2. Jurassic-Cretaceous units, 3. Sheared, Cretaceous pelagic units with olistoliths and/or blocks, 4. Stratified, Cretaceous pelagic units without olistoliths and/or blocks, 5. Maastrichtian red clastics, 6. Maastrichtian reefal carbonates, 7. Paleocene volcaniclastics-clastics, 8. Paleocene clastics, 9. Neogene volcanic centers, 10. Neogene volcanics, 11. Neogene clastics, 12. Quaternary alluvium, 13. Attitude of bed, 14. Fault, NAFZ. North Anatolian Fault Zone, İAES. Southern limit of İzmir-Ankara-Erzincan suture belt.

Şekil 1. GB Ankara bölgesinin sadeleştirilmiş jeolojik haritası. 1. Kretase ofiyolitik melanjı, 2. Jurassik-Kretase yaşlı birimleri, 3. Olistolitler ve/veya bloklar içeren makaslanmış Kretase yaşlı pelajik birimler, 4. Olistolitler ve/veya bloklar içermeyen tabakalanmış Kretase yaşlı pelajik birimler, 5. Maastriştiyen yaşlı kırmızı klastikler, 6. Maastriştiyen yaşlı resifal karbonatlar, 7. Paleosen yaşlı volkaniklastikler-klastikler, 8. Paleosen yaşlı klastikler, 9. Neojen yaşlı volkanik çıkış merkezleri, 10. Neojen volkanikleri, 11. Neojen yaşlı klastikler, 12. Kuvaterner alüvyon, 13. Tabaka, 14. Fay, NAFZ. Kuzey Anadolu Fay Zonu, İAES. İzmir-Ankara-Erzincan Kenet Kuşağının güney sınırı.

ment of Taurides (Bailey and McCallien, 1950), is a chaotic, Cretaceous tectono-sedimentary mixture of various blocks of different age, origin and facies set in an intensely sheared, mylonitized and brecciated matrix (Koçyiğit and Lünel, 1987; Koçyiğit et al., 1988; Koçyiğit, 1991). Since Blumenthal's classical studies in northern Central Anatolia (Blumenthal, 1941a,b; 1948), ophiolitic complex and ophiolites are studied, named-renamed and interpreted by various researchers (Bailey and McCallien, 1950; 1953; Egeran and Lahn, 1951; Erol, 1961; Norman, 1972; 1984; Çapan and Buket, 1975; Ünalan et al., 1976; Batman,1978a; 1978b; 1981; Batman et al., 1978; Akyürek et al., 1984; Tekeli, 1981; Akyürek, 1981; Çapan, 1981; Erk, 1981; Ünalan, 1981; Çapan et al., 1983; Koçyiğit and Lünel, 1987; Koçyiğit et al., 1988; Koçyiğit, 1991). In addition, from geochemical studies on ophiolites and related volcanics different tectonic settings and ages are defined (Çapan and Floyd, 1985; Tankut, 1984; 1990; Tankut and Gorton, 1990; Floyd, 1993; Rojay et al., 1995).

The Upper Cretaceous-Paleogene sequences that are unconformably overlying Cretaceous ophiolitic melanges in Ankara region (Fig. 2), are interpreted as fore-arc units (i. e. the sequences in Haymana-Polatlı and Tuzgölü basins). These basins are interconnected to each other during certain periods of geologic times (Lokman and Lahn, 1946; Ünalan et al., 1976; Görür, 1981; Görür et al., 1984; Koçyiğit and Lünel, 1987; Koçyiğit et al., 1988; Gökten et al., 1988; Koçyiğit, 1991). In the Tuzgölü basin, a continuous Maastrichtian-Eocene sequence unconformably overlies the ophiolitic units (Arıkan, 1975; Turgut, 1978; Uygun, 1981; Görür, 1981; Görür et al., 1984; Göncüoğlu et al., 1992). The Haymana basin, that was lithostratigraphically different than Tuzgölü basin during Senonian, displayed close similarities with Tuzgölü basin during the Maastrichtian-Eocene period (Görür, 1981; Görür et al., 1984). Closure along a north dipping subduction resulted in the emplacement of above mentioned units in contemporaneously rifted basins, which all were closely associated with a collision related magmatism (Ach, 1982; Ach and Wilson, 1986; Tokay et al., 1988; Gökten et al., 1988; Tankut et al., 1990).

The recent researches concerning the stratigraphy, volcanism and the tectonics of the Alcı-Balkuyumcu-Alacaatlı area are few (Dağer et al., 1963; Batman et al., 1978; Lünel, 1987; Koçyiğit and Lünel, 1987; Kazancı and Gökten, 1988). The stratigraphy and tectonic setting of the region are discussed in relation to the northern Ankara (Orhaniye) and the southern Ankara (Haymana-Polatlı) regions where the basin is interpreted as a Late Maastrichtian-Paleocene fore-arc basin (Koçyiğit and Lünel, 1987; Koçyiğit et al., 1988; Gökten et al., 1988; Koçyiğit, 1991). The volcanism is interpreted as a collision related magmatism of a northward subducting slab during the Late Oligocene-Early Miocene with two subvolcanic intrusions and seven distinct flows in the region (Lünel, 1987). Rock units that are briefly mentioned above are unconformably overlain by the Neogene continental clastics-carbonates and associated volcanics (Erol, 1961; Akyürek et al., 1984; Lünel, 1987; Gökten et al., 1997).

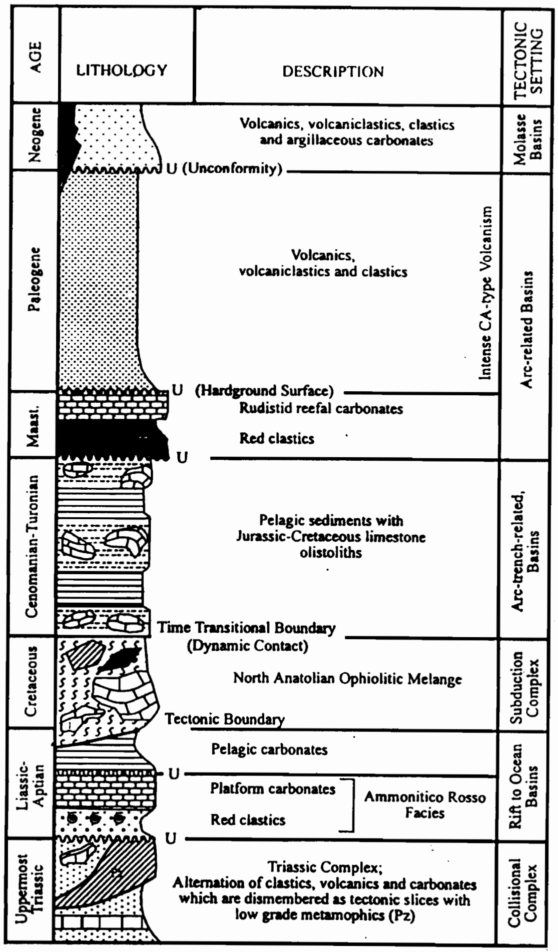

Figure 2. Generalized tectonostratigraphic section of SW Ankara (modified from Batman, et al., 1978; Akyürek et al., 1984; Koçyiğit, 1987; Koçyiğit and Lünel, 1987). Time transitional boundary = dynamic ophiolitic melange transgressively overlain by contemporaneous pelagic sediments.

Şekil 2. GB Ankara'nın genelleştirilmiş tektonostratigrafik kesiti (Batman et al., 1978; Akyürek et al., 1984; Koçyiğit, 1987; ve Koçyiğit and Lünel, 1987'lerden). Eş zamanlı ilişki = Hareketli ofiyolitli melanj, yaşıt pelajik tortullar tarafından aşmalı olarak-tan üzerlenir.

The aim of this paper is to document the Cretaceous tectonostratigraphy of the SW Ankara region using new stratigraphic findings and to shed some light onto the Cretaceous collisional history of the northern branch of Neotethys in Central Anatolia.

TECTONOSTRATIGRAPHY

The rock units exposed in the study area are catagorized as 'allochthonous' and 'para-autocthonous' units. The allochthonous units consist of

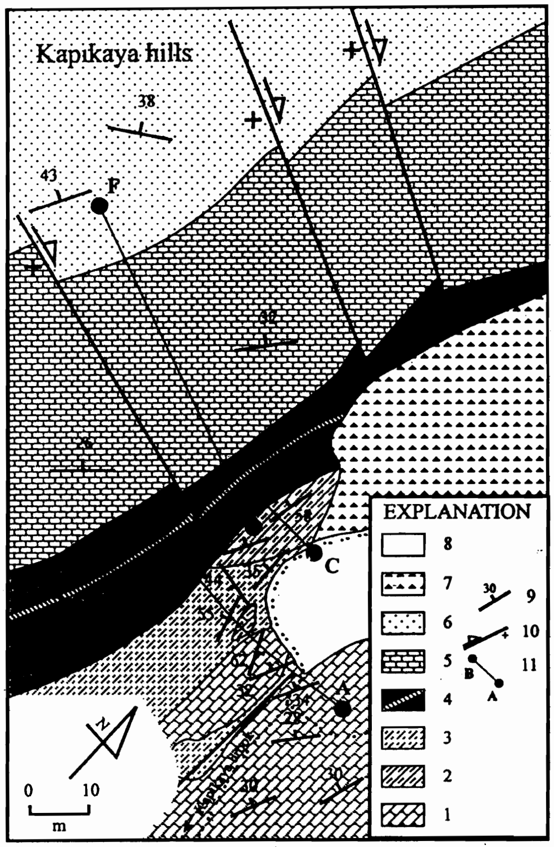

Figure 3. The geologic map showing the measured stratigraphic section lines. 1. Jurassic-Cretaceous carbonate block of NAOM, 2. Stratified, Cenomanian part of Elmalıdere member, 3. Sheared, Cenomanian-Turonian part of Elmalıdere member, 4. Maastrichtian red clastics with a lamellibranchiata-rich marker bed (İncirli Formation), 5. Maastrichtian reefal carbonates (Kapıkaya Limestone), 6. Paleocene volcaniclastics-clastics (Alcı Formation), 7. Quaternary talus, 8. Quaternary alluvium,. 9. Attitude of bed, 10. Oblique-slip fault, 11. Line of measured stratigraphic section.

Şekil 3. Ölçülü kesit hatlarını gösteren jeolojik harita. 1. NAOM'ının Jura-Kretase yaşlı bloku, 2. Elmalıdere Üyesinin Senomaniyen yaşlı tabakalı kısımı, 3. Elmalıdere Üyesinin Senomaniyen-Turoniyen yaşlı makaslanmış kısımı, 4. Lamellibranchiata'ca zengin anahtar düzey içeren Maastriştiyen yaşlı kırmızı klastikler (İncirli Formasyonu), 5. Maastriştiyen yaşlı resifal karbonatlar (Kapıkaya Kireçtaşı), 6. Paleosen yaşlı volkaniklastikler-klastikler (Alcı Formasyonu), 7. Kuvaterner talus, 8. Kuvaterner alüvyon, 9. Tabaka, 10. Verev bileşenli fay, 11. Ölçülü stratigrafik kesit hattı.

Malm-Cretaceous pelagic carbonates that are embedded in Cretaceous ophiolitic melange (North Anatolian Ophiolitic Melange) and Cenomanian-Turonian pelagic sequences (Elmalıdere member) that are developed on top of the Cretaceous ophiolitic melange (Fig. 3,4). Para-autocthonous units are, i) Maastrichtian red clastics (İncirli Formation); ii) Maastrichtian arenaceous carbonates (Kapıkaya Formation), and iii) Paleocene volcaniclastics-clastics (Alcı Formation) (Fig. 3,4) (Koçyiğit and Lünel, 1987; Kazancı and Gökten, 1988; Süzen, 1994).

North Anatolian Ophiolitic Melange (NAOM) :

In Mesozoic Tethys area, ophiolites and Jurassic-Lower Cretaceous pelagic units in the ophiolitic melanges crop out as a significant tectonic belt in Northern Anatolia (Gansser, 1974). The main tectonic front of the belt in which the foregoing units are observed, was named as İzmir-Ankara-Erzincan suture belt (İAES) (Fig.1) (Şengör and Yılmaz, 1981). The frontal edge of İAES is the southern limit of Pontides that developed between Rhodope-Pontide-Sakarya Continental Fragments and Tauride-Anatolide Platform during Cretaceous-Paleogene time (Şengör and Yılmaz, 1981; Sengör, 1984). The previously named "Anatolian Nappe" (Koçyiğit and Lünel, 1987) is renamed as "North Anatolian Ophiolitic Melange" (Rojay, 1995) that is more descriptive and genetic term to define this continuous and correlative tectonic belt in Northern Anatolia.

The NAOM is initially recognized and named as "Mésozoique a facies tectonique brouillé" (Blumenthal, 1941a,b; 1948) that is later named as "Ankara Melange" where the Triassic complex and Cretaceous ophiolitic melange were not differentiated and erroneously interpreted as a fragment of Taurides (Bailey and McCallien, 1950; 1953). Later, lithostratigraphic names are used to explain the sedimentary packages in ophiolitic melanges and collectively interpreted as resulting from sedimentary processes (Boccalletti et al., 1966; Norman, 1972; 1973; 1984; Gansser, 1974; Çapan and Buket, 1975; Batman, 1978a; 1981).

The ophiolitic melange is made up of detached blocks of red to green, intensely folded-fractured, thin bedded radiolarites; fractured peridotites-serpentinites; fractured radiolaria bearing pelagic limestones; folded and fractured Jurassic-Cretaceous carbonates; ordered Cenomanian-Turonian marl-argillaceous limestone sequences (Elmalıdere member) and rare fragments of low-grade metamorphic blocks in Alcı region. All of the units of ophiolitic melange were completely dismembered and mixed

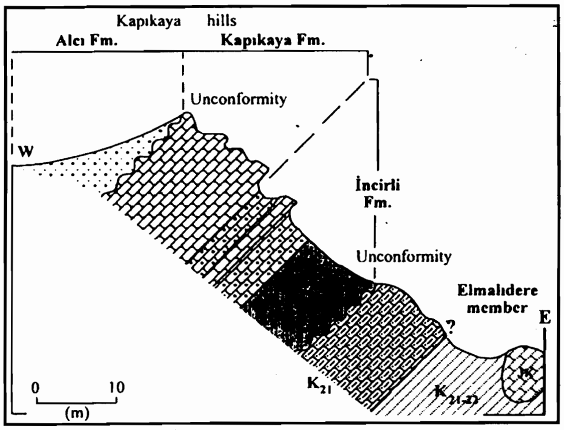

Figure 4. Stratigraphic cross-section of the research area. JK. Jurassic-Cretaceous, K_{21} : Cenomanian, K_{21-22} : Cenomanian-Turonian.

Şekil 4. Araştırma alanının stratigrafik kesiti. JK. Jurassik-Kretase, K_{21} : Senomaniyen, K_{21-22} : Senomaniyen-Turoniyen.

as a result of tectonic recycling in the accretionary prism. The blocks are set in an intensely tectonized, mylonitic-brecciated ophiolitic matrix that differs in different localities of Ankara region.

In the study area, the base of ophiolitic melange is always tectonic where the top is often marked by the transgression of sedimentary sequences of Cenomanian-Turonian or by unconformably overlying sedimentary sequences of Maastrichtian (Fig. 2). The ophiolitic melange is always extremely complex due to the progressive Cretaceous-Paleogene tectonic recycling, imbrication, lateral shifting (strike-slip deformation) and/or rotation of blocks.

Blocks: The NAOM, which is the basement in the Alcı area (Fig. 1), contains wide variety of sizes and kinds of blocks which can be grouped as i) ophiolitic blocks; ii) pelagic blocks and iii) Jurassic-Cretaceous pelagic carbonate blocks.

i) Ophiolitic blocks: The Cretaceous ophiolitic melanges contain ophiolites and related basaltic volcanics along this belt. The ophiolitic blocks consist dominantly of dark gray to green, intensely sheared serpentinized peridotites; gray to dark purple diabases; dark purple, fractured and altered pillow basalts and red to green, intensely folded and fractured, thin bedded radiolarites. However, eclogite blocks are not recorded along the belt yet.

ii) Pelagic blocks: The intensely folded and fractured, pelagic limestone blocks are Radiolaria bearing red to green Mesozoic pelagic limestones; white to cream, Cretaceous pelagic limestones and cream to beige, thin bedded Malm-Cretaceous pelagic carbonates.

iii) Jurassic-Cretaceous Carbonate blocks: Within the research area, the only mappable blocks are the Jurassic-Cretaceous carbonates (Fig. 3). The blocks consist of gray, beige to cream, folded and fractured, thin to medium bedded, cherty and argillaceous carbonates interbedded with some olistostromal levels. The blocks have a widespread distribution in the area and their lower contacts are not clear (Fig. 1). The blocks consist of biomicrites, micrites and argillaceous biomicrites. The most recognizable and traceable level, which is traced along the highway 68 and Balkuyumcu village, is orange to brown, thin to medium, graded bedded silicified clastic level that displays a fining upward sequence (Fig. 1,5).

The limestones include fossils of *Calpionella alpina, Calpionella elliptica, Tintinnopsella carpathica, Tintinnopsella* sp., *Nannoconus kamptneri kamptneri, Spirilina* sp. that indicate an age of Berriasian (C Zone of calpionellid biozonation).

Reworked clasts of fossils in the marker clastic bed are; *Calpionella alpina, Calpionella elliptica, Calpionella* sp., *Tintinnopsella carpathica, Tintinnopsella* sp., *Nannoconus kamptneri kamptneri, Tubiphytes morronensis, Nautiloculinia bronnimanni, Quinqueloculina robusta,* Radiolaria, *Spirillina* sp., fragments of echinid and blue-green algae. The age is Berriasian (C Zone of calpionellid biozonation).

However various spot samples from the other limestone blocks around the region give Tithonian to Berriasian ages.

Matrix: The matrix, in which the foregoing blocks are floating, is mylonitized and brecciated by intense shearing, deformation and fragmentation. The main constituents of the matrix are red to dark green ophiolitic breccias. Various thin sections are studied from so called arenaceous ophiolitic matrix, but matrix can not be dated because of the absence of fossils.

Interpretation: Soft-sedimentary deformational structures like slumps, olistostromes, turbidites, argillaceous beds and biomicrites with pelagic fauna indicate a pelagic depositional setting. The marker clastic bed might be a non-depositional record which is the result of uplift of Jurassic-Cretaceous platform or sea level fluctuation or both during Berriasian.

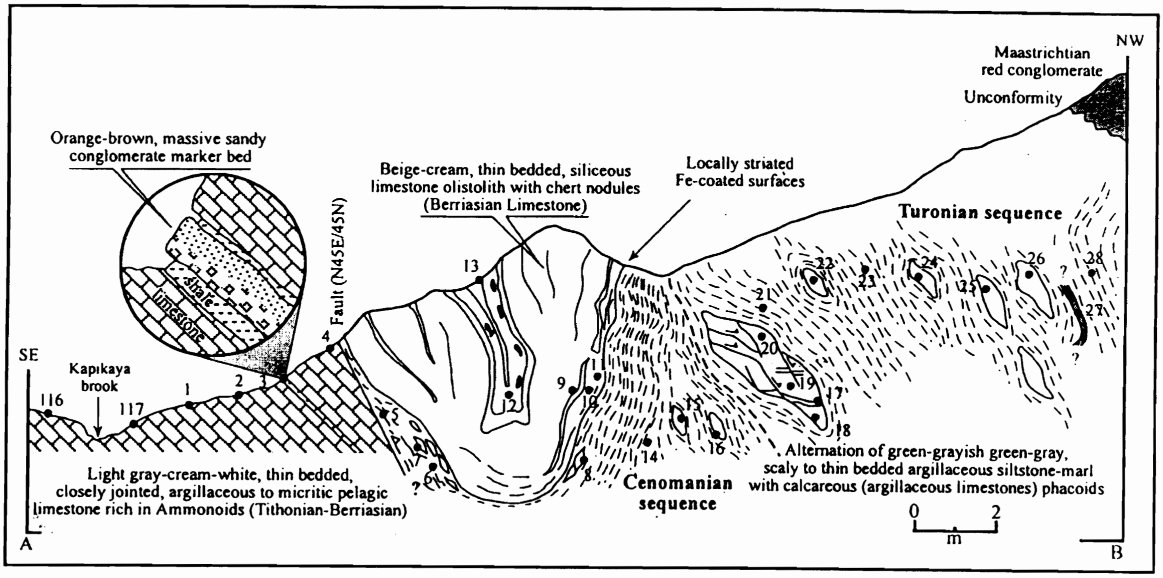

Figure 5. Measured stratigraphic section (AB line) showing the relationships and internal organization of the Cenomanian-Turonian part of the Elmalıdere member. Numbers indicate sample locations.

Şekil 5. Elmalıdere Üyesinin Senomaniyen-Turoniyen kısımının ilişkilerini ve iç düzenini gösteren ölçülü kesit (AB hattı). Sayılar örnek noktalarını göstermektedir.

Finally, the mass underwent a progressive deformation and mixed in accretionary prism.

Elmalıdere Member (Ke):

The unit consists of pelagic marls with argillaceous carbonate phacoids and Malm-Cretaceous cherty limestone olistoliths, and pelagic marls with argillaceous limestones (Fig. 4). The member is probably the equivalent unit of the Damlaağaçderesi Formation in northern Ankara (Koçyiğit, 1987).

The unit has a widespread distribution from Kapıkaya hills to highway 68 and to Balkuyumcu village (Fig. 1). It has a faulted contact with underlying Berriasian pelagic carbonate block of ophiolitic melange. It is unconformably overlain by the Maastrichtian red conglomerates along a low-angular unconformity.

The base of the sequence consists of Berriasian pelagic limestone olistolith bearing, green-grayish green-gray, scaly to thin bedded marls and argillaceous micrites with argillaceous micritic limestone phacoids (Fig. 5). The thickness of the unit is about 22 meters.

The fossils of this part are; *Rotalipora* cf. *cushmani, Rotalipora* cf. *greenhornensis, Rotalipora* cf. *appenninica, Rotalipora* sp., *Praeglobotruncana stephani, Praeglobotruncana turbinaca, Hedbergella planispira, Hedbergella* spp., *Heterohelix* sp., *Nannoconus* sp. and prismatic pelecypod (Inoceramid) fragments. The age is Cenomanian. The fossils of the top part are *Marginotruncana renzi, Marginotruncana pseudolinneiana, Helvetoglobotruncana helvetica*, globotrucaniid clasts, *Pithonella ovalis*, *Dicarinella* sp., *Hedbergella* spp., *Heterohelix* sp. and *Marginotruncana* sp. which indicate an age of Turonian-Coniacian. However, the age of the uppermost part of the unit is interpreted as Turonian based on determined faunal assemblages. Collectively, the scaly, thin bedded argillaceous part of the unit is dated as Cenomanian-Turonian.

The tectonically overlying sequence (Fig. 6), that is the stratified part, consists of yellow to green, thin bedded marls; alternation of light green-white-pink, thin bedded siltstones and marls; yellow to red, thin bedded limestones; and finally to the top, pink, thin bedded argillaceous limestones and marls, and green to red, thin bedded marls. The sequence is free from blocks, olistoliths and boudins. The thickness of this part is about 9 meters.

The fossils of the stratified part are; *Rotalipora* cf. *cushmani*, *Rotalipora* cf. *greenhornensis,*

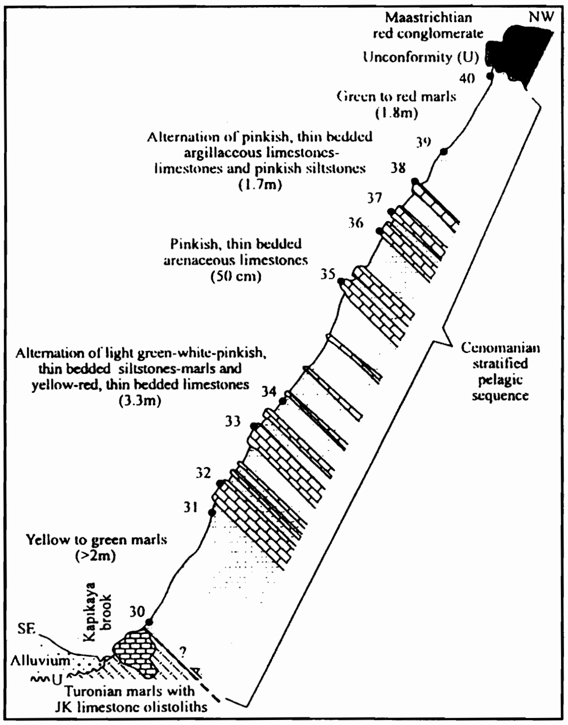

Figure 6. Measured stratigraphic section (CD line) of the Cenomanian part of the Elmalıdere member. JK: Jurassic-Cretaceous. Numbers indicate sample locations.

Şekil 6. Elmalıdere Üyesinin Senomaniyen kısımının ölçülü kesiti (CD hattı). Sayılar örnek noktalarını göstermektedir.

Rotalipora spp., *Hedbergella planispira*, *Hedbergella* sp. and *Heterohelix* sp. The age is Cenomanian.

Interpretation: Tectonically active, NE-SW trending submarine arc-trench basin, which was situated on a progressively dynamic accretionary ophiolitic melange prism, became tectonically quite where stratified rock units deposited like a sedimentary blanket. As a result of continuing tectonic activities, the sequence is tectonically triggered and Tithonian-Berriasian carbonate masses slid into the basin. Scaly to thin bedded argillaceous part with carbonate phacoids formed. Both sequences that are free from volcanic material, comixed during the accretion. Collectively, Elmalıdere member deposited in a submarine, dynamic arc-trench basin that developed on an accretionary ophiolitic melange prism far away from the magmatic arc or, a magmatic arc may not be developed yet. Afterwards, the sequences were tectonically comixed before the deposition of Maastrichtian red clastics.

Based on the presented data and earlier studies cited in the text, a youngest age of Berriasian from the pelagic "blocks" and the unconformably overlying Maastrichtian clastics lead to an interpretation that the NAOM is initiated between at least after Berriasian and pre-Maastrichtian interval in the Alcı region.

İncirli Formation (Ki) :

The formation (Koçyiğit and Lünel, 1987) trends as a NE-SW trending linear, continuous belt and overlies unconformably the Cenomanian-Turonian argillaceous carbonates and Jurassic-Cretaceous pelagic limestones of NAOM (Fig. 1).

The İncirli Formation is lithologically subdivided into two subsequences from the bottom to the top (i) red conglomerates and sandstones, (ii) yellow-green to blueish gray siltstones and marls with a marker arenaceous Lamellibranchiata rich limestone bed (arenaceous biosparite) and calcareous siltstones (Fig. 7). The sequence displays a fining and thinning-upward order with a thickness of about 50 meters.

Due to lack of index fossils, an age of post-Turonian-pre-Maastrichtian is proposed. However, an age of Maastrichtian is accepted which was previously assigned to the formation (Koçyiğit and Lünel, 1987).

Four sets of cyclic grading, conglomerate lobes plus crossbeddings with tabularly imbricated pebbles with attitudes of N52E/36NW to N86E/65NW indicate SE flowing stream in a highly oxidizing fluvial depositional environment. However, to the top of the formation, an active, shallow marine environment of deposition was dominant.

Kapıkaya Formation (Kk):

This unit displays a conformable boundary with the underlying Maastrichtian clastics and it is overlain unconformably by the Paleocene clastics (Koçyiğit and Lünel, 1987) (Fig. 4, 7). Thickness is about 32 meters.

The Kapıkaya Formation consists of reefal carbonates (arenaceous biomicrites, arenaceous biomicrosparites and arenaceous micrites) with cross-bedded calcareous siltstones.

The Maastrichtian age is accepted with the following fossil assemblage: *Marsonella* sp., *Lenticulina* sp., *Siderolites* sp., Miliolidae, *Eponides* sp., rudists, gastropods, cyclolites, echinoids, crinoids and fragmented red algae. However, an age of Turonian-Maastrichtian (Dağer et al., 1963), Maastrichtian (Özer, 1983) and Upper Maastrichtian (Koçyiğit and Lünel, 1987) were previously assigned to the formation.

There are some correlative equivalent units in the Haymana-Polatlı, Tuzgölü, northern Ankara and Çankırı-Çorum basins (Özer, 1983; 1992) where lithostratigraphic evolutions of the sequences were quite different.

The presence of arenaceous micritic interbeds and volcanic particles also indicate clastic influences from a volcanic terrain and wave action during the development of reefal build-up.

Alcı Formation (Ta):

The Alcı Formation (Koçyiğit and Lünel, 1987) consists of pebbly sandstones and siltstones with rudistid limestone olistoliths. The base of this formation is characterized by an oxidized surface (Fe-Mn coated hardground/crustification surface) developed on top of the Maastrichtian reefal carbonates (Koçyiğit and Lünel, 1987).

The Paleocene age is accepted for this unit that was previously proposed by the correlation of the unit with the equivalent formations in Central Anatolia (Koçyiğit and Lünel, 1987).

The hardground surface indicates a subaerial exposure after Maastrichtian time in the region. The presence of rudistid limestone olistoliths and well-developed topset and foreset beds indicate a fan-delta environment (Koçyiğit and Lünel, 1987). The non-altered crystals of plagioclases, amphiboles, pyroxenes and micas in sandstones with angular and poorly sorted pebbles support that the source will be a magmatic terrain that is not far away from the depositional site.

Collectively, Maastrichtian-Paleogene units deposited in a fluvial to submarine fore-arc basin (Koçyiğit and Lünel, 1987) that developed on an accretionary ophiolitic melange prism and on previously developed dynamic arc-trench basins. The sequence was closely associated with shoshonite-alkaline magmatism (Koçyiğit and Lünel, 1987).

TECTONIC EVOLUTION

The collision tectonics is marked in the Ankara region (Central Anatolia) by the İzmir-Ankara-Erzincan suture belt that is a continuous and correlative tectonic belt along northern Neotethyan suture belt (Fig. 1). Cretaceous is the time of subduction in northern branch of Neotethys where the oceanic leading edge of the Tauride-Anatolide Platform subducts beneath the Rhodope-Pontide-Sakarya Continental Fragments and both plates continue to move towards each other during the Cretaceous-Paleogene (Fig. 8).

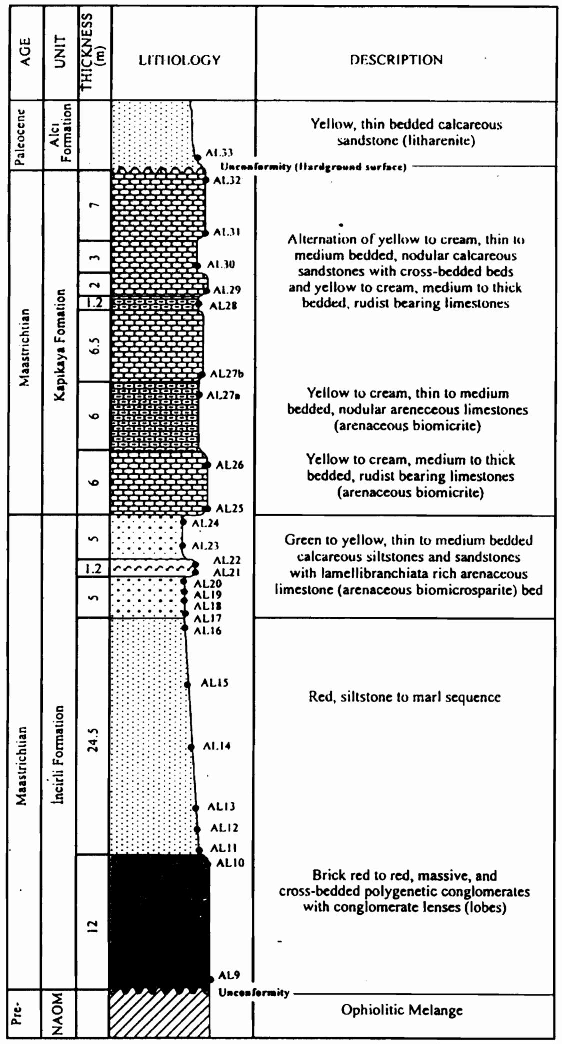

Figure 7. Measured stratigraphic section (EF line) of the Maastrichtian units. (after Süzen, 1994). NAOM: North Anatolian Ophiolitic Melange. Numbers indicate sample locations.

Şekil 7. Maastriştiyen birimlerin ölçülü stratigrafik kesiti (EF hattı) (Süzen, 1994'den sonra). NAOM. Kuzey Anadolu Ofiyolitli Melanjı. Sayılar örnek noktalarını göstermektedir.

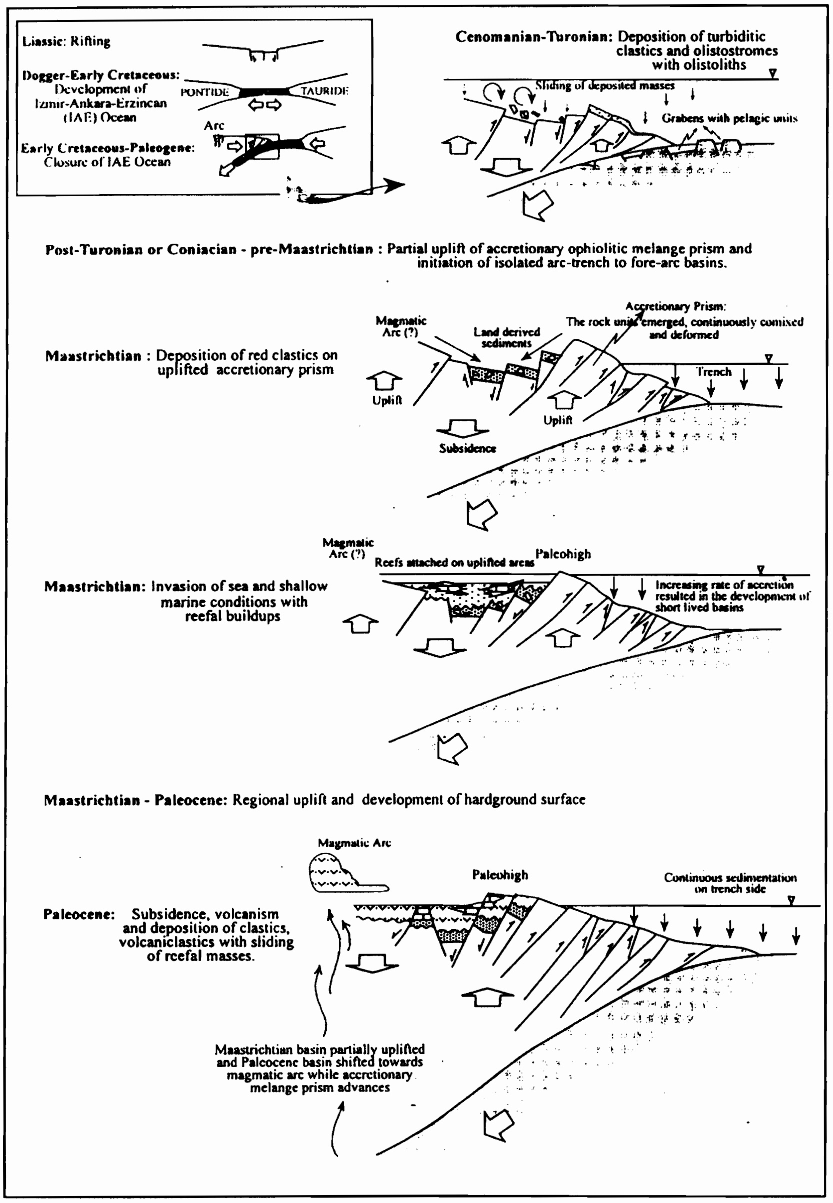

Figure 8. Tentative Cretaceous-Paleocene evolutionary model of arc-trench to fore-arc basin on a dynamic accretionary ophiolitic melange prism.

Şekil 8. Aktif eklenir ofiyolitik melanj kaması üzerinde gelişen yay-hendek ve yay-önü havzaların evrimi için önerilen Kretase-Paleosen evrim modeli.

The increase of bulk thickness of accretionary prism was resulted in the evolution of arc-trench basins on elevated accretionary ophiolitic melange prism of downgoing IAE oceanic crust during the Cretaceous. As a result of this uplift, the tectonically unstable terrain was isostacially balanced with extensional faults and arc-trench pelagic basins developed in the subsided areas. The gravitational instability of the terrain triggered the formerly deposited rock units to slide through submarine canyons as olistoliths and olistostromes, and pelagic clastics comix contemporaneously with these gravity slides (Fig. 8). Submarine slumps, soft-sediment deformations and turbiditic accumulations in front and back of the olistoliths were well developed during that sliding processes. The olistostrome and olistolith bearing sedimentary sequences that were interbedded with the stratified sequences (Elmalıdere member) deposited in arc-trench basins during the Cenomanian-Turonian time (Fig. 8). Coeval tectonic recycling, imbrications, lateral shifting and/or block rotations along strike-slip faults caused much more complexities in the accretionary melange prism and in the simultaneously developing basins. All of these processes may result in the tectonically mixing of ophiolitic suites together with non-ophiolitic rocks and Cretaceous pelagic sediments, and finally resulted in the formation of the olistostromes, tectono-sedimentary melanges and ophiolitic melanges (North Anatolian Ophiolitic Melange) in the area. Continued convergence resulted in the continuous growth and uplift of the accretionary ophiolitic melange prism together with arc-trench basins. However, some parts of the accreted ophiolitic melange prism were still under an influence of both shallow marine and deep marine conditions where thick, turbiditic flyschoidal sequences deposited in isolated dynamic basins developed on prism during the Cretaceous-Paleocene time (Fig. 8).

Parts of the accretionary ophiolitic melange prism uplifted and exposed to subaerial erosion at a time after Turonian or Coniacian. As a result, the uplift was isostatically balanced with block faulting and resulted in the deposition of fluvial red conglomerates, red siltstones and shallow marine calcareous siltstones (İncirli Formation) on accretionary ophiolitic melange prism during the Maastrichtian (Fig. 8). The gradual deepening of the basin continued, and transgressively arenaceous carbonates and rudistid carbonates (Kapıkaya Formation) of reef facies were deposited on the elevated margins of the rifted basin during the Maastrichtian. Tectonic processes continued during the evolution of the basins, and ophiolitic melanges and olistostromes evolved simultaneously. Following the growth of carbonate buildups, the area uplifted again and post-Maastrichtian subaerial exposure of the prism occurred (Fig.8). The ceased deposition followed by a sudden subsidence of the basin and deposition of coarse clastics (Alcı Formation) on the reefal carbonates during the Paleocene. A shoshonitic and alkaline arc magmatism (Tokay et al., 1988) cooperated to the evolution of Paleocene basin.

The Cretaceous-Paleogene basins therefore developed on a dynamic accretionary ophiolitic melange prism since the Cenomanian and interpreted as Cenomanian-Turonian arc-trench and Maastrichtian-Paleocene fore-arc basins that were shifted away from the trench towards magmatic arc, farther north.

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