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TECTONO- SEDIMENTARY EVOLUTION OF THE EOCENE TRANSGRESSIVE DEPOSITS IN SW TURKEY: AN OVERVIEW

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Abstract: Western Anatolia is characterized by N-S and NE-SW oriented extensional neotectonic regime and with E-W, NE and NW-trending depression fields. The Aegean region has been subjected to active N-S extensional tectonics, under the control of the westward movement of the Anatolia plate bounded by the North Anatolian and East Anatolian faults. Tectonic evolution stages of SW Turkey can be divided into four main periods (from latest Cretaceous to the late Miocene). These are in ascending order; (1) Closure of the Pamphylian basin and emplacement of Antalya nappes (during the latest Cretaceous and the Paleocene), (2) Emplacement of Lycian nappes (end of Eocene-Early Oligocene), (3) Forming of the Oligocene molasse basins, (4) Opening of the Baklan and Acıgöl grabens (late Miocene) under the NW-SE and N-S extensional regimes of which has developed simultaneously. The Middle-Upper Eocene sedimentary sequence in Acıgöl (Başçeşme formation), Burdur (Varsakyayla formation) and Isparta (Kayıköy formation) basins (SW Turkey) have commenced with conglomerates and coarse grained sandstones and change to the shale dominated turbidites and limestone interbeds in the upper most part. Generally, the amount of fauna fossils and calcium carbonate content increase upward from the conglomerate to the limestone. The main sedimentary structures of the coarse conglomerate and sandstone constituents in the lower most part of the Eocene sequence indicate the terrestrial (alluvial fan) andtransitional (tidal flat) environments. Further more thin bedded sandstone- mudstone alternations point out marine facies (flysch facies) through the eastern part of study area (Isparta region). As a result of this study it can be mention this palaeoenvironmental changes associated with sea level fluctuation depends on the transgression and tectonic activity.

Keywords: SW Turkey, Eocene transgressive deposits

1. Introduction

Southwestern Turkey is a place of the active continental extension and thus the most seismically active regions of the world (Jackson, 1984; Bozkurt, 2001). This region is affected in order of NW-SE, N-S and NE-SW extensional neotectonic regimes during the late Miocene and the result of this regime has been formed E-W, NE and NW-trending depression fields (Fig. 1).

The aim of this paper is to present an overview of the tectono-sedimentary settings of the Paleocene-Upper Eocene transgressive deposits in SW Turkey. In this aim, it has been done sedimentary facies analysis (based on lateral and vertical facies relationships, provenans studies) on Acıgöl, Burdur and Isparta Eocene outcrops and investigated in relation to pre-Eocene basement rocks.

2. Methods and Terminology

The Eocene deposits have been studied in three sections cropping out at the following three localities and these are Acıgöl, Burdur and Isparta regions (Fig.1). The term facies is used to average grain size, grain textural parameters including type of framework support, orientation fabric, grading, roundness, sorting and type of stratification, as well as sometimes the internal structures and geometry of clastic bodies.

3. Geological setting

The western Turkey is characterized by an active tectonic regime that has been moving to the westward extrusion of the Anatolian block since the late Serravalian (12Ma) leaving in its southwestern part, Acıgöl, Burdur and Isparta regions, a trail of NE-SW oriented, normal-fault bounded basins (Bozkurt, 2001, 2003; Koçyiğit, 1999, 2005). The Burdur - Isparta region is a transitional zone between two distinct neotectonic domains in Turkey:

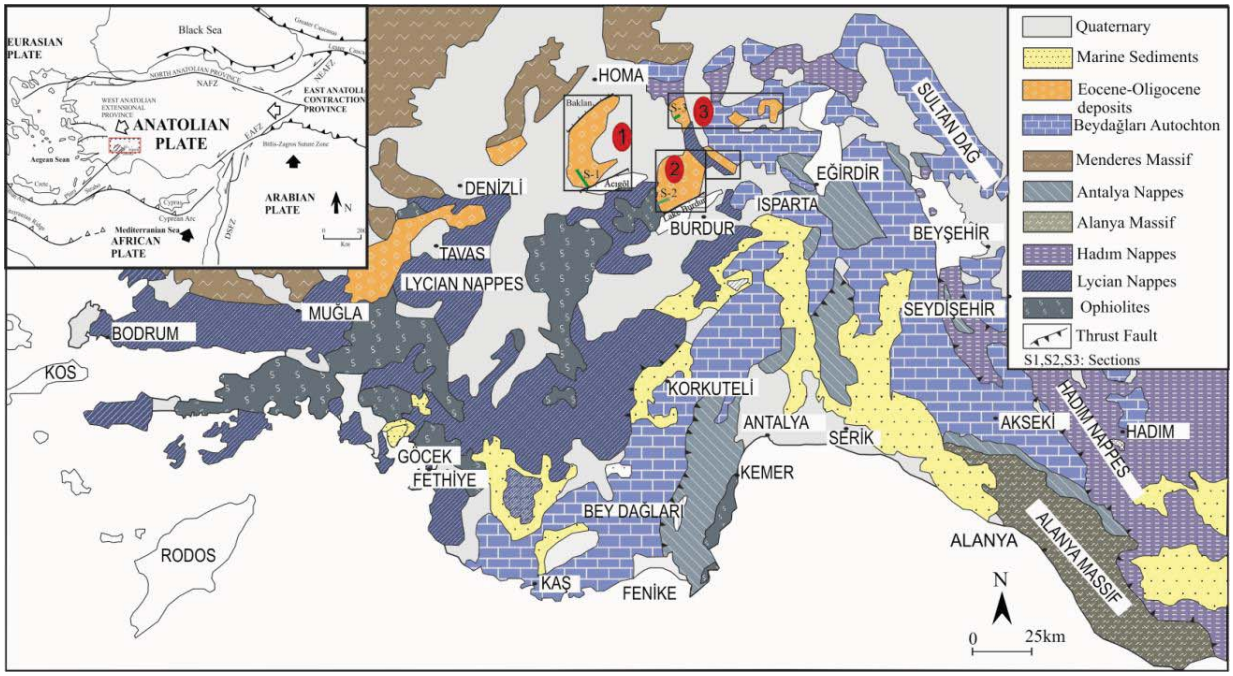

Fig. 1. Simplified geological map of the Eocene-Oligocene deposits and surrounding area in SW Turkey. (1) Acıgöl, (2) Burdur and (3) Isparta regions.

The Burdur graben system as the northeastern part of the Fethiye-Burdur fault zone and the Kovada graben at the apex of the Isparta angle. Each field represents a particular stress regime. These basins continue to settle progressively getting deeper from southwestern (Acıgöl, Burdur) toward the eastern (Isparta) direction (Fig.6).

West Anatolia is formed by four main tectonostratigraphic units and these are; Bornova Flysch zone, the Menderes Massif, the Lycian Nappes and Bey Dağları Autochton (Şengör and Yılmaz, 1981; Collins and Robertson, 1999; Okay et al., 2001; ten Veen et al., 2009). The Bornova flysch unit is located within the İzmir-Ankara ophiolite belt and consists mainly of irregular bedded sandstone, shales and clayey limestones with giant Cretaceous limestone olistolithes. The Menderes Massif represents a relatively autochthonous Panafrican augengneiss basement, which is overlain by a pre-Devonian–Eocene metasediment cover (schists and marbles). Lycian nappes and overlying supra–allochthonus sediments occupy a large area between Menderes Massif in the north and Bey Dağları in the east. The Lycian nappe zone in the SW-Anatolia consists dominantly of serpantinized peridotite, gabbro, diabase, chert, and giant limestone olistolithes. Furthermore, the Mesozoic carbonate sediments belonging to Bey Dağları autochthon are also observed around the area surrounding Isparta. Jurassic–Cenomanian carbonates of the Bey Dağları masif occupy a large part of the region and consist dominantly of neritic and pelagic limestones, dolomitic limestones and dolomites.

There is also that the extension occurred in two distinct stages and there was a short time interval corresponding to N-S compression between them. The first phase of extensional basin formation in the region began in Early Oligocene (Rupelian) time subsequent to the main Menderes metamorphism and the imbrication of the Menderes Massif (Bozkurt and Mittwede, 2005; Koçyiğit, 2005). The second phase commenced by latest Miocene-Pliocene time and is attributed to the combined effects of back-arc extension to the north of the Aegean arc and westward tectonic movement of the Anatolian plate along its bounding structures, the North Anatolian and east Anatolian fault systems. The between of these two phases may have corresponded to a time of tectonic quiescence or N-S continental compression (Bozkurt et al., 2005).

The geology of the study area –Acıgöl, Burdur and Isparta- is primarily characterized by NE-SW-trending foreland depressional basins the margins of which are generally limited with normal faults both of margin. These marginal faults control within the Eocene basins. On the other hand, the marginal faults of the NE-trending grabens are typically left-lateral oblique-slip extensional faults

with an almost straight in trend traces (Bozkurt, 2003).

4. Sedimentary features of the transgressive Eocene sequences in the study areas

Middle-Upper Eocene sedimentary sequence in Acıgöl, Burdur and Isparta areas (SW Turkey) have represented mainly the transgressive sequence. The sequences of Acıgöl-Burdur domains (Başçeşme- Varsakyayla Formations) composed of reddish-claret conglomerates, sandstones, siltstones are represented by fining upward sequences whereas Isparta (Kayıköy Formation) region showing turbiditic character are mainly composed of sandstone and shale alternations with few chert interbeds and conglomerate intercalations (Fig. 2,3&4). The main sedimentary structures of the conglomerate and coarse-grained sandstone constituents in the lower most part of the Eocene sequence indicate the alluvial fan and tidal environments (Fig.5,6). Generally the amount of fauna fossils and calcium carbonate content increase upward from the conglomerate to the limestone while the amount of coarse detritic material decreases in this interval (Toker, 2009).

The sequence of the Eocene deposits commences with conglomerates and the most common components of pebbles are black dolomites, serpentinites, and ophiolithic fragments. The conglomerates are red, massive, poorly sorted, matrix-supported and their main sedimentary structure is the planar cross- stratification. Pebbles show horizontally ori-

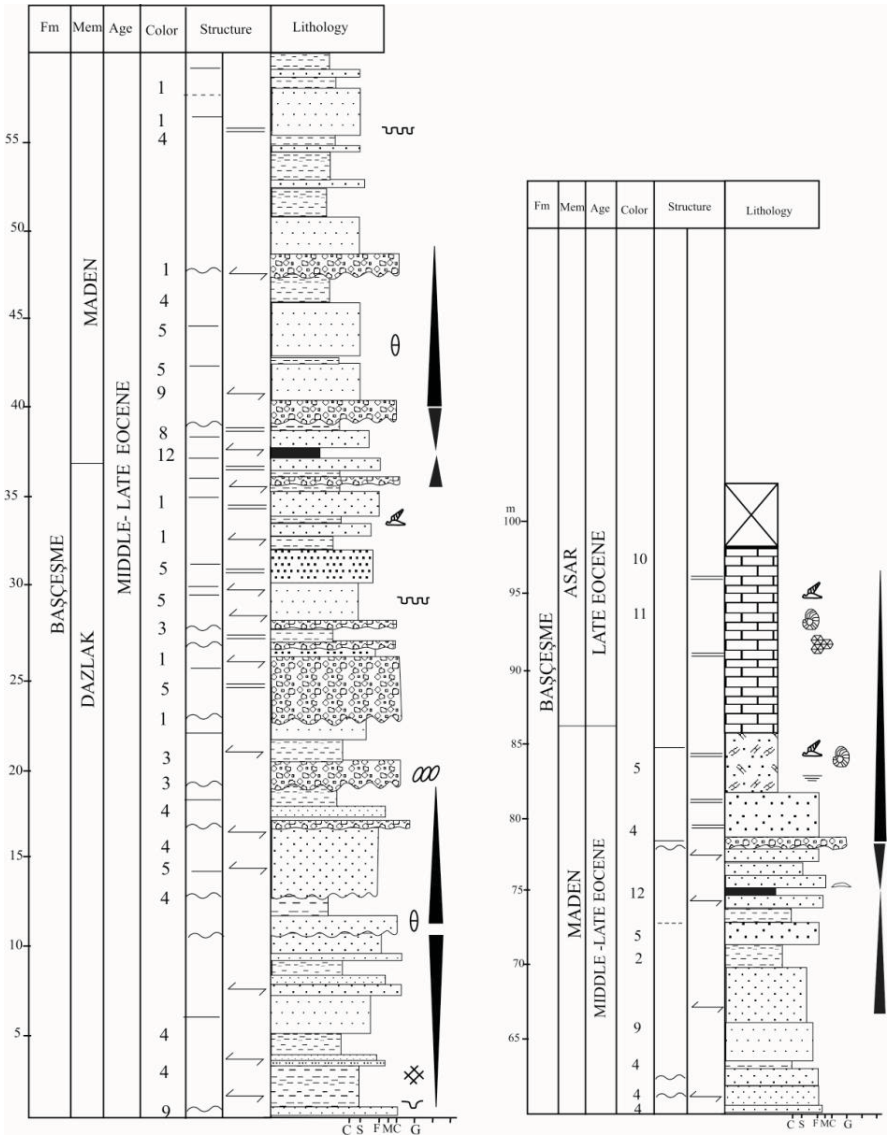

Fig. 2. Measured section of Başçeşme Formation the northern part of Acıgöl. It can be shown in figure 1, S-1 section.

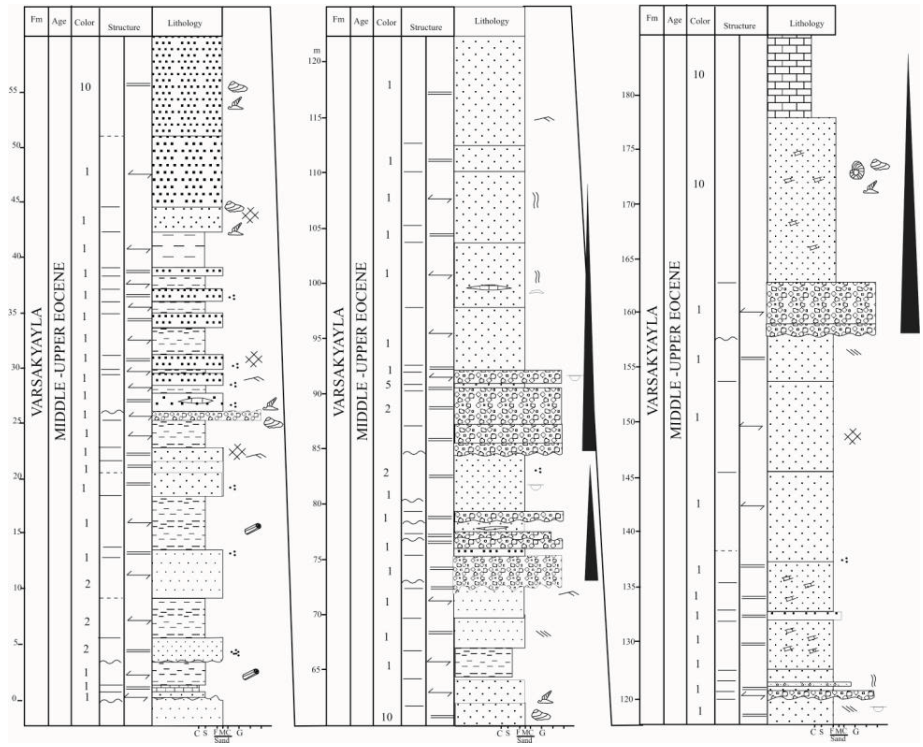

Fig. 3. Measured section of Varsakyayla Formation the northern part of Burdur Lake. It can be shown in figure 1, S-2 section.

entation and imbrication structures Their basal parts were laid down in terrestrial (alluvial-fan) conditions, while the upper part in shallow marine –marine environments (Akkiraz, 2009) (Fig.6).

The conglomerates are conformably overlain by quartz sandstones and these sandstones are greyish cream coloured, medium to coarse grain, poor laminated and intercalated with coal seams. It can be interpreted to deposit on tidal flat environment. Typical representatives are suspension feeders (bivalves, gastropods) living at or below the sediment surface. These clastics are succeeded by up to 350m thick sequence of Eocene transgressive limestone deposits. Further up the foraminiferal limestones rich in larger foraminifera (in particular, such as *Nummulites fabiani, Discocyclina* sp., *Halkyardia*) and coralline algae were deposited. These limestones generally comprise of cream–coloured reefal limestone and in some places, include sandstone, sandy limestone and mudstone. These limestones were deposited in an intertidal environment, including an ecologic reef complex (Göktaş et al., 1989). The Oligocene formations unconformably overlie on this transgressive deposits. Thickness of these limestones is up to 150m in Acıgöl area.

On the other hand the Eocene outcrops through the eastern part (Isparta region) were deposited on marine environment (Fig.6). This sequence commences with grey, coarse–grained, poorly sorted, clast–supported conglomerates and yellowish red, medium - to coarse–grained sandstones. Further up it is observed sandstone- mudstone alternations (Fig.4). Thick bedded sand–mud couplets with well developed normal grading and commonly T-abc division of Bouma sequence are represented to deposit from turbidity currents, ranging from high concentration to low concentration (Stanley and Kelling 1978; Stow and Piper, 1984). The Eocene turbiditic sediments in which deposited on Isparta area can be termed for the flysch sediments.

5. Tectono-sedimentary evolution of SW-Anatolia

In SW-Anatolia, two sets of nappes thrust over the Bey Dağları carbonate platform: the Lycian Nappes to the northwest, and the Antalya Nappes to the east (Poisson, 1977; Gutnic et al., 1979; Robertson, 2000). The Lycian Nappes, issued from the Northern branch of the Neotethys were initially thrust southwards upon the margin of the Anatolian micro-continent during the Late Cretaceous. Subsequent southwards thrusting across the Anatolian micro-continent brought the Lycian Nappes to their present position during the Langhian (Poisson, 1977).

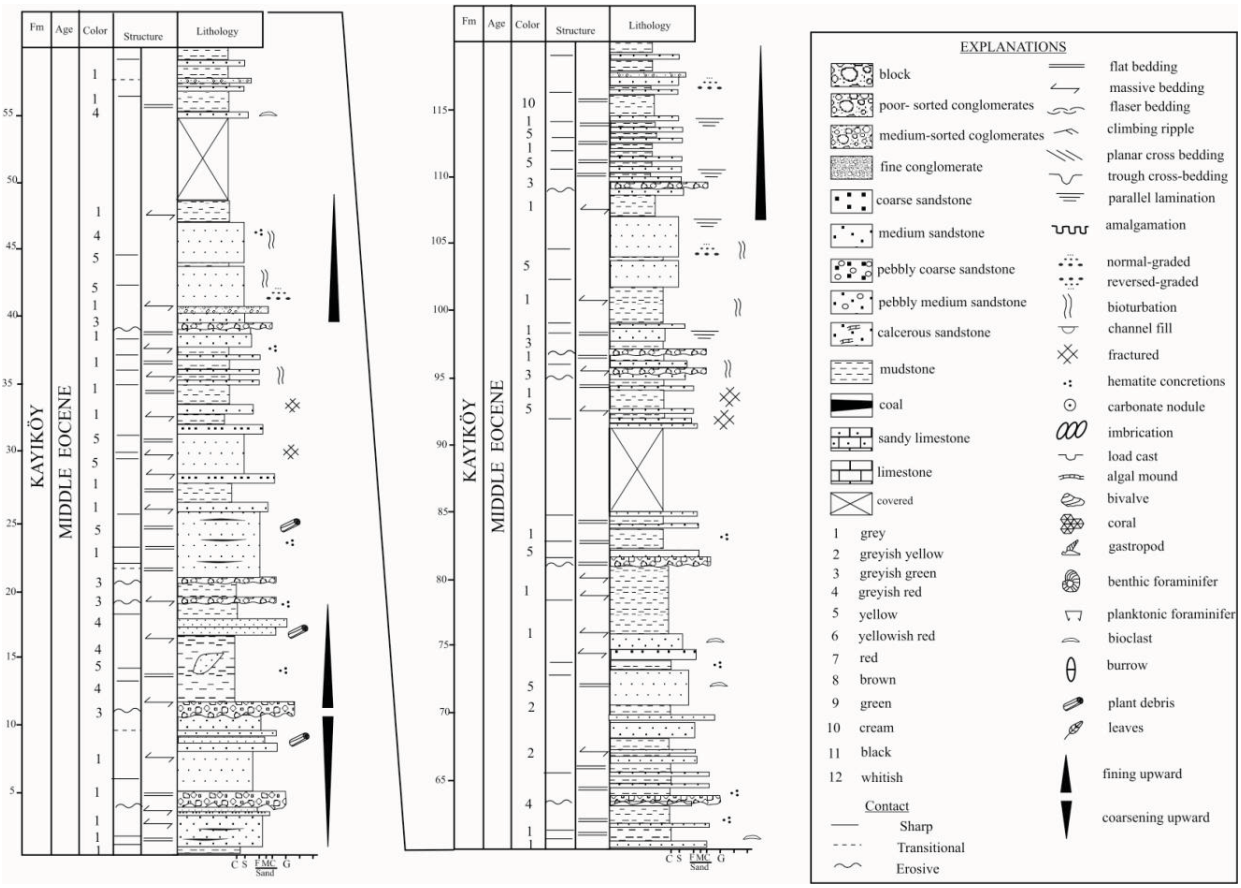

Fig. 4. Measured section of Kayıköy Formation the north side of the Isparta region. It can be shown in figure 1, S-3 section.

The Palaeocene–Upper Eocene supra-allochthonous sediments which are observed around the southwestern Turkey rest unconformably on different tectonostratigraphic units, such as the Lycian Nappes (Poisson, 1976; Özkaya, 1991; Şenel, 1991; Collins and Robertson, 1997, 1998, 1999), the Menderes Massif (Poisson, 1976; Özkaya, 1991; Özer et al. 2001), and the Bey Dağları carbonate platform (Özkaya, 1991; Collins ve Robertson, 1998) (Fig 6). The non– metamorphosed Palaeocene–Eocene supra–allochthonous sediments generally consist of turbiditic sandstone–mudstone alternations, coaly sandstones and mudstones, bioclastic and reefal limestone lenses, blocks of limestone. The supra–allochthonous sediments are separated from the basement rocks by a regional unconformity (Sözbilir, 2002).

On the other hand, tectonic development of the Oligocene –Late Miocene sediments which unconformably overlie the supra–allochthonous sediments, which the letter have been regarded as the sediments of piggy–back basins (Akgün et al., 2000; Gürer and Yılmaz, 2002; Sözbilir, 2002) or molasses basins (Koçyiğit, 1984; Göktaş et al., 1989; Yağmurlu, 1994; Sözbilir, 2005). These basins are accepted as sequences of continental and shallow marine sediments of transition between palaeotectonic and neotectonic periods in western Turkey (Koçyiğit, 1984). In these basins, sedimentary sequences are described by interdependence between tectonism and sedimentation, the latter of which involves fining–and coarsening–upward sedimentary cycles. In some places, the sequences include reefal limestones. The Oligocene-Late Miocene sediments, which are generally composed of coarse-grained conglomerates, have unconformable boundary underlying Eocene flysch sediments.

According to Poisson et al. (2003), tectonic evolution of the SW-Anatolia and surrounding areas can be divided into four main periods. These periods started with the closure of the Pamphylian basin was completed during Mid-Late Paleocene times and the Antalya Nappes were thrust on to margin of the Anamas Dağ and Akseki Massif to the NE and on to Beydağları to the SW (Fig. 7). During

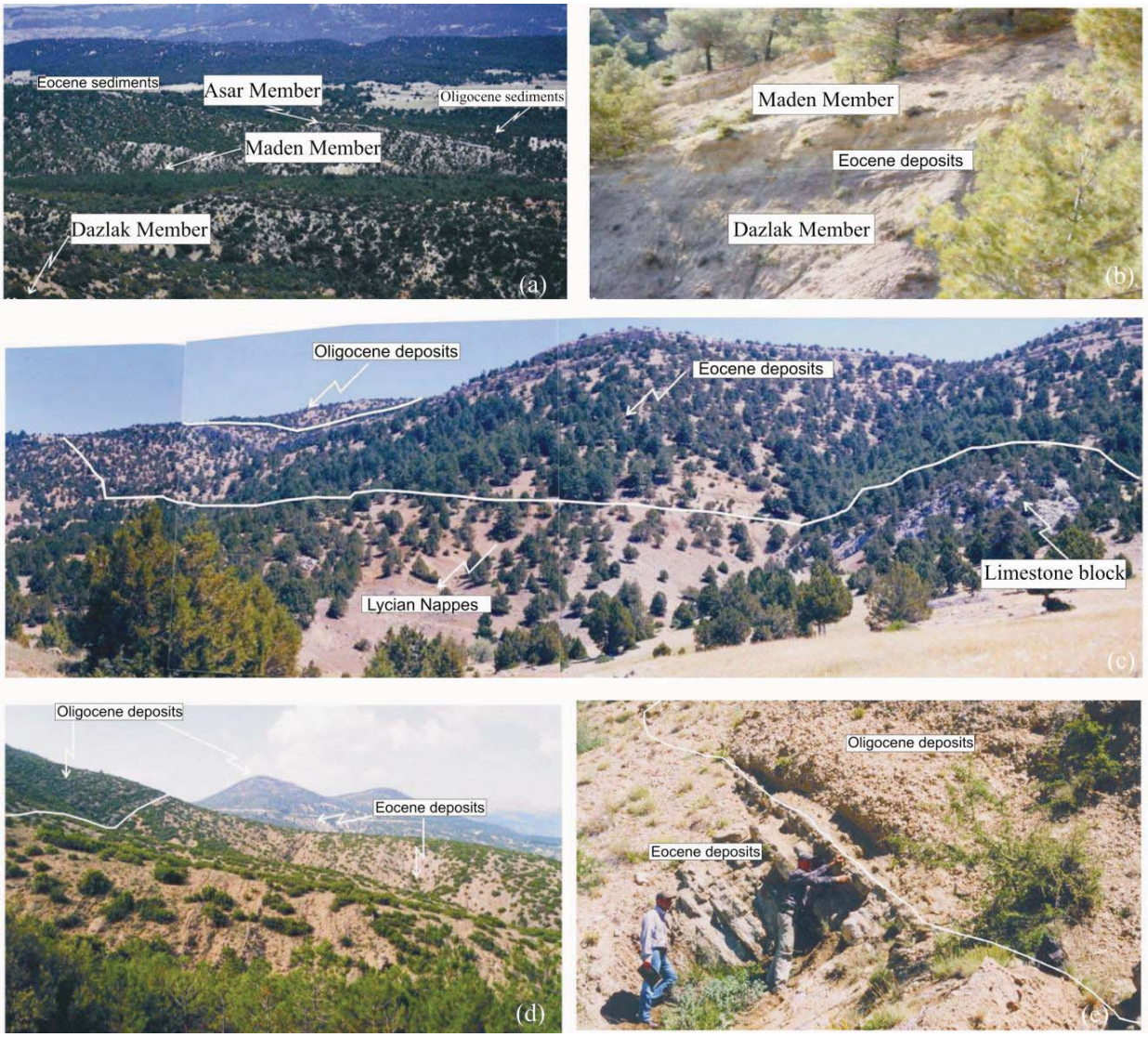

Fig. 5. Field photos of the Eocene outcrops and relationship with Oligocene sediments in Acıgöl (Başçeşme Fm.), Burdur (Varsakyayla Fm.) and Isparta (Kayıköy Fm.). (a-b) Başçeşme Formation in Acıgöl area; (c) Varsakyayla Formation in Burdur area; (d-e) Kayıköy Formation in Isparta area.

the end of Eocene-Early Oligocene Lycian Nappes and related the Beyşehir-Hoyran Nappes were emplaced from the NW and NE onto Beydağları and Anatolian platforms (Anamas-Akseki) and meanwhile, syntectonic sedimentation has commenced in the Acıgöl- Burdur- Isparta regions (Fig.7). The supra-allochthon basins of which are characterized by alluvial-fan, fluvial, tidal and shallow marine environments have developed during the Eocene. The thick bedded and coarse grained clastic sediments cover the metamorfic units of the Menderes Massif in the northern regions of Acıgöl and Oligocene coarse conglomerates cover the ophiolithic melange and Mesozoic carbonate units in the NE regions of Isparta. Acıgöl and Burdur grabens began to be opened with neotectonic period of Turkey and extension in the region commenced in the Late Miocene and has continued, possible without a break and is still presently active (Kaymakcı, 2006).

6. Conclusions

Our goal has been to gain insight into the Eocene transgressive deposits and particularly the tectono-sedimentary developing of Acıgöl-Burdur-Isparta basins. After the emplacement of the Lycian nappes in the SW-Anatolia, the according to their division of the basins are Paleocene-Upper Eocene supra-allochthon basin formed on the ophiolithic basement. The sedimentary sequence of the supra-allochthon basin consists dominantly of alluvial –

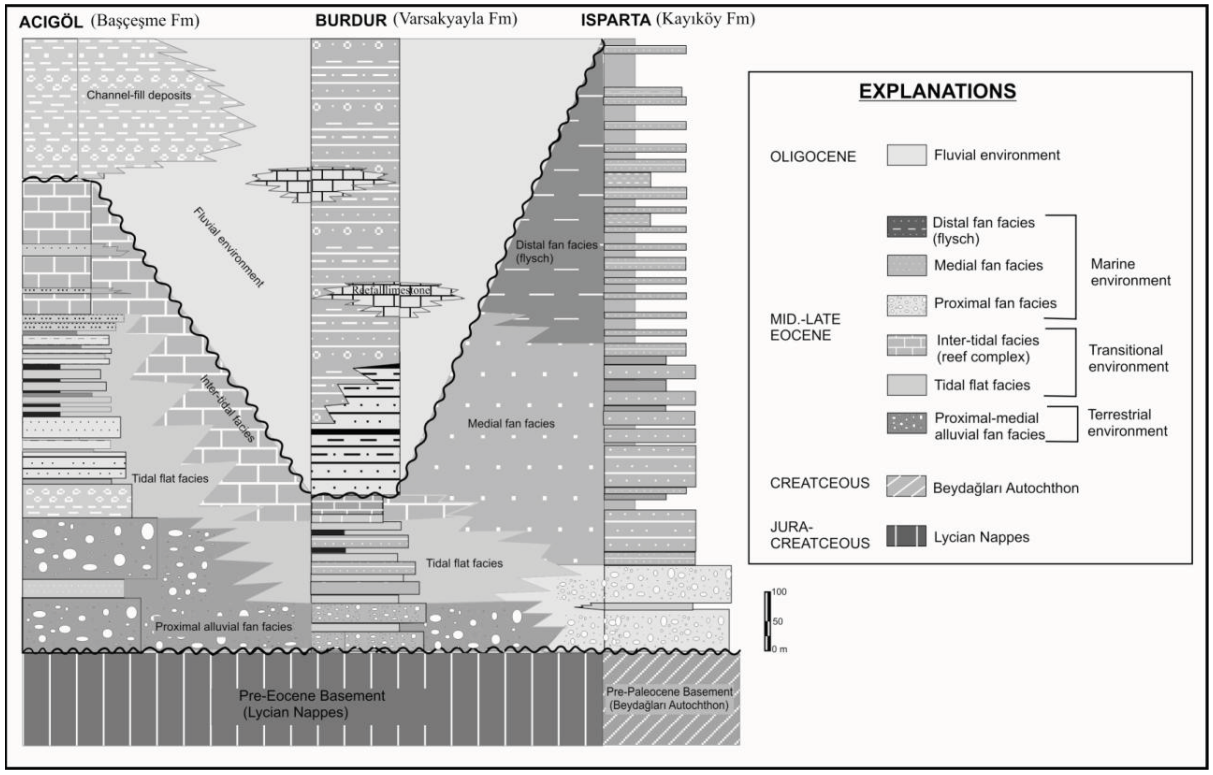

Fig. 6. Generalized schematic illustration of the lithologically vertical and lateral changes of Eocene –Oligocene outcrops in the study areas.

fan, fluvial, tidal and shallow marine sedimentary constituents.

The collected data allow us to hypothesize that the Paleocene-Upper Eocene tectono-sedimentary history was characterized by pre-transgressive con-

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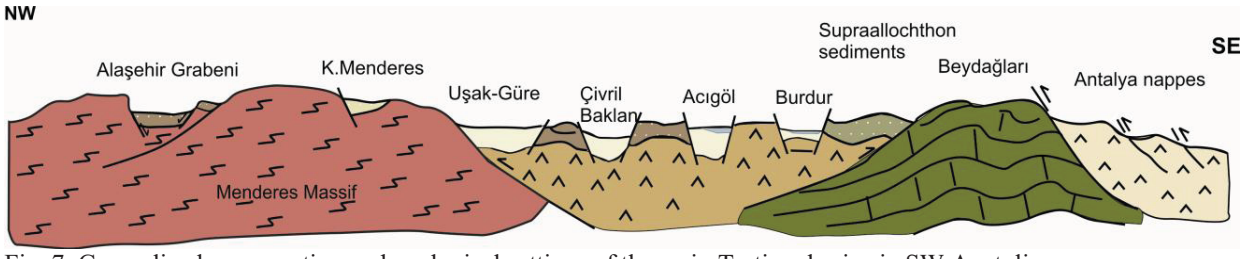

Fig. 7. Generalized cross section and geological settings of the main Tertiary basins in SW Anatolia.

glomerates-sandstone, transgressive shallow marine-marine deposits (reefal limestone and flysch like fine grained sediments). The tectono-sedimentary evolution of the Eocene outcrops in SW Anatolia has been probably developed through progressive different depositional environments (such as shallow to basinal marine) towards to the eastern part of Turkey (Toker et al., 2009).

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