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STRATIGRAPHY OF EOCENE SEDIMENTS IN THE SOUTHWEST THRACE**

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ABSTRACT. - The area concerned is situated in the Gelibolu peninsula, north of the Saros bay and northwest of the Marmara sea sediments of Upper Cretaceous to Miocene age, having a variety of fades crop out SW of Thrace. During the present survey, the goal was to examine the stratigraphic features of the Eocene sediments in the region. The Tertiary basin is underlain by an ophiotitic complex emplaced prior to Maastrichtian and limestone of Maastrichtian to Paleocenc age. The base of the limestone is not exposed within the region. The Tertiary transgression began in the Early Eocene in the Gelibolu peninsula. Massive mudstones, sandstone sequences that become thicker and coarser upward, and channel fill sediments are the first products of this transgression (Karaağaç limanı formation). This sequence is overlain by deltaic sediments beginning with massive mudstones and becoming thicker and coarser upward (Koyun limanı formation). These sediments are conformably and transitionally overlain by interbedded mudstone and sandstone, cut by channel fill deposits (Rcitepe formation). This formation was formed by meandering rivers. The sea that progressed inward to the Gelibolu peninsula during the Early Eocene began to become shallower again at the beginning of Lutetian and as a result, the region as a whole became a positive area during the Middle Lutetian. During the Late Lutetian, a new transgression occurred in the entire region. The first product of this transgression was a limestone (Soğucak formation). This limestone which was deposited in a shallow sea environment is locally intercalated with sandstone and conglomerate. The sea became deeper from the beginning of Upper Eocene. Firstly, turbiditic sandstone, and mudstone, interbedded hemipelagic mudstone (Gaziköy formation) with tuff, and carbonate mudstone and massive mudstone (Burgaz formation) were deposited. These units are products of flat basins. These are, in turn, overlain by sequences consisting of siltstone, mudstone, and conglomerate, which become thick bedded and coarser upward (Korudağ formation) and fining upward sequences (Keşan formation). These are submarine fan deposits of turbiditic origin. The basin became shallower again towards the end of Upper Eocene. During this period, rock units made up of mudstone, siltstone, sandstone, and conglomerate were deposited. This sequence deposited in a deltaic environment has been named differently, the Kanlıbent formation in the Gelibolu peninsula and the Yenimuhacir formation between Keşan and Tekirdağ, due to its diverse local features. The basin as a whole became a continent during the Oligocene (?) and alluvial deposits that consist of mudstone, sandstone, and conglomerate formed (Armuttepe formation).

INTRODUCTION

The study area is located between Enez-Keşan-Tekirdağ and Şarköy, southwest of Thrace and northwest of Gelibolu peninsula (Fig. 1).

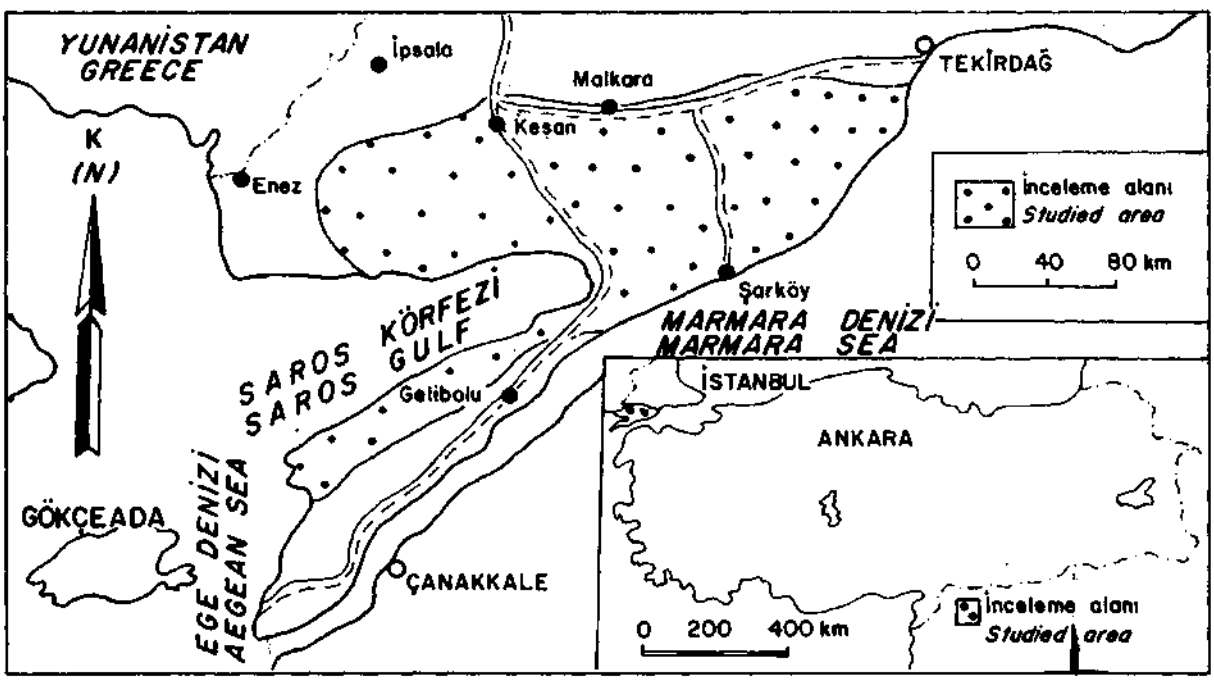

Fig. 1 - Location map.

The purpose of this paper was to introduce stratigraphic properties of the Eocene sediments that crop out in the southwestern Thrace. In the study area. Tertiary rock units belonging to distinct facies are exposed, exceeding 7000 m. in total thickness. The detailed, reliable and complete stratigraphic positions of these rock units for regional integrity have not previously been defined. Also, some formation names are not suitable with rules of stratigraphic nomenclature. A study was carried out within the framework of a project titled "Thrace Tertiary Project" in 1979 and 1982 in order to make up for this type of gaps in the region. This paper deals with a part of this project. Air photographs and 1:25 000 scale topographic maps were utilized during these studies. Rock units in the study area were differentiated and mapped on the basis of facies. Later, macro tectonic features was studied and measured stratigraphic sections were defined. In addition, some collected samples were examined pctrographically and paleontologically. With regard to these features and studies of earlier workers, formations were named. For interpretation of depositional environments of rock units, available data and conclusions drawn by Bourna (1962), Allen (1964, and 1970), Mutti and Ricci Lucci (1972, 1974, and 1978), Ricci Lucci (1975), Wilson (1975), Mutti (1977), Walker (1978), Guido Ghibuudo (1980, and 1981) and Stewart (1981) were evaluated.

A number of studies dealing with the southwestern part of Thrace were conducted, the vast majority of wich have focused on economic potential of the area (petroleum and coal). Druit (1961), Turkse Shell (1969), Kellog (1973), Önem (1974), Saltık and Saka (1972, and 1973) and Saltık (1974) investigated the area for exploration of petroleum. In addition, Lebküchner (1974) investigated the northern part of the study area for ccal. The studies by these workers lack at least one or more of the above mentioned points. The present writers alm to complete this type of gaps to some extent.

GENERAL GEOLOGIC SETTING OF THE REGION

With regard to Thrace as a whole, one can say that the rnetamorphics making up the Istranca massif in the northeastern part of the region form the basement. Tertiary sediments are not very thick and are exposed immediately south of the massif. Conversely, Tertiary sediments with a total thickness of more than 7000 m. occur in the southwestern pan of Thrace including the study area. The relations of the Eocene Miocene rock units and all facies are observed throughout this region. Inner parts (Ergene basin) are wholly covered by younger deposits (Pliocene?)

The oldest exposed unit within the study area which is located in the southwestern part of Thrace is an ophiolitic melange (Fig. 2). This unit also constitutes the basement of the Tertiary basin in the region. The ophiolitic melange comprise rock types such as serpentinite, phyllite, diorite metadolerite, metachert, glaucophanc schist, spilite, recrystallized limestone, altered porphyntic dacite and graphite schist conclusively suggesting varying environments (Şenrtürk and Okay, 1983). Blocks that make up this unit, named as the Yeniköy melange, are a non-matrix assemblage. These blocks display traces of deformation at their contacts. A melange with these properties is likely to correspond to a melange developped within a subduction zone. The emplacement age of this melange is probably pre-Maasirichtian (Şentürk and Okay, 1983).

The relation of the Upper Cretaceous-Paleocene limestones exposed adjacent to the southern coast of Saros bay, Gelibolu peninsula with the basement is unknown (Fig. 2,3). These limestones are also observed near Yeniköy on the Gelibolu-Şarköy highway. They are wine, green and greenish gray and thin to medium bedded and are usually pelagic limestones.

The Eocene-Oligocene (?) rock units, main lilhologies of the Tertiary basin form various facies. The Miocene sediments unconformably rest upon the underlying units. From the base upwards, the sequence consists of interbedded siltstone, claystone, and conglomerate, 500 m. thick, interbedded sandstone, less abundant siltstone, and claystone, 150 to 250 m. thick, interbedded siltstone, claystone, and sandstone, 90 m. thick, and interbedded sandy limestone, siltstone, sandstone, and oolitic limestone, 220 m. thick. This sequence is named the Çanakkale formation and is Middle-Upper Miocene in age.

The Upper Miocene unit is the youngest formed lithology after actual deposits in the study area. This unit consists of alternating siltstone, sandstone and conglomerate, about 300 m. thick and is named the Conkbayırı formation.

The N70E-trending Saros bay-Gaziköy fault, the most prominent tectonic element of the region, that has been continuing its activity in the present day passes through the central part of the study area. This fault coincides with the western extension of the North Anatolian Fault (NAF) (Fig. 2). The northern parts of the Gelibolu peninsula were more intensely affected relative to the southern parts by tectonic movements. The northern parts include folds with low attitudes parallel to the trend of the peninsula. Fractures are poorly developped. In general, the central part of the peninsula where Paleogene and Neogene are in contact, the units are overturned southwards. This may be attributed to the presence of the North Anatolian Fault passing through the north of the peninsula and Saros bay graben. While, in general, the northern parts of this fault were

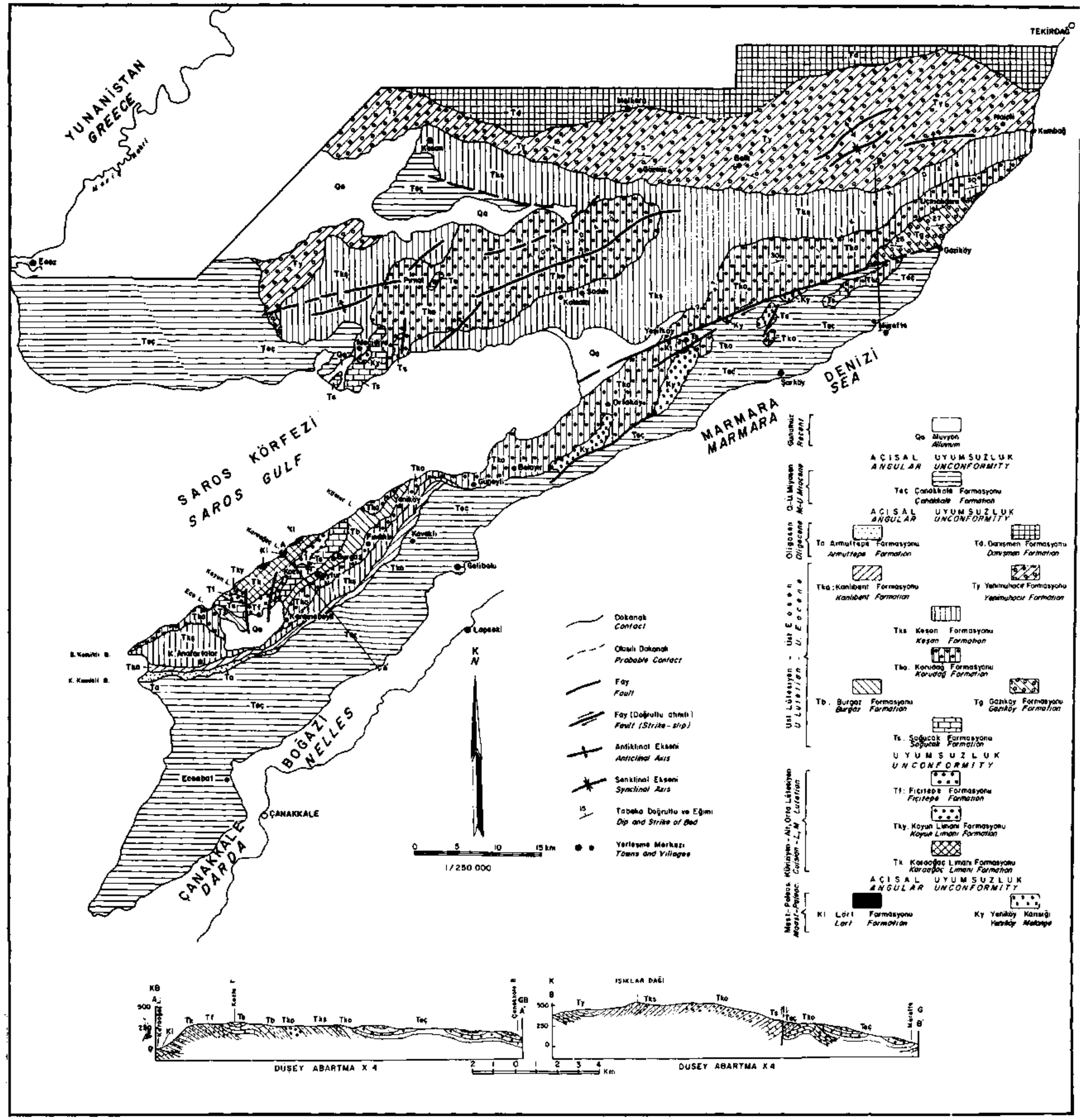

Fig. 2 - Geological map of the investigated area.

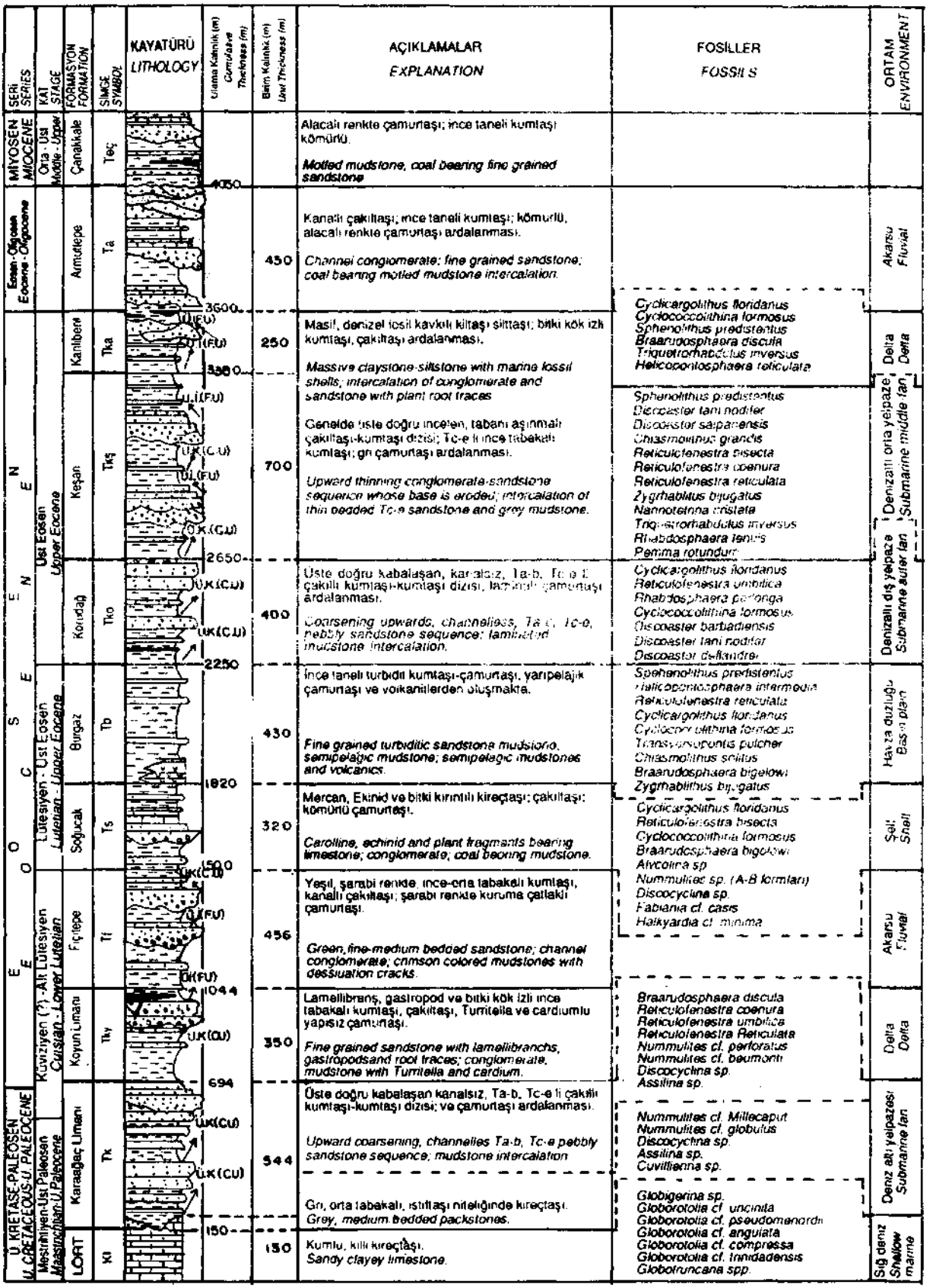

Fig. 3 - Generalized, scaled stratigraphic columns of the Eocene sediments in the Gelibolu peninsula.

weakly affected by tectonic movements, reverse faults and overthrusts are seen in the southern parts (Sümengen and others, 1987).

STRATIGRAPHY

The Eocene sediments that occur in the study area were subdivided into 11 formations, with regard to facies and depositional environments. Each formation will be described under subtitles such as definition and name, type section and type locality, distribution and setting,lithologic features and depositional environment.

Karaağaç limanı formation (Tk)

Definition and name. _ It consists of alternating siltstone, claystone, and sandstone, intercalated with lenses of conglomerate. In addition, a limestone horizon lying at the base was defined for the first time by the present writers (Fig. 3). Druit (1961) and Kellog (1973), named this unit "Karaağaç formation". Later on, it was named "Karaağaç limanı formation" by Turkse Shell (1969), 'Tayfur formation" by Ünal (1967), and Saltık and Saka (1972, and 1973) and "Karaburun formation" by Önem (1974), and Saltık (1975). "Karaağaç limanı formation" is preferred by the authors, since, it is best exposed near Karaağaç limanı and this name is commonly used by previous researchers.

Type section and type locality. _ This formation is typically exposed along a coastal area extending from Manda limam to Koyun limanı. Measured type section is located in this area. In addition, some sections along the road of Saz limanı-Tayfur village are type localities for this formation.

Distribution and setting. _ Exposures of this formation are seen only in a limited area to the south coast of the Saves bay (Fig. 2).

The Iower contact of this formation has been differently interpreted by earlier workers. Druit (1961) and Turkse Shell (1969) report that the contact is conformable, whereas Kellog (1973), Önem (1974) and Saltık (1975) regard it as unconformable contact. The fact that basal conglomerate is seen at the lower contact and the formation rests upon various levels of the underlying formation suggests that the contact between two formations is unconformable.

Lithoiogic features. _ Limestone in the lowermost part of the Karaağaç limanı formation is restricted to a small area. This limestone is moderately to thickly bedded, contains abundant fossil and has a packslone character. Dominant lithologies are unbedded claystone, sandstone sequence becoming thickly bedded and coarsening upward and channel fill deposits. The claystone contains small lenses of unbedded sandstone with ripple marks, and plant fragments. The sandstone is fine to medium grained, moderately to thickly bedded and contains a variety of sedimentary structures (graded bedding, ripple marks, sole markings etc.). In addition, channel fill deposits composed of conglomeratic sandstone, and conglomerate occur widespread in the uppermost levels of the formation (Fig. 3).

The thickness of the formation is variable in different places. In general, the thickness was measured to be between 500 and 1100m.

Age. _ Turkse Shell (1969), Kellog (1973) and Önem (1974) assigned a Lower Eocene age to this formation. In contrast, Paleocene-Lower Eocene age was assigned to it by Saltık (1975). The age of the formation is Lower Eocene (Cuisian)-Lutetian (Lower) on the basis of benthonic foraminifera contained in the underlying limestones and nannoplanktons identified from claystones (Fig. 3).

Depositional environment. _ It is concluded that the underlying limestone was deposited in a shallow sea environment, whereas the overlying claystone, and sandstone were deposited in submarine fan environment on the basis of lithologic characteristics, sedimentary structures, geometries and fossil contents of the sediments within the formation, and their relations will; the overlying formation.

Koyun limanı formation (Tky)

Definition and name. _ While the lower parts are made up of unbedded mudstone, the upper parts are made up of sandstone and conglomerate. This unit was mapped as a differentiated formation and named for the first time during the present studies. It is named after Koyun limanı where it is best exposed.

Type section. _ A type section was measured over a coastal area extending from Koyun limanı southwestward.

Distribution and setting. _ This formation does not occur widespread as does the overlying formation. It is seen confined only to a small area between Koyun limanı and the locality of Sağırtaş, south coast of the Saros bay (Fig. 3).

The formation gradually passes into the underlying Karaağaç limanı formation (Fig. 3).

Uthologic features. _ The formation begins with an unbedded mudstone with a total thickness of 250 m. at the base. The mudstones are enriched in carbonate and display globular and striped exfoliations. They are rich in plant fragments and sea shells. They gradually pass upward to alternating sandstone and mudstone. The sandstone is thin to medium bedded, fine-grained, and comprise ripple marks. Its lower and upper contacts are sharp. It contains small scale slump structures and small sized nummulites. Sea shells, variable scale animal burrows and organic marks were determined in both sandstone and mudstone. This part grades upward to massive and cross bedded, medium to coarse grained sandstone and mudstone. The sandstone is observed as lenticular horizons as much as 5 m. thick, thinning upward. It contains plant roots, coal-bearing bands, a variety of sedimentary structures and sole markings. The uppermost portion of the formation consists of levels of red and green clayey silty mudstone and fine grained sandstone, mostly having a wavy appearance (Fig. 3).

The thickness of the formation was measured to be 350 m., 250 m. of mudstone level and 100 m. of sandstone, and mudstone.

Age. _ No fossils were found for age determination, although the samples (mudstone) collected from the formation was studied in detail for identification of nannoplanktons. However, the fact that this formation shows lateral and vertical transitions into the underlying Karaağaç limanı formation suggests that it may be of Lutetian age (Lower ?) (Fig. 3).

Depositional environment. _ On the basis of sedimentary features and other available data, it may be suggested that the Koyun limanı formation was deposited as deltaic sediments in a shallow sea environment influenced by river actions.

Fıçıtepe formation (TO

Definition and name'. - The formation consists of alternating mudstone and sandstone, intercalated with conglomerate as lenses. It is termed "Fıçıtepe unit" by Sfondrini (1961) and Druit (1961), Panayırtepe formation" by Turkse Shell (1969), "Fıçıtepe formation" by Kellog (1973). "Sağırtaş member of Tayfur formation" by Önem (1974) and Saluk (1975) and 'Tayfur formation" by Ünal (1967) and Saltık and Saka (1972, and 1973). During the presents studies, it was termed after Fıçıtepe where it is best seen.

Type section and type locality. - Type locality is located to the north of Kozlutepe. Type section was measured at this locality Other type localites include northern part of Tayfur village, locality of Sağırtaş, Fıçıtepe and its surrounding.

Distribution and setting. _ The outcrops of this unit are seen as parallel to the Saros bay, Gelibolu peninsula (Fig. 2). It is readily identifiable by its distinct red and wine color.

The formation gradually passes into the underlying Koyun limanı and Karaağaç limanı formations (Fig. 3).

Lithologic features. _ The Fıçıtepe formation consists of conglomerate sandstone fades, usually fining upward, interbedded with mudstone (siltstone, claystone) and very fine-grained sandstone (Fig. 3). The conglomerate sandstone fades ranging from 5 to 10 m. in width and having an average length of 50 m. occurs as horizontal lenticular sequences fining upward. Pebbles are mostly derived from limestone and various rocks of metamorphic and volcanic origin, and clast supported or cemented by sand to clay size material. The sandstone is medium to coarse grained, fines upward and exhibits cross bedding, grading and sorting. Bute casts are common markings of the lower surfaces. The mudstone is wine colored, and laminated and commonly contains organic tracks, remnants, and fragments of plant roots, desiccation cracks and carbonate concretions. Mudstones are inierbedded with thinly bedded, fine to very fine grained green sandstones with ripple marks.

The thickness of the formation was measured to be 450 m. in the vicinity of Kozlutepe, 540 m. immediately north of Tayfur village. However, this thickness shows variations and ranges from 200 to 600 m. in average.

Age. _ Due to lack of fossil, the Fıçıtepe formation has been dated on the basis of stratigraphic relationships. This formation conformably overlies the Koyun limanı formation of Lutetian (Lower ?) age. These two formations show lateral transitions into each other in some places. It is suggested that this formation is likely to be of Lutetian age, on the basis of the fact that it is unconformably overlain by the Soğucak formation (Fig. 3).

Depositional environment. _ On the basis of grain size distribution pattern within the fades of conglomerate sandstone, and wine colored mudstone, constituting the formation, internal structures, color, lateral and vertical relations of the facies, it is concluded that these lithologies are sediments of meandering rivers, and flood plains.

Soğucak formation (Ts)

Definition and name. _ This unit consisting mostly of limestone, and locally of sandstone, and claystone with subordinate conglomerate was differently named by earlier workers. It was named "Tayfur formation" by Druit (1961), "Mecidiye and Pırnal member" by Kellog (1973), "Kozlutepe member" by Önem (1974), "Mecidiye formation" near Şarköy and "Kozlutepe member" in Gelibolu peninsula by Saltık (1974). During the present studies it was termed after Soğucak, a common name used within the entire Thrace by TPAO workers where it is best seen.

Type section and type locality. _ Type locality is located near Kozlutepe in Gelibolu peninsula. A type section was measured at this locality. The other type localities are located near Tayfur village, in a stream bed near Pırnal village, along a road cut between Mecidiye and İbrice quay, and at Doluca tepe near Şarköy.

Distribution and setting. _ This formation crops out in different places of the study area. Exposures of this formation are seen near Kozlutepe and Tayfur village in Gelibolu peninsula, near Mecidiye village and Pımal village, south of Keşan, around Doluca tepe and Kamil tepe, near Şarköy (Fig. 2).

The lower contact of the formation was differently interpreted by many workers. Druit (1961), Kellog (1973) and Saltık (1975) report that this unit conformably rests upon the underlying unit. Conversely, the lower contact was interpreted to be unconformable by Turkse Shell (1969). The present observations indicate that the formation rests on the basement in the vicinity of Mecidiye and on ophiolitic basement around Yenice village, immediately north of Şarköy by angular unconformities. On the other hand, there is an uncertain unconformity between this formation and the underlying Fıçıtepe formation in Gelibolu peninsula (Fig. 3,4, and 5).

LUhologic features. _ The sequence from Gelibolu peninsula begins with sandstone, and conglomerate at the base, grades upward into limestone and continues with sandstone and marl including limestone olistoliths, the latter representing the uppermost part of the sequence (Fig. 3). The sandstone at the base is medium to thick bedded, unsorted and contains plant fragments and clayey horizons with coaliferous bands. Pebbles of conglomerate are up to 5 cm. long, subangular and matrix and clast supported. The conglomerate is unsorted and grading is indistinct The limestone from Gelibolu peninsula and Pırnal village is gray, dark gray colored, moderately bedded and locally imbedded, contains abundant fossils and very scarce sandstone strata and shows wackestone packstone character. The limestone from Mecidiye and Şarköy is brownish yellow, locally white colored, generally unbedded and folded and contains abundant shells of macrofossils. The limestones are overlain by sandstone and limestone olistolith bearing marl as the uppermost level in Gelibolu peninsula. The formation is characterized only by limestone in other places of the study area (apart from Gelibolu peninsula) (Fig. 4, and 5).

The formation has a thickness of 313 m. near Kozlutepe and 242 m. in the vicinity of Tayfur village in Gelibolu peninsula. The thickness was measured to be 100 m. near Mecidiye, 150-200 m. near Pırnal and 100-200 m. at Doluca tepe.

Age. _ On the basis of benthonic foraminifera and nannoplanktons determined, the formation is of Upper Lutetian Upper Eocene age (Fig. 3,4, and 5).

Depositional environment. _ It may be concluded that the unit was deposited in an open restricted shelf microfacies environment on the basis of microscopic studies of samples collected from limestones of the formation as well as fauna contained in carbonates and sedimentary structures in sandstones.

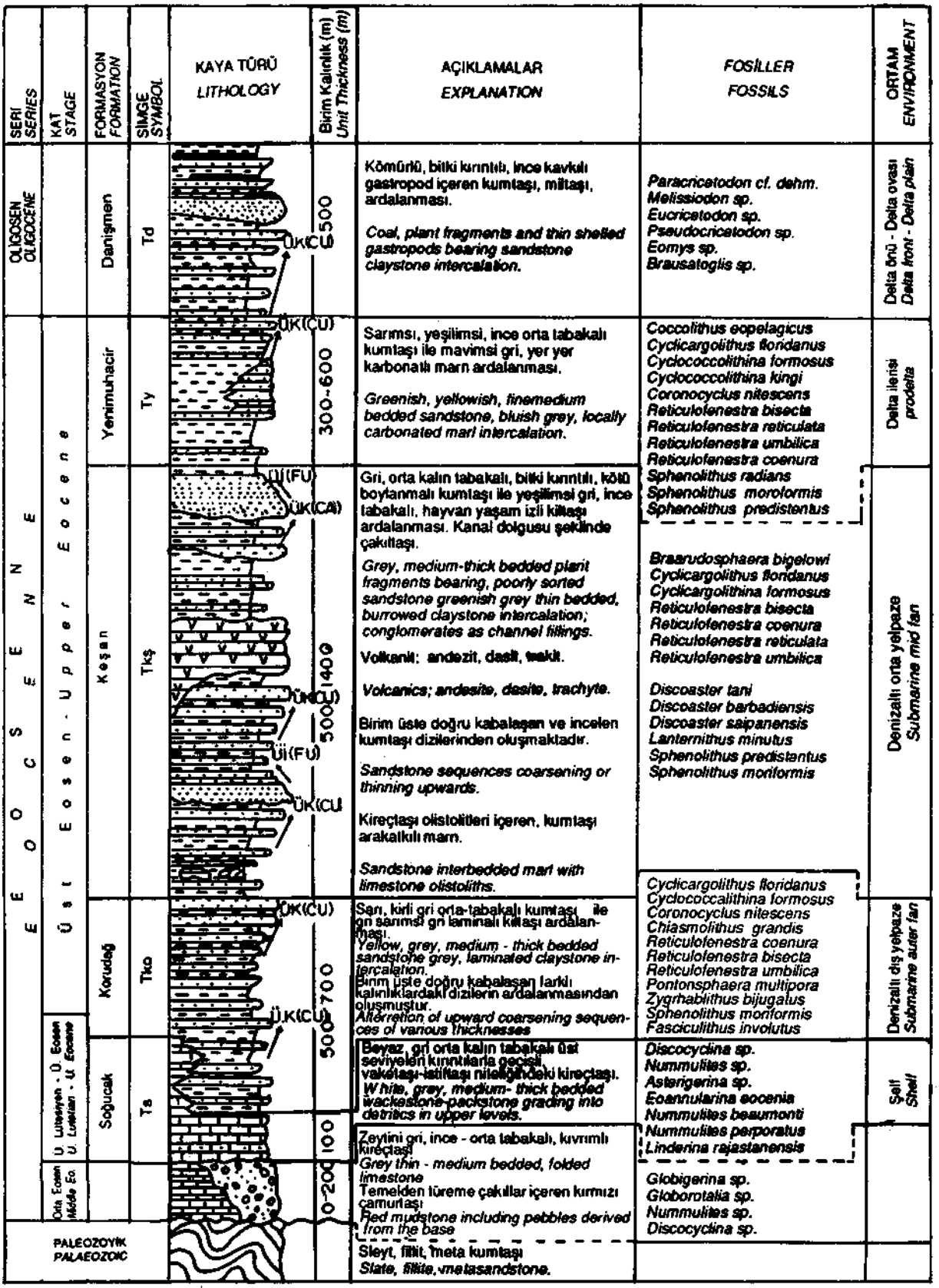

Fig. 4 - Generalized scaled stratigraphic columns of the Eocene sediments in the Korudağ-Keşan region.

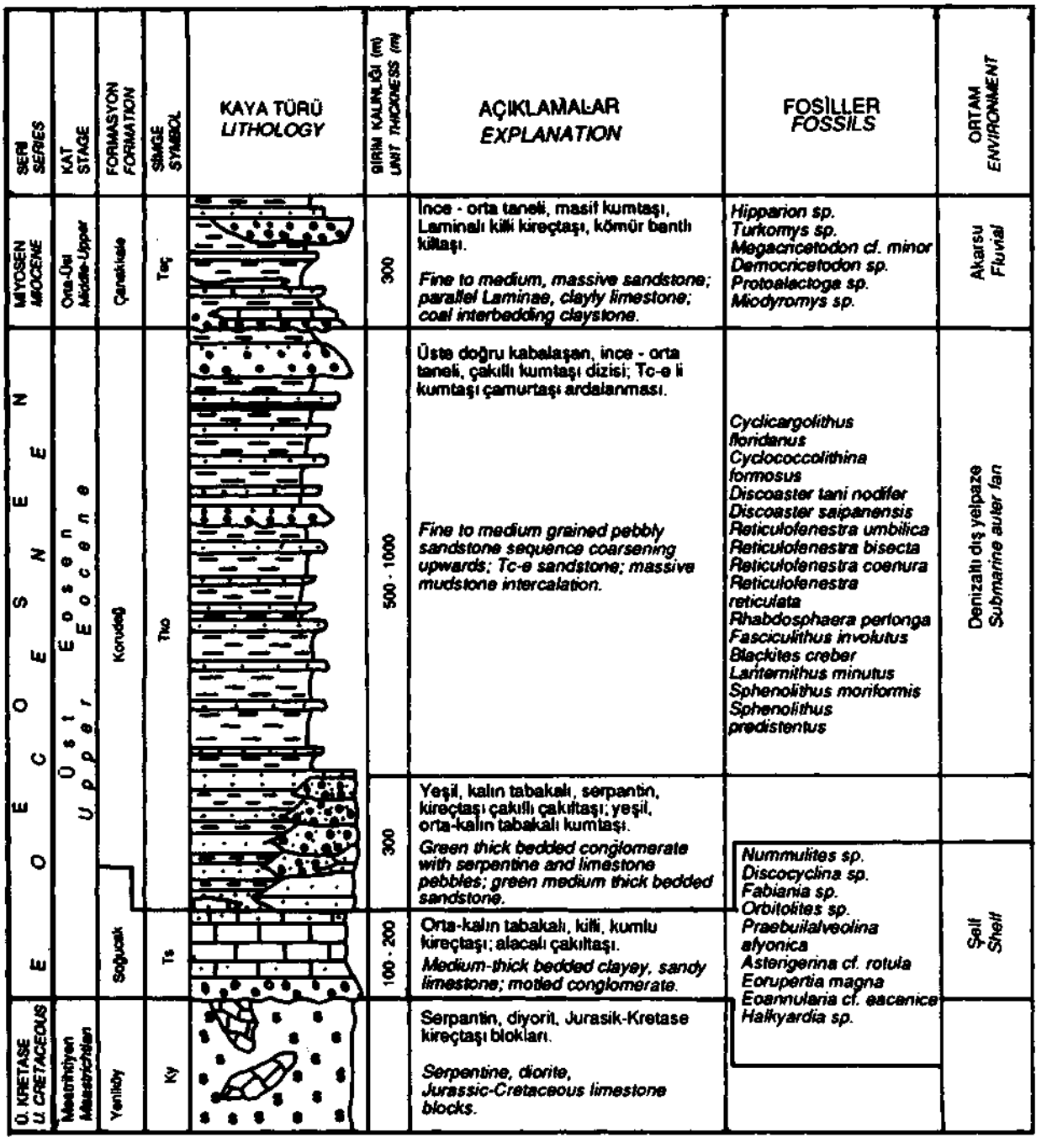

Fig. 5 - Generalized scaled stratigraphic columns of the Eocene sediments in the Şarköy-Mürefte region (South of the Gaziköy-Saroz fault).

Burgaz formation (Tb)

Definition and name. _ This formation consists of carbonate mudstone locally bearing volcanic levels, and unstratified mudstone. Earlier workers have used different names for this unit. It was named "Burgaz formation" by Druit (1961), "Member of Tayfur formation" by Turkse Shell (1969), "Yeniköy formation" by Saltık and Saka (1972), "Burgaz formation" by Kellog (1973), "Küllüdere formation" by Saltık (1975) and "Karaağaç member of Burgaz formation" by Önem (1974). Of these names, "Burgaz formation" was adopted to be used during the present studies.

Type section and type locality. _ Type locality is a small gully situated to the southeastern pan of Ece limanı. Measured type section was made at this locality. Besides, a stream valley to the southeast of Tayfur village, a stream valley through Burgaz village and both sides of the road between Fındıklı village and Kömür limanı are other type localities for this formation.

Distribution and setting. _ The formation occurs widespread particularly around Burgaz and Fındıklı villages (Fig. 2). In addition, it is observed to the southeast of Ece limanı and in the vicinity of Karainebeyli and Tayfur villages.

It grades into the underlying Soğucak formation. The contact between these units is coincident with the site where massive mudstone begins (Fig. 3).

Lithologic features. _ The Burgaz formation from the base up consists of volcanic tuffs, carbonated mudstone, and imbedded mudstone (Fig. 3). The volcanic facies within the formation is divided into two units; thin bedded tuff and unbedded tuff. At the base, a tuff containing a varying size of mud particles, pebbles, and volcanic rock fragments, which are embedded in a fine grained volcanic groundmass occurs. This tuff grades upward either into bedded or imbedded fine grained tuffs. The latter grades upward into carbonated mudstone. The mudstones are thinly bedded, enriched in carbonate exhibit no sedimentary structure and rarely contain thin bedded granular sandstone levels. The carbonate mudstones grade upward into imbedded mudstones. These mudstones are gray, imbedded and contain vertical, and horizontal animal burrows. In addition, they include interbeds of thin to medium bedded, fine grained turbiditic sandstone in the upper sections.

Measured thickness of the formation is 560 m. However, this thickness shows variations. It ranges from 300 to 600 m., depending on basin morphology.

Age. _ On the basis of nannoplanktons identified. Middle Upper Eocene age is assigned to the formation (Fig. 3).

Depositional environment. _ Having regard to the straligraphic position of the Burgaz formation in relation to the other formations, lateral and vertical relations of the facies constituting the formation with each other, and internal structures of the facies, the lithologies that make up the formation are considered to be deposits of deep sea basinal plain.

Gaziköy formation (Tg)

Definition and name. _ This unit consisting of fine grained turbiditic sandstone mudstone and hemipelagic mudstone is described for the first time during the present studies and named the Gaziköy formation.

Type section and type locality. _ This formation is typically exposed along the road of Gaziköy-Uçmakdere and type section was made at this locality.

Distribution and setting. _ The formation crops out over an area including Mürselli, Gaziköy and Uçmakdere villages (Fig. 2). The lower contact relation of the formation is disrupted due to movement of a strike slip fault. Thus, the relation is unclear. Presumably, it unconformably overlies the pre Tertiary units.

Lithologic features. _ The formation displays a regular sequence that consists generally of turbiditic sandstone mudstone and hemipelagic mudstone (Fig. 6). The upper sections contain submarine slump deposits composed of tuff horizons, and volcanic rocks. Sandstone strata laterally show continuity. Its lower contact with turbiditic mudstone and hemipelagic mudstone is sharp and eroded on a small scale, whereas the upper contact is transitive and seldom sharp. Te, Tc-e and Tb-e units are present from sandstone strata, and Tc-e unit is typically observed. Hemipelagic mucstone differs from turbiditic mudstone by having a light color. Individual bed of hemipelagic mudstone begins with a sandy level ranging from 10 to 20 cm. in thickness at the base. It grades upward into silty and clayey horizon rich in carbonate.

Age. _ On the basis of nannoplanktons identified, the formation is of Middle Upper Eocene age (Fig. 6).

Depositional environment. _ The fact that turbiditic sandstones typically include Tc-e units, the proportion of sandstone mudstone is relatively low, turbiditic sandstones are interbedded with hemipelagic mudstones, any regular sequence is absent from facies, strata laterally persist, constantly ramaining in thickness and the formation grades upward into submarine outer fan deposits suggests that the sediments of the formation were deposited in a deep sea basin.

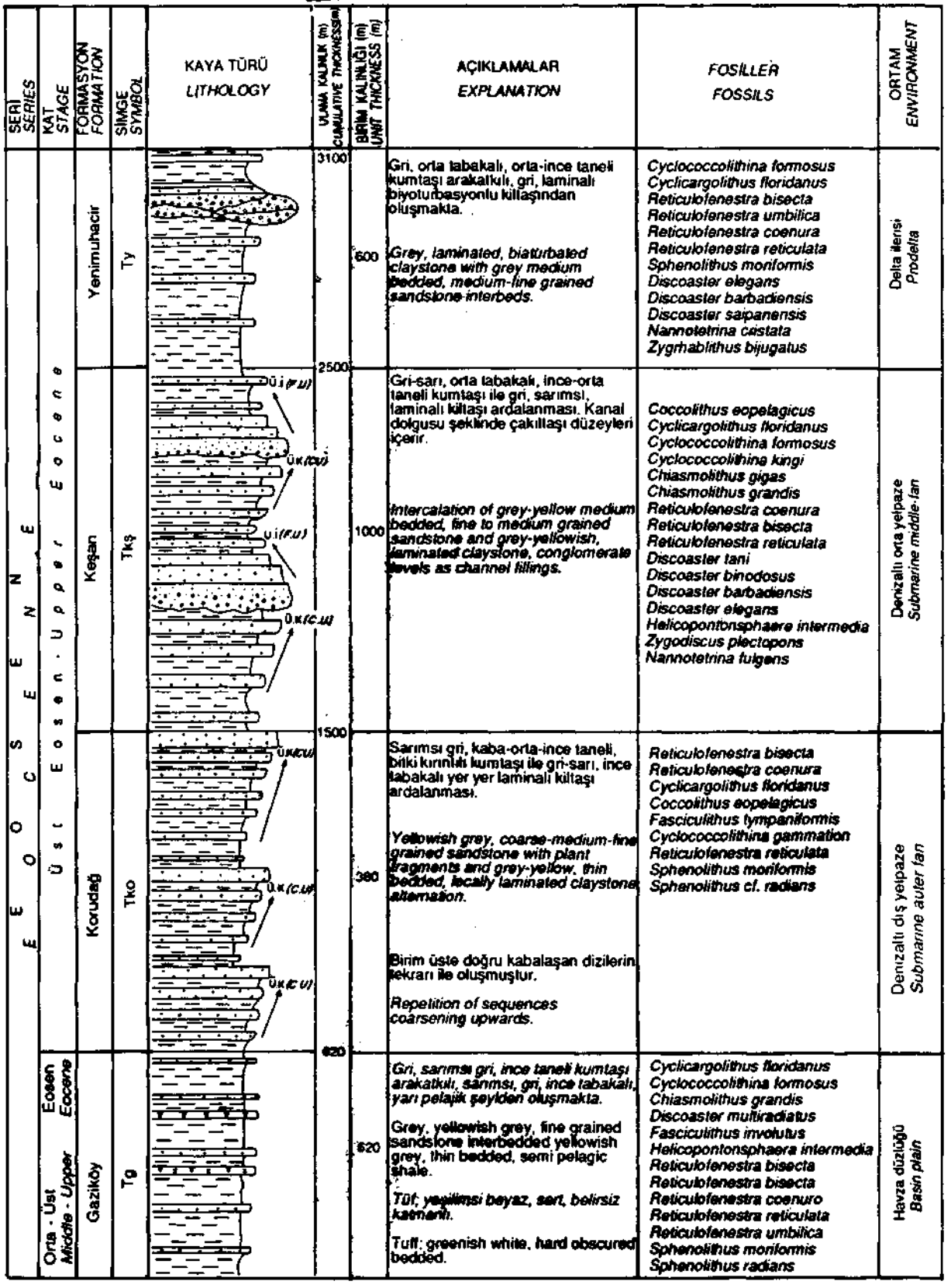

Fig. 6 - Generalized scaled stratigraphic columns of the Eocene sediments in the Işıklar mountain region.

Korudağ formation (Tko)

Definition and name. _ It consists mainly of sandstone, and mudstone and locally intercalations of conglomerate. This unit that occurs over a very extensive area was defined under different names during the earlier studies in the vicinity of Korudağ and Işıılardağ in Gelibolu peninsula. On the other hand, Kellog (1973) called the same unit exposed near Korudağ and Işıklardağ the Korudağ formation. The facies considered to be equivalents to the same unit are named the Korudağ formation by the present writers.

Type section and type locality. _ This formation is typically exposed along the road of Uçmakdere Yeniköy and type section was made at this locality. Besides, the line connecting Ayvasıl stream with Limni stream along the coast and Ece limanı are the other type localities for this formation.

Distribution and setting. _ The formation is exposed within an area including Büyük Kemikburnu, Ece limanı and Küçük Anafartalar from Gelibolu peninsula and around Korudağ and Işıklardağ in the vicinity of Karainebeyli and Yeniköy (Fig. 2).

Lithologic features. „ The Korudağ formation consists of thin bedded, fine grained turbiditic sandstone, and mudstone and moderately to thick bedded, medium to coarse grained sandstone (Fig. 3,4,5, and 6). These two facies are observed as sequences coarsening and thickening upward that developed depending on grain size and thickness of bed in vertical direction.

Each negative sequence begins with fine grained, thin bedded turbiditic sandstone, and mudstone at the base. Tc-e units are well developed within sandstones. This facies grades upward into moderately to thickly bedded, medium to coarse grained sandstone rarely containing pebbles. Ta-b, Ta-c and Ta units are particularly well developed within these sandstone strata. Small scale, and large scale collapse structures, flute casts and groove marks are observed on lower surfaces of sandstone strata.

Age. _ On the basis of identified, nannoplanktons Upper Eocene age is assigned to the formation (Fig. 3,4,5, and 6).

Depositional environment. _ On the basis of its lower and upper contact relations with the other units and sedimentary features of sandstone sequences coarsening and thickening upward, the formation was interpreted to be submarine outer fan deposits.

Keşan formation (Tkş)

Definition and name. _ The formation consists mainly of conglomerate, sandstone as channel fill deposits and massive clayey silty mudstone, and locally of interbeds of tuff. The unit was defined under different names during the earlier studies in the vicinity of Korudağ and Işıklardağ in Gelibolu peninsula. G6k9en (1967) and Kellog (1973) named these units as the Keşan formation during the studies near Korudağ and its surroundings.

Type section and type locality. _ The formation is typically exposed along the road connecting Yeniköy with Mermerköy and type section was made here. Other type localities include neighborhood of B. Kemikburnu from Gelibolu peninsula, shoreline between Dut limanı and Kumbağ near Işıklardağı, and Karanlık dere to the east of Keşan.

Distribution and setting. _ The Keşan formation occurs very widespread as does the Korudağ formation (Fig. 2). It is observed within an area bounded by K. Kemikburnu, B. Kemikburnu and K. Anafartalar and between Karainebeyli and YenikSy in Gelibolu peninsula; near Keşan, Gözsüz, Evreşe, Suluca, Kalealtı, Kanlı, and Karatepe in the vicinity of Korudağ; near Yeniköy, Mermer and Kumbağ in the vicinity of Işıklardağ.

This formation conformably overlies the Korudağ formation and there is a gradual transition between these units (Fig. 3,4, and 6).

Lithologic features. _ The formation is characterized by thinly bedded, fine grained sequence of sandstone, siltstone, and mudstone and sequences of medium to coarse grained, moderately to thickly bedded channel fill sandstone, which fine

upward (positive) and show lateral discontinuities (Fig. 3.4, and 6). Each sequence begins (ascending) with largely eroded surface and overlying massively to weldedly bedded pebble sandstone. This pebble bearing level grades upward into medium to coarse grained, moderately to thickly bedded sandstone. Ta-c, Ta and Ta-b units are well developed in these sandstones. These sequences are overlain by massive mudstones. These sandstone sequences of varying thicknesses are encompassed by a second fades consisting of fine grained sandstone, and siltstone and claystone. The most pronounced features of sandstones within this fades are that they have sharp upper surfaces with current ripples and laterally thin out at a short distance and finally pass into mudstones. Siltstones and claystones are commonly massive and locally display parallel laminations on millimeter to centimeter scale. The formation includes tuffaceous horizons in the vicinity of Keşan.

Age. _ On the basis of nannoplanktons identified, the formation is of Upper Eocene age (Fig. 3,4, and 6).

Depositional environment. _ The fining upward sequences that begin with thickly and weldedly bedded massive pebble sandstones and grade upward into classical turbiditic sandstone, and mudstone are interpreted to be distributive channel fill sediments formed within submarine fan system, whereas coexisting siltstone claystone fades is regarded as intracharmel sediments.

Kanlıbent formation (Tka)

Definition and name. _ While its lowermost sections consist of claystone and siltstone, its uppermost sections consist of alternating sandstone, and conglomerate. This formation that appears confined only to Gelibolu peninsula was named and defined during the present studies.

Type section and type locality. _ The formation is typically exposed along the Kanlıbent stream cut to the east of K. Anafartalar village. Type section was made at this locality.

Distribution and setting. _ The formation is also exposed near Sivli village and its surroundings and between Yeniköy and Kavaklı mahallesi (Fig. 2).

The formation gradually passes into the underlying Keşan formation (Fig. 3).

Lithologicfeatures. _ The formation occurs as a sequence coarsening upward. This sequence (ascending) begins massive mudstone and grades upward into silty sandstone and thickly bedded pebble sandstone (Fig. 3). The uppermost levels of the sequence are overlain by mudstones interbedded with coal bearing horizons. Sandstones are massively bedded and contain abundant plant and leaf remnants, whereas pebble sandstones have eroded lower surfaces and laterally occur as lenticular bodies. Coaliferous horizons 10 to 20 cm. thick are locally found within the formation.

Age. _ On the basis of nannoplanktons identified from samples of mudstone collected from the lower sections of the formation. Upper Eocene age is assigned to the formation (Fig. 3).

Depositional environment. _ Having regard to a change in grain size throughout the sequence (from the base up) from silt to coarse sand (coarsening upward), lateral and vertical stratigraphic relations, sedimentary structures, and geometries of fades, it may be suggested that the sediments making up the formation were deposited in an environment similar to a deltaic environment.

Yenimuhacir formation (Ty)

Definition and name. _ This unit that consists dominantly of claystone, and siltstone and locally of sandstone levels was named the Yenimuhacir formation by Gökçen (1967), Turkse Shell (1972) and Lebkuchner (1974).

Type locality. _ Numbers of measured stratigraphic section was made for this unit during the present studies. However, the Soğukkaynak stream through Yenice village to the north of Işıklardağ, the Kocakirazlık stream near Naipli village and an unnamed stream through Yenimuhacir village can be suggested as type localities.

Distribution and setting. _ The formation crops out to the south of the line connecting Tekirdağ, Malkara and Danınment together and to the north of the line connecting Kumbağ, Mermer and Keşan together (Fig. 2).

The formation conformably overlies the Keşan formation. The boundary between these formations is coincident with the site where massive mudstone begins and was mapped on the basis of this relation (Fig. 4, and 6).

Lithologic features. _ The formation consists commonly of alternating fine grained, thinly bedded sandstone, and massive mudstone and sand to pebble channel fill sediments (Fig. 4, and 6). The sandstones are fine grained and thinly bedded. Their lower surfaces are sharp and upper surfaces include current ripples. Strata are laterally continuous and lenticular in appearance. Small scale cross bedding and rippled lamination are common within the sandstones. Conversely, sandstones are also found as thinly bedded sequences that thicken upward in places. Channel fill pebble sandstones that have eroded lower surfaces and laterally extend as lenticular bodies are observed either as individual beds or as occurring in the uppermost levels of sandstone sequences that thicken upward. These levels include leaf remnants and lamellibranch shells.

Age. _ On the basis of narmoplanktons identified, the formation is of Upper Eocene age (Fig. 4, and 6).

Depositional environment. _ Because of the fact that it is bounded by submarine fan (middle fan) deposits at the bottom and by river and deltaic plain deposits at the top and of internal structures of facies, the formation is interpreted to be deltaic deposits (developed forward from delta and on slope).

Armuttepe formation (Ta)

Definition and name. _ The formation consists of green siltstone, sandstone and pebble to sand channel fill deposits. It was named and described for the first lime during the present studies.

Type section and type locality. _ The formation is typically exposed along the line extending from Kanlıbent stream to Armuttepe and type section was made at this locality.

Distribution and setting. _ Outcrops of the formation are not common. It appears confined only to small areas near K. Kemikburnu, Armuttepe and Sivli in Gelibolu peninsula (Fig. 2).

The formation gradually passes into the underlying Kanlıbent formation (Fig. 3).

Lithologic features. _ The formation consists mainly of conglomerate, sandstone, siltstone and mudstone (Fig. 3). The most prominent feature of the formation is that it comprises the sequences of the above lithologies of varying thicknesses which become thin bedded and fine upward. Each sequence is bounded by eroded lower surface overlain by conglomeratic level that laterally shows discontinuity. This pebble bearing level in turn grades upward into the coarse to very coarse grained sandstone with large scale cross bedding, medium grained, horizontally bedded sandstone, fine to very fine grained, thin silty sandstone displaying parallel and cross lamination, and finally imbedded mudstone, and siltstone. These sequences are overlain and underlain by red, green and brown siltstone, and mudslone horizons. The latter includes calcium carbonate concretions of varying size, oxidized surfaces and common animal burrows.

Age. _ Because no fossil evidence is available, the formation has been dated on the basis of straligraphic relations. The formation conformably overlies the Eocene Kanlıbent formation everywhere in the study area. On the other hand, it is overlain by Middle Miocene Çanakkale formation with angular unconformity. These relations suggest that the formation is of Upper Eocene-Oligocene (?) age (Fig. 3).

Depositional environment. _ On the basis of lithologic, paleontological evidence and many other features (concretions composed of calcium carbonate, desiccation cracks, etc.), it is suggested that the formation was deposited in an alluvial environment.

CONCLUSIONS

The following conclusions were drawn from the present stratigraphic studies;

1 - As a result of the studies, the detailed stratigraphy of Eocene units was defined, applicable to the southwestern Thrace.

2 - The stratigraphic nomenclatures suggested by earlier workers comply with the rules.

3 - The Koyun limanı, Gaziköy, Kanlıbent and Armuttepe formations were named, defined and mapped for the first rime by the present authors.

4 - An exposure of Lower Eocene (Cuisian) limestone was recognized at the base of the Karaağaç limanı formation.

5 - The ages of the formations were discussed in detail and documented on the basis of identified fossil evidence.

6 - Although the Keşan, Yenimuhacir and Kanlıbent formations were previously considered to be of Oligocene age by Kellog (1973) and Önem (1974), the present studies suggest that they are all of Upper Eocene age.

7 - The presence of two transgressive episodes that occurred during the Eocene was recognized.

8 - The lithologic features, sedimentary structures, fossils and geometries of the formations were studied in detail and their depositional environments were defined on the basis of certain data.

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