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Tectono-Stratigraphic Outline of the Burdur-Isparta Area (Western Taurides, Turkey)

İsparta ve Burdur Dolaylarının Tektono-Stratigrafik Özellikleri (GB Türkiye)

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Abstract

The aim of this paper is to investigate the tectono-stratigraphic characteristics and the geologic evolution of the southern Taurides orogenic belt in Southwestern Turkey. The rock stratigraphic units in the study area are divided into autochthonous and allochthonous categories. The Cretaceous carbonate sequence is the oldest autochthonous unit in the region consisting of two units from bottom to top: (1) Söbüdağ

Formation (Cenomanian-Turonian), and (2) Senirce Formation (middle Maastrichtian). All Cretaceous rock units are overlain unconformably by the Lower Tertiary detritic sediments divided into two units from bottom to top: (1) Kmlkirma Formation is Upper Paleocene-Lower Eocene in age and, (2) The Kayıköy Formation is Middle Eocene in age. Other Tertiary sediments are formed following Formations: (3) Yazir Formation (Aquitanian), (4) Ağlasun Formation (Burdigalian), (5) Gönen Formation (Middle-Upper Miocene), (6) Burdur Formation (Upper Miocene-Pliocene), (7) Gölcük Formation (Pliocene), (8) Karaçal Formation (Quaternary), (9) Yakaköy travertine (Quaternary). The Quaternary alluvium and alluvial-fan deposits are the overlag assemblage in the study area. The Gölcük Formation consists of volcanics of late Miocene to Early Pliocene age. The Internal Taurus Nappe is the allochthonous unit in this region consisting of two units: The Gökçebağ ophiolitic melange and The Akdağ limestone unit. These allochthonous units were primarily emplaced during Late Cretaceous to early Paleocene period.

Öz

Bu yazının amacı, Güneybatı Türkiye'de Güney Toros Orojenik kuşağının jeolojik evrimi ve bölgenintektono-stratigrafik özelliklerinin incelenmesidir. İncelenen alanın stratigrafik birimleri, otokton ve allokton kökenli olmak üzere başlıca iki gruba ayrılabilir. Otokton birimlerin en yaşlısı Kretase yaşlı karbonat istifidir ve bunlar en alttan üste doğru başlıca ikiye ayrılır. (1) Söbüdağ fin (Senamoniven-Türoniyen), (2) Senirce fim (Orta Maastrihtiyen). Tüm Kretase yaşlı kayabirimleri, uyumsuz olarak Alt Tersiyer yaşlı detriîik sedimentlerle örtülmüş olup, bunlar en alttan üste doğru, (1) Kızılkırmafm (Üst Pal eosen-Alt Eosen) , (2) Kayıöyfm (Orta Eosen) dir. Diğer Tersiyer yaşlı sedimentler ise aşağıdaki formasyonlardan oluşmuşlardır. (3) Yazırfin (Akitaniyen), (4) Ağlasun fin (Burdigaliyen), (5) Gönen fin (Orta-Üst Miyosen), (6) Burdur fin (Üst Miyosen-Pliyosen), (7) Gölcük fim (Pliyosen), (8) Karaçal fin (Kuvaterner), (9) Yakaköy Traverteni (Kuvaterner). En üstte ise Kuvaterner yaşlı alüvyonlar ve birikinti konileri yer alır. Volkaniklerden meydana gelen Gölcük formasyonu gec Miyosen-erken Pliyosen yaşlıdır. Bölgenin allokton kökenli kaya birimi olan İç Toros Napı ikiye ayrılır. Bunlar 81) Gökçebağ ofiyolitli melanjı, (2) Akdağ kireçtaşı birimidir. Tüm bu allokton birimler bölgeye ilk kez Kretase-erken Paleosen 'de yerleşmişlerdir.

INTRODUCTION

The study area is located northwest-inner part of İsparta bend. The area is bordered by Isparta-Antalya road to the south, the lake of Burdur to the northwest, Gönen and Atabey towns to the north and Isparta-Konya road to the east (Fig. 1) Previous study in the area and vicinity, include Gutnic and et al. (1979); Dumont et al. (1979); Karaman (1986, 1988, 1990, 1994) and Karaman et al. (1988, 1990); Kazancı and Karaman (1988); Koçyiğit (1982, 1983, 1984); Sarıız (1985); Yalçmkaya et al. (1986); Price and Scott (1989,1991), Şenel (1984). Blumenthal (1947) described the Cretaceous, Eocene and Miocene formations. The detailed map published by

Karaman (1986, 1988, 1990) shows the geological complexity and general stratigraphy of the region. In the study area, the relationship between Tertiary and Cretaceous units are controversial. While some investigaters accept that the boundary is conformable (Saniz, 1985), other consider it as unconformable (Yalçmkaya et al., 1986; Yalçmkaya, 1989; Karaman et al, 1988; Yıldız and Toker, 1991). in addition to these, some studies explained the stratigraphic and tectonic evolution of the region (Blumunthal, 1947; Gutnic et al., 1979; Özgül, 1976; Poisson, 1977; Poisson et al., 1984; Waldron, 1982). The scope of this study is to clarify the general stratigraphy and tectonics. 1/100 000 scale of geological map has been made by using the previous works and new field data which were put on the 1/25 000 scale of topographical maps and 1/35 000 aerial photographs. Stratigraphic, tectonic, petrographic and geochronological studies were also carried out.

STRATIGRAPHY

The rock stratigraphic units in the study area have been divided into autochthonous and allochthonous categories (Fig.2). The autochthonous rocks are represented by Mesozoic and Cenozoic sedimentary sequences. The allochthonous rocks include, ophiolitic melange and deep marine sediments. The Upper Cretaceous rock sequences are the oldest part of the autochthon. These are from bottom to top; (1) Söbüdağ Formation (Cenomanian-Turonian), (2) Senirce Formation (Maastrichtian). These formations are unconformably overlain by the Lower Tertiary deposits, clayey limestones of the Kızılkırma Formation. The Kayıköy Formation conformably overlies the Kızılkırma Formation and consists of deep marine biomicrites, shales and claystones. The Kayıköy Formation is divided into two members namely the Delikarasi and Havdan members (Fig.2). The former is made of mainly limestone while the latter consists of clayey limestone and sandstone. Reefal limestones of the Yazir Formation (Aquitanian) comformable overly the older units. The youngest unit, the Ağlasun Formation (Burdigalian) consists of shale and sandstone. These basement rocks are uncomformably overlain by the Gönen Formation (Middle-Upper Miocene) which consists conglomerate and sandstone. The Gönen Formation and others are overlain by continental-lacustrine sediments including, a) Upper Miocene-Pliocene Burdur Formation, b) Upper Miocerfe-Pliocene Gölcük Formation, c) Quaternary Karaçal Formation and d) Quaternary travertines and alluviums (Fig.2). The Burdur Formation was deposited in a graben the Upper Miocene-Pliocene. It comprises pebblestones, sandstones, claystones, marls, mudstones and tuffites in marginal lacustrine and offshore lacustrine facies associations. The Burdur lacustrine formation rests unconformably on older formations The Gölcük Formation comprises from the Gölcük volcanic rocks. Gölcük volcanism evolved in two different stages: Early volcanic stage (andesitic member) and late volcanic stage (tüff, tüffite and pumice of Gölcük Formation). The allochthonous rocks are represented by the Internal Taurus nappe divided mainly into two units, the Gökçebağ ophiolitic melange and Akdağ limestone (Fig.2). Description of these rock-stratigraphic units and their characteristics will be given below.

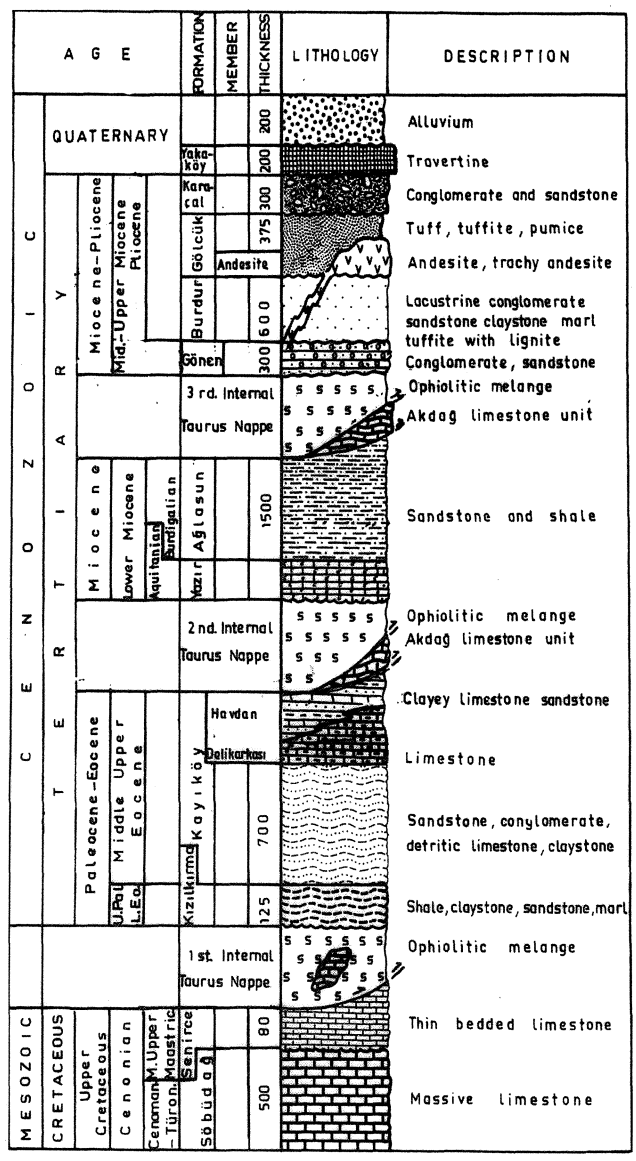

***Figure** 2: The tectono-stratigraphic columnar section of the study area (not to scale).*

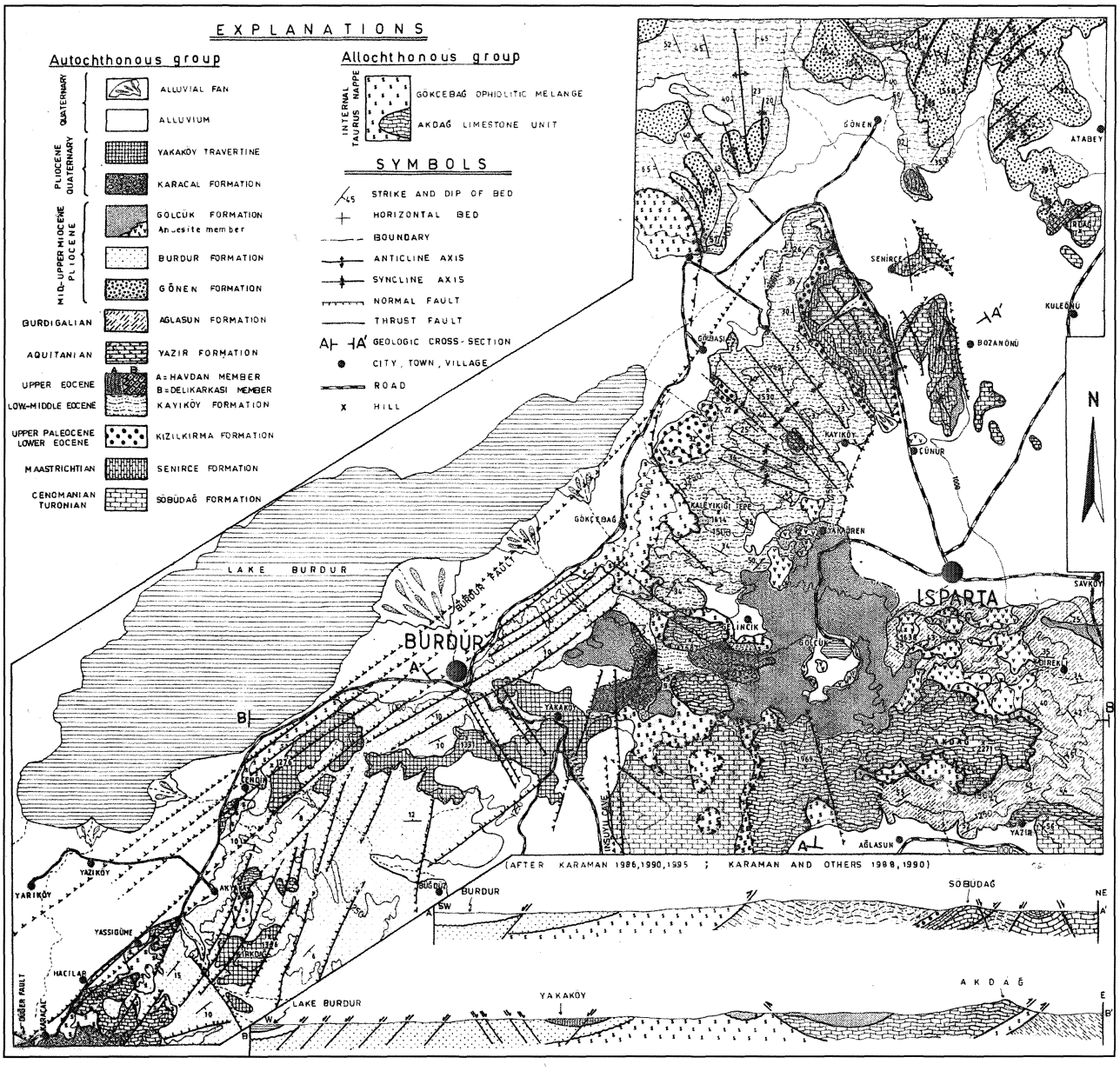

Figure 1: Location map of the investigated area at the southwestern Turkey

AUTOCHTHONOUS UNITS

Söbüdağ Formation: Söbüdağ Formation was named by Karaman (1995). The name of the unit has been taken from the Söbüdağ hill where it exposes well.(Fig.l). It crops out around the Söbüdağ Hill, Senirce willage in the north, Insuyu cave and Yazir village in the south (Fig.3). It consists of of light and dark grey or cream, thick beddied to massive, locally medium bedded and fractured limestone. The bottom of the Söbüdağ Formation is not exposed in the area (Fig.2, 3). Hence, its bottom the stratigraphic relation with the older formation is not known. The thickness of the formation is about 500 m. It is unconformably overlain by the Senirce Formation (Fig.2). The following microfossils have been identified: *Triloculina* sp., *Quinqueloculina* sp., *Pseudolituonella reicheli* Marie, *Cuneolina* sp., *Nezzazata* sp., *Nummoloculina* sp.,Textulariidae, Miliolidae. According to these microfossils the age of Söbüdağ Formation is **Cenomanian-Tu.onian (Upper Cretaceous).** It can be correlated with the Davraz Limestone (Akbulut, 1980), Beydağları unit (Gutnic et all, 1979; Poisson et al, 1984; Şenel, 1984; Yalçmkaya et al., 1986)

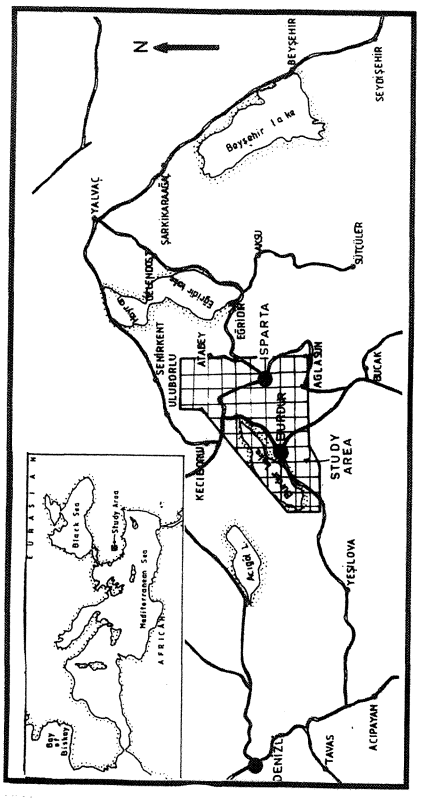

Figure 3: The geological map and the cross-sections of the investigated area.

Senirce Formation: Senirce Formation was named by Karaman (1995). The name of the unit has been taken from Senirce village which is situated in the northern part of the area (Fig.l). This formation crops out.extensively on the southwestern slopes of the Söbüdağ hill. It can be observed around Senirce, Bozanönü villages and Söbüdağ hill (Fig.3). The Senirce Formation is generally represented by light cream coloured pelagic biomicritic limestones with Globotruncana. Higher • on the section, limestone includes chert and clay. The thickness of the formation is approximately 80 m. The limestone could be divided into three units according to Görmüş and Karaman (1992). These are from the base to top: 1) Grey coloured limestones just above the contact with the Söbüdağ Formation. These biomicritic limestones are thin to medium bedded, with turbiditic levels and silicified layers. 2) Red-coloured limestones occur toward the Tertiary boundary, where they are about 4 m. thick and have planktonic fauna. The limestones have also microfissures. 3) Grey coloured limestones form the top of the Senirce Formation. Bedding thickness changes from 5 to 50 cm. The ratio of the fassil occurences increase up to 30 %. Both base and top contacts of the formation are unconformable (Fig.2). Benthic foraminifera occur within the turbiditic levels The foraminifera within the turbiditic levels are: *Quinqueloculine sp., Orbitoides cfmedius* (d'Archiac), *Orbitoides apiculatus* Schlumberger, *Omphalocyclus macroporus* Lamarck, *Helenocyclina beotica* Reichel, *Lepidorbitoides sp.*, *Sulcoperculina globosa* de Cizancourt, *Sulcoperculina vermuntu* (Thaidens), *Siderolites calcitrapoides* Lamarck, Miliolidae, Algal fragments can also be seen (Görmüş and Karaman, 1992). Planktonic foraminifera occur within the micritic limestones. *Globotruncana area* (Cushman), *G. gagnebini* Tilev, *Globotruncanita stuarti* (de Lapparent), *Glc. stuartiformis* (Dalbiez), *Ganserina ganseri* (Bolli), *Globotruncanella* sp., *Globigerinelloides* sp., *Hedbergella* sp., *Rugoglobigerina* sp., *Heterohelix* sp., and *Pseudotextularia* sp. have been identified giving **Maastrichtian** (Probably Middle-Upper) **(Upper Cretaceous)** age. The fossil content, the micritic lithological characteristics, chert layers and the pelagic fauna of the Senirce Formation indicate relatively deep water conditions. It can be correlated with the Seyrekler member of the Davraz limestone (Yalçmkaya, 1989) and Çiğdemtepe formation (Koçyiğit, 1982).

Kızılkırma Formation: This formation was named for the first time by Karaman et al. (1988). This unit covers a small area and crops out in the southwestern slope of the Söbüdağ hill (Fig.2). The Kızılkırma Formation 125 m thick is generally represented by red -coloured clayey limestone, clay, mudstone, marl and rhytmically deposited sandstones having lateral and vertical facies changes. This formation is located on top of the Mesozoic carbonate platform and forms a key interval in the Western Taurides. The formation has a parallel unconformity relation with the underlying Senirce Formation. The Kayıköy Formation conformably overlies this formation (Fig.2). Benthic foraminifera are predominant fauna within the sandstones while planktic foraminifera are predominant within the mudstones. Biomicritic lithology composition and pelagic fauna content indicate an open shelf environment. Fauna and lithology of the formation are summarizied from base to top (Görmüş and Karaman 1992): 1) Red coloured clayey limestones: The Tertiary sequence starts with this level (35 cm thick) with planktic fossils. 2) Red coloured mudstones (3.5 m. thick). The bedding can not be distinguished. The mudstones have microfissures developed parallel to bedding. The rhytmic silicified and calcareous laminations have abondant globigerinids. The fossil content locally is as high as 40-50 %. 3) Rhtymically deposited sandstones-mudstones with sandstones increasing towards the top of the Kızılkırma Formation. The sandstones are grey and yellowish grey in colour, and have locally fine grading, well sorting but are occasionally poorly sorted. Thickness of bedding changes from 10 cm to 30 cm. Sandstones include benthic and planktic foraminifera. Samples collected from the southwest of the Söbüdağ hill have yielded benthic foraminifers such as *Alveolina (Glomalveolina)* sp., *Nummulites* sp., *Assilina* sp., *Miscellanea* cf. *prirnative* Rahaghi, *Keramosphaera* sp., *Rotalia* sp., *Kathina* sp., *Planorbulina cretae* (Marsson), *Discocyclina* sp., *Asterigerina* sp., Textulariidae; Planctic foraminifers such as *Globigerina triloculinoides* Plummer, *Morozovella aragonensis* (Nutall), M cf. *formosa formosa* (Bolli), M. *formosa gracilis* (Bolli) M. *lensiformis* (Subbotina), *Acarinina* soldadoensis soldadoensis (Brönnimann), A. Bulbrooki (Bolli), *Globorotalia* sp., *Truncorotaloides* sp., *Planorotaloides* sp.: Algal such as *Distichoplax biserialis* (Dietrich) and *Ethelia alba* (Pfender), which indicate **Upper Paleocene-Lower Eocene** age (Karaman et al. 1988). This formation may be correlated with the Yukantirtar formation (Koçyiğit, 1983), Yavuzlar formation (Saniz, 1985), Kabaktepe formation (Yalçmkaya, 1989) in a large area around İsparta and Burdur.

Kayıköy Formation: Karaman et al. (1988) named this formation from outcrop localites in Kayıköy village, in the northwest of İsparta (Fig.3). The Kayıköy Formation is represented by marine conglomerate, sandstone, claystone, marl and detritic limestone deposited in a flysch basin. There are lateral and vertical facies changes, this formation is overlain by the Söbüoağ Formation of Upper Cretaceous age along the Isparta-Çünür high road (Fig. 3). It has been divided into two members, the Delikarasi member consists of limestone, and the Havdan member consists of clayey limestone and samdstone (Fig.2). The thickness of this formation is about 700 m. They have lateral and vertical facies changes. The base of the formation is concordant with the Kızılkırma Formation while the top is concordant with the Delikarasi member of Upper Eocene age (Fig.2). The following microfossils have been obtained from the Kayıköy Formation: Benthic foraminifers *Alveolina* sp., *Nummulites* sp., *Assilina* sp., *Discocyclina* sp., *Actinocyclina* sp., *Miliolidae;* Planktic foraminifers *Morozovella* cf. *lehneri* (Cushman and Jarvis), *M.ct quetra* (Bolli), *Acarinina* cf. *brodermanni* (Cushman and Bermudez), A *mathewsae Blow.* Turborotalia cf. *rohri* (Brönnimann and Bermudez), *Hantkenina* sp., *Ps eudohas tigering* sp., *Orbulinoides* sp., *Planorotalides* sp. According to these microfossils the age of Kayıköy Formation is **Middle Eocene** age. It may be corelated with the Dereköy formation (Saniz, 1985), Gölbaşı formation (Karaman, 1986), Yavuzlar formation (Yalçmkaya, 1986) and Taşkapı formation (Yalçmkaya, 1989).

Delikarasi Member: The name of the member is first used by Karaman et al. (1988) and is taken from the Delikarasi hill which is located to the north of Kuleönü village (Fig.2). This member is mainly composed of light yellow, cream coloured limestones that are rich in microfossils. It is 75 m. thick. The base of the member is lateral changes and concordantly followed with the Kayıköy Formation while the top is lateral and vertical changes followed by the Havdan member of Upper Eocene age (Fig.3). The following microfossils have been obtained from

the Havdan member: *Triloculina* sp., *Peneroplis* aff. *damesini* Henson, *Rotalia* sp., *Amphistegina* sp., *Halkyardia minima* (Liebus), *Discocyclina* sp., *Textulariidae*, *Miliolidae*, *Alveolinidae*, *Ethelia alba* (Pfender) and Algal. According to these microfossils the age of Delikarasi member is **Upper Eocene (Priabonian)** (Karaman ve diğ. (Sirel and Acar, 1982). This member may be corelated with- the Hüyük formation (Yalçmkaya et al., 1986).

Havdan Member: The name of the member was first used by Karaman et al. (1988) and is taken from Havdan hill Gönen (Fig.3). Havdan member is mainly composed of light yellow, cream coloured mostly clayey-sandy limestone, locally sandstone and conglomerate. The thickness of the member is about 25 m according to field and map data. The base of the member is concordant with the Kayıköy formation while it is top is lateral and vertical followed by the Delikarasi member of Upper Eocene age (Fig.2). The following microfossils have been obtained from the Havdan member: *Rotalia* sp., *Chapmanina gassiensis* (Silvestri), *Silvestriella tedraedra* (Gümbel), *Nummulites* sp., *Operculina* sp., *Heterostegina* sp., *Spiroclypeus* sp., *Globigerina* sp., *Amphistegina* sp., *Planorbulina* sp., *Gypsina* aff. *mastalensis* Bursch, *Discocyclina* sp., *Aktinocyclina* sp., *Textulariidae, Nosariidae* Rotaliidae. Rupertininae, Victoriellinae, Ethelia alba* (Pfender) *Lithothamnium* sp., *Lithophyllum* sp., Algal, bryozoers. According to these microfossils the age of Havdan member is (Rahaghi, 1978; Sirel and Acar, 1982). This member may be correlated Hüyük formation (Yalçmkaya et al., 1986) in the region.

Yazir Formation: Yazir Formation was named by Karaman (1990). The name of the unit has been taken from the Yazir village which is situated southeastern part of the area (Fig.l). It can be only observed around of Yazir village (Fig.3). Yazir formation is generally represented by dark grey coloured reefal limestone with rich macrofossils. This unit includes dark grey-black coloured sandy limestone, thin bedded and laminate clayey limestone, claystone and shale in some place. East of Yazir village, the bottom of the formation has a relation of unconformity with the older formations while it is top is concordantly followed by the Ağlasun Formation of Burdigalian age (Fig.2). The thickness of the formation is between 75-150 m. Within the thin sections of the samples taken from this unit, *Lepidocyclina (eulepidina) favosa* (Cushman), *Lepidocyclina (eulepidina) formosa* (Schlumberger), *Lepidocyclina (eulepidina)* sp., *Lepidocyclina (nephrolepidina) verbeeki* (Newton and Holland), *Lepidocyclyclina (nephrolepidina)* sp., *Miogypsina* sp., *Miogypsinoides complanatus* (Schlumberger), *Operculina complanata* (Defrance), *Amphistegina* sp., *Gypsina* sp., *Globigerina* sp., *Globorotalia* sp., *Acervulinidae, Globigerinidae, Globorotaliidae, Archaeolithothamnium* sp., *Lithophyllum* sp., Algal and Bryozoa have been identified, and the Yaziry Formation has been given to **Aquitanian (L. Miocene)** age. It can be correlated with the Karabayir formation (Poisson, 1977); Atabey fm (Yalçmkaya et al. 1986); İmrezi limestone (Yalçmkaya, 1989) and Yazir limestone (Karaman, 1990) in the region.

Ağlasun Formation: The name of this formation was first used by Yalçmkaya et al. (1986) and is taken near Ağlasun which is located to the south of the region. It widely crops out south of İsparta, east and south of Akdağ mountain (Fig.3). Ağlasun Formation represents a flysch stage and was deposited in a deep basin. It is generally represented by light yellow, brown, grey or greenish coloured marine sandstone and interbedded shale. The sandstones include diverse minerals such as quartz, calcite, chlorite with carbonate matrix. The thickness of this formation is about 1500 m. near Yazir village. The base of the formation is concordant with the Yazir Formation The thickness of the formation approximately 75 m.thick around Yazir (Fig.2). The Ağlasun Formation is tectonically overlain by the 3 rd Internal Taurus Nappe (Fig.2). The following microfossils have been obtained from the lower or middle sections of the Ağlasun Formation: *Lepidocyclina (eulepidina) favosa* (Cushman), *Lepidocyclina (eulepidina) formosa* (Schlumberger), *Lepidocyclina (eulepidina)* sp., *Miogypsina irregularis* (Michelotti), *Miogypsinoides grandipustulus* (Cole), *Miogypsina* cf. *intermedia* (Drooger), *Miolepidocyclina* cf. *burdigalensis* (Cumbel), *Amphistegina* sp., *Operculina complanata* efrance), *Nodosaria* sp., Algal and Bryozoa. According to these microfossils the age of the Ağlasun Formation is Lower **Miocene (Burdigalian)** age. It may be correlated with the Karakuştepe formation (Poisson, 1977); Salur formation (Şenel et al. 1983) in the region.

Gönen Formation: The name of the formation first used in this study and the type locatize is localized near Gönen to the south of the area (Fig.3). The formation consists of a conglomerate, which is a post-orogenic molasse (Karaman et al., 1990). The conglomerates are polygenic in lower and middle parts while they are monogenic and thick bedded in the upper part. All pebbles are well-rounded. The upper most part of this formation is made up of a light coloured, massive and monogenic conglomerates seemed to be a limestone at a further distance. It also contains the intercalation of clay and marl. Gönen Formation has been deposited in a very shallow, technically active marine-continental environment of high energy. At the bottom , it conformably rests on the Kayıköy and other older formations (Fig.3). The lithologic content, the relation of boundary, regional tectonics and post orogenic molasse characteristics of the Gönen Formation indicate the age of is Middle-Upper Miocene. It may be correlated with the Gökdere formation (Yalçmkaya et al. 1986), Gönen conglomerate (Karaman, 1990) in the region.

Burdur Formation: The formation was named by Karaman(1986) and the name was taken Burdur city which is located south of Burdur lake (Fig.l, 3). This unit covers large area. It widely crops out south of Burdur lake, around of Akyaka, Yassıgüme, Çendik Büğdüz village and Burdur city (Fig.3). Burdur Formation is represented by light cream or white coloured well bedded, intercalated lacustrine conglomerate, sandstone, mudstone, claystone, fine marl and tuffite. Coal and gypsum bearing horizons are also found within the lacustrine sediments. These sediments, whose thickness reaches 600 m, started to be deposited in a lacustrine environment developed in the Burdur closed basin. These lacustrine sediments can easily be distinguished from other rock units by their light colours. In the region basin subsidance and deposition of the Burdur Formation began at the start of the Upper Miocene and continued Pliocene time. The Burdur Formation is unconformable on the allochthonous units, including the ophiolitic melanges. It is unconformably overlain by the Gölcük Formation. No diagnostic fossils have been found in this formation within the situated area. But, according to E. Akyol, some pollens and polynomorphs from lignite horizons within the Burdur Formation indicate **Upper Miocene-Pliocene** age to the succession. The Burdur Formation has been described by various authors in the past. Wedding (1966) was the first to study the Neogene of the Burdur region in detail, proposing the first lithostratigraphic sub-division. Wedding and Inque (1967) stated that its deposition occured mainly after the Miocene and continued until the end of the Pliocene. According to Price and Scott (1989), the Burdur Formation can be divided into four facies associations. Each individual member of the formation has sediments representive of one or more of these facies associations as described below: a) Alluvial fan-fluvial facies association, b) Marginal lacustrine facies association, c) Offshore lacustrine facies association, and d) Volcaniclastic facies association. On the other hand, Burdur Formation may be correlated Yankkaya formation (Demirkol, 1984) and Kızılcık formation (Koçyiğit, 1984) at the north of the region.

Gölcük Formation: The formation was named by Karaman, (1990) and is taken from the Gölcük volcanic crater lake in S W of İsparta. It widely crops out between the Akdağ mountain and the Gölcük crater lake. It covers an area of about 75 km^2 (Fig.3). The material of the Gölcük Formation is formed by the activity of the Gölcük volcanism. The Gölcük Formation consists of volcanic and volcanoclastic rocks including tuff, tuffite and pumice. The lower levels of the volcaniclastic sequence are relatively compacted while the upper levels consist of loose tuff and pumice horizons. Total thickness of the Gölcük Formation is approximately 375 m. In some sections, continental tuff were spread as far as 30 kms. away the crater. More ver, some reached as far as the Burdur graben lake, and formed intercalations within the upper levels of the Upper Miocene-Pliocene lacustrine sediments. The widespread occurence of lacustrine tuffite, especially in the upper sections of the Upper Mio-Pliocene lacustrine sediments suggest that the age of the late volcanic stage may be **Upper Miocene-Pliocene (Probably Pliocene).** In summary, continental tuffs around the Gölcük crater were deposited either directly on the lava of the early volcanic stage, or unconformably on the paleotopographic basement of Eocene-Miocene units. Tuff and pyroclastic material deposited in alternation behaved in a fluid-like manner. Observed strata dips are primary and are related to the paleotopograpy on which the tuff were deposited.

Andesite Member: The andesite member is named by Karaman (1990). This unit covers small area and it outcrops around of Gölcük crater lake, Çünür, and between İsparta and Akdağ region (Fig.3). All the outcrops of this member cover an area of about 30 km2 in the region. Although the main volcanic crater was at Gölcük eruptions occured from several marginal craters (Karadağ, Hisar tepe, Karakaya tepe). These craters were probably active during the late Miocene-early Pliocene. These units consist of grey, greenish, yellow or light brownish coloured andesitic-trachytic lava and agglomerate. In thin-section, feldspar amphibole, pyroxene, biotite, sphene, sanidine, and opaque minerals can be identified in the lava. Andesitic-trachytic lavas are calc-alkaline type and they outcrop at Gölcük crater lake and around (Hisar and Karakaya tepe). This member is unconformably overlain by tuff and pumice of the Gölcük Formation (Fig.2). Lefevre et al. (1983) published K-Ar radiometric dates of 4.0 to 4.7 Ma (early Pliocene) for the ignimbrite flows and lavas in the İsparta region. K-Ar dating of biotites from lavas at the volcanic centre (Gölcük lake), which are presumably the oldest lavas to rest upon basement limestones at the caldera edge, give an age of 4.6 Ma+0.2 Ma (Price and Scott, 1989). Therefore, the age of the andesitic lava is Upper Miocene-Pliocene. Volcanism in the Gölcük area was controlled by extensional faults. There are also exposures south of İsparta (Bucak) and north of İsparta (Gönen), These two volcanic crater and Gölcük volcanism located on nearly N-S trending fault on the map. On the other hand, the Gölcük volcanism were proposed maar type by two vorkers in the past (Kazancı and Karaman, 1988 ; Price and Scott, 1989).

Karaçal Formation: The formation was named by Karaman(1986) and the name was taken from the Karaçal village located southwest of the study area (Fig.3). It crops out near Karaçal village and between Yakaköy and Gelincik villages (Fig. 1,3) The Karaçal Formation is dominated by conglomerates and sandstones of alluvial fan-fluvial facies. This formation is a basin-edge facies. The thickness of this formation is nearly 300 m and was deposited during the Quaternary. The basal contact is defined by an unconformity. The upper contact is unconformably overlain by the Yakaköy travertines (Fig 2). No diagnostic fossils have been found in this formation. The lithological characteristics and the contact relationship of the Karaçal Formation suggest a Quaternary age. It may be corelated with Taşyayla formation (Yalçın, 1993); Gökpmar conglomerate (Yalçmkaya, 1986) in the region.

Travertine and Alluvium: The other Quaternary units of the region are marked by the Yakaköy travertine (200 m thick) and alluvium (300 m thick) and alluvial fans. The lower contact of the Yakaköy travertine can be observed at Yakaköy village (Fig 3) where it unconformably overlies the Burdur and Karaçal Formations (Fig 2).

Travertine may be massive or porous. Alluvium is made up of Unconsolidated or lightly cemented gravels, sands, silts, and clays. All these lacustrine-continental sediments are cut by late-stage block-faulting (Karaman, 1986).

ALLOCHTHONOUS GROUP

In the study area, the allochthonous group is named as the Internal Taurus nappe. Internal Taurus nappe was named by Koçyiğit (1984). According to the tectonic emplacement age, there are different units in this nappe based on tectono-stratigraphic correlations. Lithological and other geological characteristics of these units are similar. But they are differentied according to the tectonic emplacement timing (Fig 2). These are:

1 st Internal Taurus Nappe: It crops out around the Insuyu cave (Fig 3) to the south of the study area. It was emplaced during the Late Cretaceous Early Paleocene in the region. ^11 the Cretaceous rocks are tectonically in contact with this nappe south of the study area. This nappe is known Antalya Nappe in southwestern Turkey.

2 nd Internal Taurus Nappe: It outcrops around of Gökçebağ around, north of Gölbaşı and north of Gönen villages. It was emplaced after the Eocene. All the Lower Tertiary rocks are in tectonic contact with this nappe north of the study area.

3 rd Internal Taurus Nappe: It outcrops around the Akdağ mountain and Ağlasun, south of the study area (Fig 3). It was emplaced after the Miocene (Burdigalian). The basal contact is with Burdigalian-aged Ağlasun Formation, south of the study area.

This region has a very complex structure. The time of emplacement age of the 1 st Internal Taurus Nappe (it is known as the Antalya Nappe .in south-western Turkey.) is after Cretaceous (probably upper Cenonian-Danian); After the emplacement, it continued to move, carrying blocks of cover rocks many tens of kilometers.

The 2 nd and 3 rd Int.Taurus nappes are known as the Lycian Nappe. The 2 nd Int Taurus Nappe was emplaced in upper Eocene time (probably Lutetian-Priabonian); the 3 rd Int. Taurus Nappe is Miocene (probably after Burdigalian) (Fig 2, 3).

The Internal Taurus nappe is represented by two units in the s tudy area: (1) Gökçebağ ophiolitic melange, and (2) Akdağ limestone unit. Description of these units and their characteristics follows:

Gökçebağ Ophiolitic Melange: This unit was named by Saniz (1985) from the Gökçebağ village which is situated norhwestern of the area (Fig.2) This unit widely crops out around the Gökçebağ, Yassıgüme, Çendik villages and southern İsparta (Fig,3), The ophiolitic melange consists of blocks of basic and ultrabasic rocks and (serpantinite, radiolarite, peridotite, gabbro, diabase) radiolarite, limestone and sandstone.

The matrix of the melange consist serpentinite, but locally is pelitic such as marl, clay and shale. The serpentinite is highly sheared and brecciated. The larger blocks, mostly limestones are faulted against each other and against the melange matrix but on a large scale are "floating" in the melange. Some limestone blocks are interbedded with radiolarites and cherts indicating Triassic, Jurassic or Cretaceous ages. The contact between the Akdağ limestone and the melange is a fault (Fig 2). This contact is best exposed in the south of the area (Fig 3). Gökçebağ ophiolitic melange rocks were primarily emplaced in the region, during Late Cretaceous to early Paleocene time (Fig 2). But after first emplacement age, depending on the tectonic activity, the Mesozoic, Eocene or Miocene aged rocks in the study area are overthrusted by the ophiolitic melange rocks again. On the other hand, the melange is unconformably overlain by Kayıköy Formation in Eocene age around of Gökçebağ or Burdur Formation in Mio-Pliocene age around of Burdur lake (Fig.3).

Akdağ Limestone Unit: The name of the unit is first used by Karaman (1990) and is taken from the Akdağ mountain in southern İsparta. It crops out around of Akdağ, south of Burdur and north of Gönen (Fig.3). It is represented by light cream and white coloured jointed, thick bedded or locally massive and recrystallized limestone. Some lowermost levels of the formation are made up of dolomites and include reddish coloured limestone, radiolarite and chert. But upwards, limestone has a biomicrite character. The base of the unit has a tectonic boundary with the ophiolitic rocks (Fig.2). The following microfossils have been obtained from this unit: *Involuting sinuosa* sp., *Involuting* sp., *Trocholina permgdie coides* Trochginmina* sp. According to these microfossils the age of this levels is Upper Triassic; *Opthalmidiinge* (Nubeculariidae), *Protopenowplis striatg* (Weynschenk), *Trocholina* sp., *Thgumgtopo'rellg* sp., *Kurnubig* sp., Textulaiidae, Miliolidae. According to these microfossils the age of this levels is Jurassic (Dogger-Malm). On the other hand samples collected from the micritic levels of this unit have been yielded: *Globotruncgng* sp., *Globigerina* sp., *Heterohelix* sp., *Ticinellg* sp., *Hedbergellg* sp.According to these microfossils the age of this levels is Upper Cretaceous. Age of the Akdağ limestone unit, according to all these microfossils giving different levels is Triassic-Jurassic-Cretaceous.

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