

PRE - NEOGENE TECTONOSTRATIGRAPHY OF DİLEK PENINSULA AND THE AREA SURROUNDING SÖKE AND SELÇUK

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ABSTRACT.- At Dilek Peninsula-Söke-Selçuk areas, to the western-southwestern parts of Menderes Massive, structurally related various tectono-stratigraphical units crops out. The sequence commences with the "Dipburun nappe" in the Dilek Peninsula which is probably Jurassic to Late Cretaceous in age and composed of marble, cherty marble and metavolcanites, turbiditic marbles and phyllites depicting a flysch facies. It is overlain by the "Efes nappe" which comprises various schists and marbles of Late Paleozoic-Early Triassic age and metabauxite bearing metacarbonates of Triassic-Late Cretaceous age. Around Söke-Selçuk area, The Efes nappe is tectonically overlain by the "Şirince metaflysch" comprising olistoliths or tectonic slabs of metabasic rocks, metaultrabasic rocks, eclogites, marbles, amphibolites and cherty marbles in a matrix made up of pelitic and basic schists. The Şirince metaflysch is a probable lateral equivalent of the metaflysch forming the upper levels of the Dipburun nappe. Upward, "Akçakonak unit" tectonically overlies the Şirince metaflysch. The Akçakonak unit is the equivalent of Bodrum Nappe which is a part of Lycien Nappes. It consists of metadetritics of Early-Middle Triassic age, in its lower levels and carbonates of Middle Triassic-Cenonian age in its upper levels. It is overlain by the "Izmir flysch" which is olistostromal in parts. The Izmir flysch is presented over the Efes nappe and also over and under the Akçakonak unit as tectonic slabs. All of these units are overlain unconformably by the Early Miocene-Quaternary aged formations.

Key words: Dilek Peninsula, metavolcanites, gneissic schists, metabauxit, metaflysch.

INTRODUCTION

It has been reported that the Menderes Massif, which has previously been identified in general as a "monotonous" sequence from Precambrian to Early Tertiary, is comprised of different tectonostratigraphic rock units which are overlain by various sequences of the allochthonous Lycian nappes in Dilek peninsula and surrounding region of the western Anatolia in the recent studies (related literature in the reference list). In order to differentiate the various rock units included in the Menderes Massif in Dilek Peninsula, Söke, Ortaklar, Kuşadası and Selçuk regions, 1/25 000 scale detailed geological mapping, revision, correlation and compilation studies were realized between the years 1992 - 1996 (Figure 1a). Consequently, the 1/25 000 scale map sheets of L18-c3, c4, d3 and M18-a1, a2, a3, c1, d1, d2 have completely and the sheets of M18-c2 and d3 were partially mapped in this study. The

others map sheets of the region, on the other hand, have been revised and the whole work has been compiled together under the same legend.

The Neogene - Quaternary units in the study area are simplified after Göktaş (1998) (Figure 1a and 1b) and "Kösele formation - Söke formation - Dedeğaç formation - Kuşadası formation" have been defined as Neogene deposits (Nç); "Savulca formation - Ortaklar formation - Yamaçköy formation" have been defined as Plio-Quaternary units (PIQb) in the content of "Büyük Menderes Group". "Balatçık" (Nbv) and "Hisar-tepe Volcanics" as (Nhv)] are the Neogene volcanic units of the region.

The metabauxites which are used among the data for structural differentiation, have been known since Önay (1949) and Wippert (1963) studies in the region.

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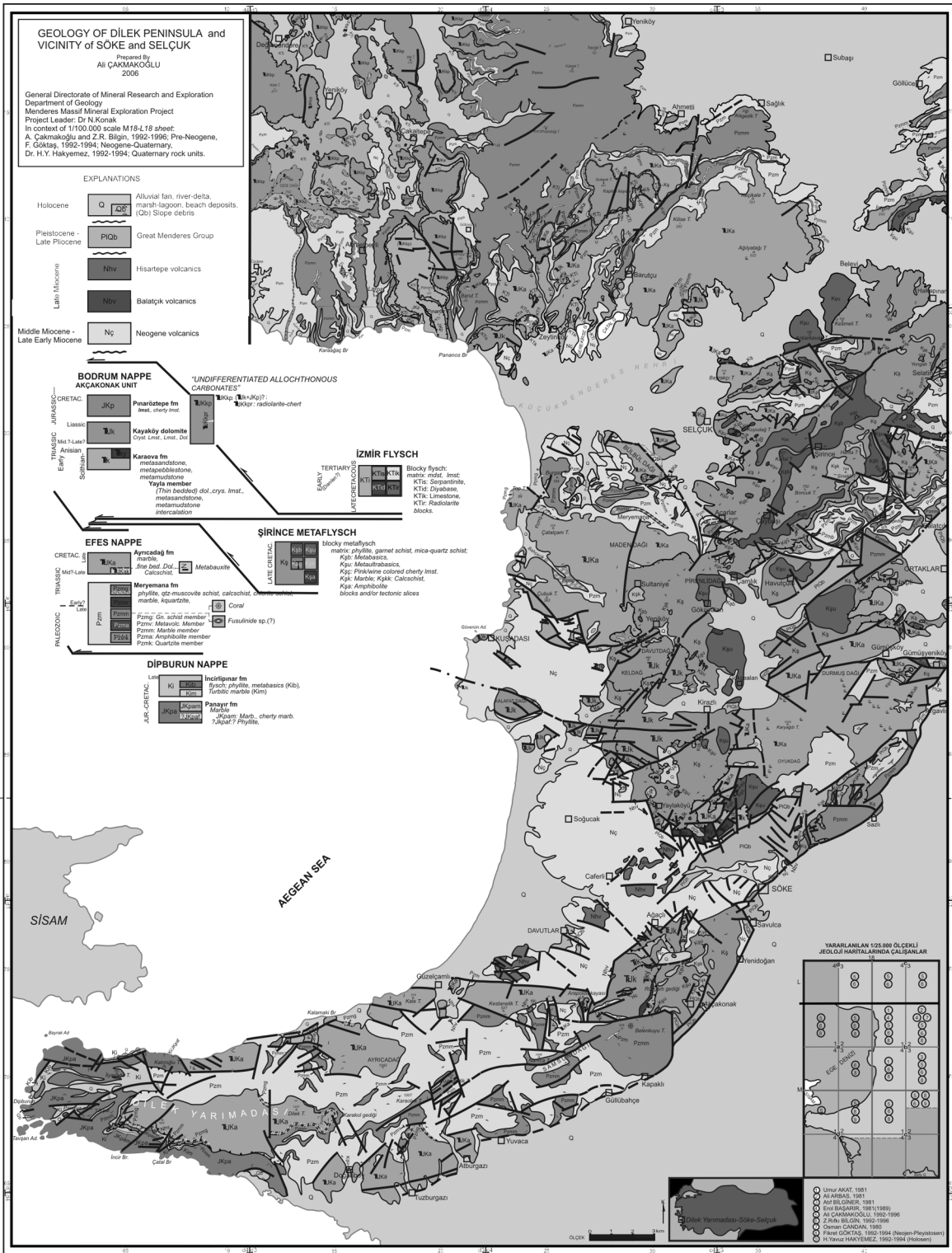


Figure 1a- Geological map of the region around Dilek Peninsula, Söke and Selçuk

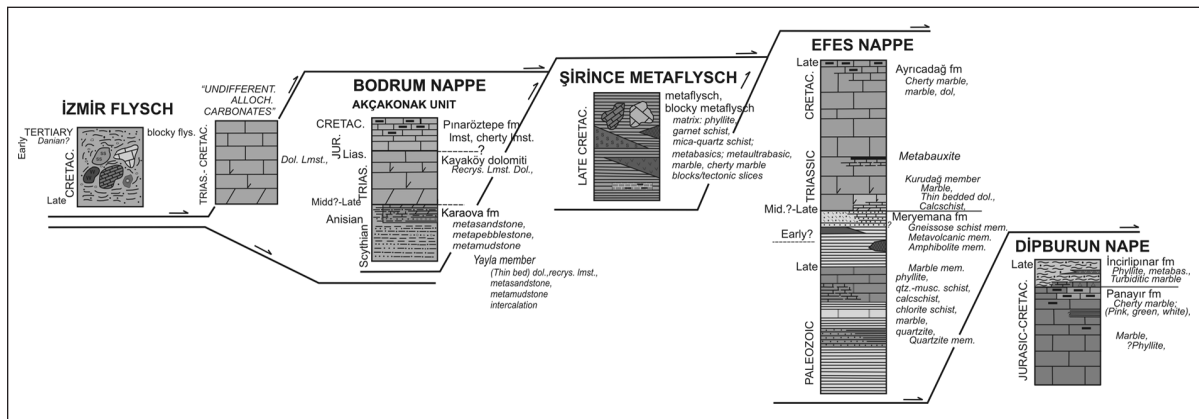


Figure 1b- Pre-Neogene tectonostratigraphic units in the study area

The studies in Menderes Massif can be dated back to 1840s; in the study area, however, geological mapping and structural - stratigraphic studies have begun in 1980s. In this study, some previous studies have been used for the discussion and evaluation of the units.

STRATIGRAPHY

The pre-Neogene rock units that have tectonic relations with each other are located as, from bottom to top, Dipburun nappe, Efes nappe, Şirince metaflysch, Bodrum nappe and İzmir flysch. Of these units, the "Dipburun nappe" is defined for the first time and its basement can not be observed in the study area. This nappe is comprised of marble, cherty marble and metavolcanics, turbiditic marble and phyllites in flysch facies and its probable age is Jurassic - Late Cretaceous. Dipburun nappe is tectonically overlain by the Efes nappe which comprises Paleozoic - Early Triassic (?) schists, marbles and Triassic - Late Cretaceous metacarbonates including metabauxite. The "Şirince metaflysch" which is tectonically located on higher levels has the characteristics of a "metaolisthostrome" with a pelitic and basic origin matrix. It contains metabasites, ultrametabasites, eclogite, marble, amphibolite and cherty marbles at various scales of blocks and/or tectonic slices. The "Akçakonak unit", one of the "Bodrum nappe" units, is tectoni-

cally located at the top. The unit is formed by Early - Middle Triassic metaclastics at the bottom and by Middle Triassic - Cenonian carbonates at the top. It is tectonically covered by olisthostromal Late Cretaceous - Early Tertiary (Danian?) "İzmir flysch" in places and moreover, interfingering as tectonic slices, The İzmir flysch overlies the Efes nappe with a tectonic contact. All of these tectonostratigraphic units are overlain by Early Miocene deposits with an angular unconformity.

DİPBURUN NAPPE

The Dipburun nappe, which is in general represented by metacarbonates (Panayır formation) at the bottom and by metaflysch (İncirliçinar formation) at the top, is observed to the west of the Dilek Peninsula. It is Jurassic - Late Cretaceous in age and the lowest observable tectonostratigraphic unit of the study area. It is partly similar to the Middle - Upper Mesozoic units of the Efes nappe and is the possible extension of the "Kerketefs unit" on the Samos Island (Papanikolaou, 1979) or "Kerketas nappe" itself (Ring et al. 1999) (Figure 2).

Panayır formation (JKpa)

This unit which is comprised of marbles and cherty marbles, is differentiated as "Panayır for-

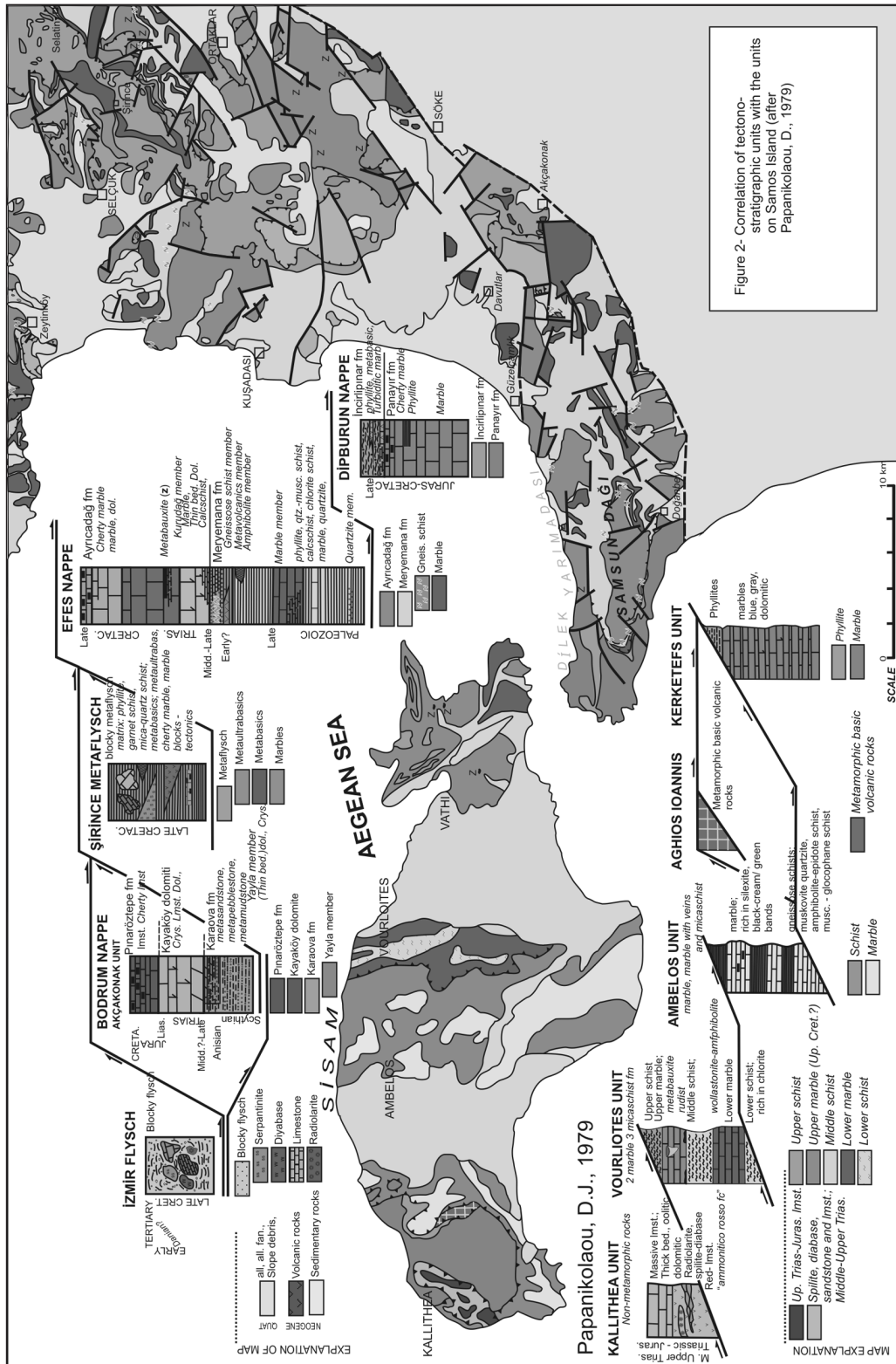


Figure 2- Correlation of the tectono-stratigraphic units with that of Samos Island (data for the Samos Island, after Papanikolaou, 1979)

mation". The medium to thick bedded marbles are dark gray, gray, bluish gray with light gray laminations, having thin to medium crystals. Towards the upper levels of the sections, local calcschist and phyllite lenses and pinkish - brown, beige colored, 1 -15 cm thick chert bands are observed. Dark green, brownish / grayish "phyllites" and yellowish Brown "calcschists" (JKpaf) are very similar to the phyllites and calcschists of the İncirliipınar formation, located at the topmost levels of the nappe (Figure 1b). Besides, the chert banded, pinkish beige / white, light wine colored marbles having thin to medium crystals and brownish yellow / pink colored calcschists are differentiated as "Pink Marble Unit" (JKpam) (Figure 1b).

The Panayır formation is 400 m thick in the study area. The marbles contained in the Kerketefs unit are reported to be at least 1000 m thick on the Samos Island (Papanikolaou, 1979).

No fossils were detected in the formation. Ring et al. (1999) reports that the Kerketas nappe is of post-Carboniferous age and ends up with a Eocene flysch. However, considering the correlative Cenonian age of the overlying İncirliipınar formation, the unit can be dated as Jurassic - Cretaceous.

İncirliipınar formation (Ki)

This is a flysch - like unit composed of phyllites and is differentiated as "İncirliipınarı formation". The formation is comprised of dark / light green, brownish beige, bluish gray colored phyllites, yellowish / pinkish, brown colored calcschists and a few m thick, green, brownish green colored metabasics and turbiditic, chert banded and clastic marbles (Figure 1b). Pinkish white, wine colored marble, cherty marble and chert banded turbiditic marbles (Kim) with marble pebbles resemble to the Campanian - Maestrichtian micritic, turbiditic limestones that are frequently observed in the western Anatolia.

A dark green, greenish -redish brown metabasic lens (Kib) of almost 4 m thick between calcschist and cherty marbles is differentiated (Figure 1b). Candan et al. (1997) discussed the presence of a "relicts of blueschist" and "glocophane + crossite paragenesis" in the extensional area of the formation which the metabasic lens (Kib) possibly reflects the same blueschist facies conditions in the study area.

No fossils were detected in the formation and based on the rock type, facies and correlations, the formation is presumed to be of Cenonian age.

EFES NAPPE

The Efes nappe which is comprised of Late Paleozoic - Early Triassic (*) schists and marbles at the bottom and Mesozoic metacarbonates at the top tectonically overlies the Dipburun nappe. Efes nappe, on the other hand, is tectonically overlain at different localities in the study area by Bodrum nappe (Şenel, 1997c); Şirince metaflysch (Çakmakoğlu, 2005a, b); İzmir flysch (Öngür, 1972; Eşder, 1988) or "undifferentiated allochthonous carbonates" (Figure 1b). The unit probably is the stratigraphical equivalent of the "Vourliotes unit" and partly "Ambelos unit" (Papanikolaou, 1979) on the Samos island. The overlain Late Paleozoic - Early Triassic (?) metamorphics and the overlying Mesozoic metacarbonates are differentiated as Meryemana and Ayrıcadağ formations, respectively.

Meryemana formation (Pzm)

This unit, comprised of schist, marble and quartzites and metavolcanics and gneissose schist lenses at the upper levels, is differentiated as "Meryemana formation". In the previous studies, Meryemana formation has been defined as Bafa formation (Akat, 1980) and Bayındır formation (Erdoğan and Güngör, 1992).

The dominant lithologies in the formation are mica schist, quartz schist, phyllite and marbles.

Especially the marbles are observed to extend over large areas to the north of the study area. At the upper levels, calcschist intermediate levels are observed. At the upper levels of the both schists and marbles, "gneissose schists" and metavolcanics are the other prominent lithologies of the formation, even if they are not throughly continuous laterally. To the west of the Top Tepe (M18-b1) poorly sorted metapebbles made up of half rounded pebbles of marble are observed. Besides, the amphibolite (Pzma) observed 2 km east of Meryemana (M18-b1) is defined as "biotite - quartz - amphibole - epidote schist" and interpreted as the "equivalent of a heteroblastic gabbroic rock in greenschist facies" by Akat (1980). Başarır (1981, 1989), on the other hand, defines it as "amphibolite" and shows it between the "micaschists with garnet". Candan et al. (1997) advocates the presence of "chloritoid + cyanide" assemblage in Meryemana formation which locally contains garnet, biotite and muscovite. There are various lithologies defined as members of the formation.

The quartzites display very distinct morphology with thick, very thick foliation, white, yellowish / brownish beige color among the schists; they are defined as the "quartzite member" (Pzmk) to the northwest of the study area (Figure 1a, 1b). The average thickness of the quartzites vary between 20 - 30 m. Especially towards gneissose schists situated at top levels, the amount of quartz increases significantly, and white, yellowish / brownish, beige colored quartzite, beige / pinkish yellow quartz schist, quartz - muscovite schists are observed.

The unit which is comprised mainly of marble including dolomite, calcschist and schist intercalations, is differentiated as "Marble member" (Pzmm). It is partly equivalent to the "Şenköy formation" (Akat, 1980) among the previous works. The marbles are in general dark gray, gray, blackish gray and white in color, and gray - white banded, mostly medium, sometimes thick / fine bedded, laminated, medium to fine crystallized.

Towards the gneissose schists located at the upper levels of the formation, sometimes it includes rare silica bands, a few mm thick. Greenish yellow / light gray calcschist, brownish / whitish yellow quartz schist, dark / light gray, whitish gray colored quartz cerisite schists and blackish gray colored dolomitic marbles with thin calcite veins, medium to large crystals, graphite, and having fossil traces similar to fusulines are the other rock types of the unit.

A few meter thick "metavolcanic member" (Pzmv) located at the upper levels of the schists and at immediately below the gneissose schists are mostly mapped by exaggerating. The unit is defined as "epidot - chlorite - muscovite - quartz schist, biotite - epidote - muscovite - quartz schist" by Akat (1980). Erdoğan and Güngör (1992) discuss the presence of 20 - 30 m thick "mafic metavolcanics" lenses in "Bayındır formation"; besides, Güngör and Erdoğan (2001) reports the presence of Late Triassic clastics and "metatuffs / alkali basalts" intercalated with carbonates included in "Çaltaşı formation" as mafic metamorphic rocks. It can be accounted that the metavolcanics mark a volcanism in Lower Triassic (?) period, if we consider the stratigraphic relation and the relative age relations with gneissose schists.

In Meryemana formation, at the levels close to the lower contact of marbles containing "metabauxite" (Ayrıcadağ formation), there are metapebbleless resembling gneiss/ augen gneiss. The metapebbles defined as "gneissose quartz schist" by Başarır (1981, 1989) and as "gneissose schists" by Gümüş et al. (1983) were differentiated as "Gneissose schist member" (Pzmg) in this study. Gray, grayish / yellowish white colored unit is attractive with its appearance as augen gneiss. The augen structure formed by quartz resemble boudinage, however, at some observation locations [for example, North of Tuzburgazı village (M18-d2), west of Top Hill (M18-b1)] the primary rock of quartz pebbles and quartz sandstone can be differentiated (Figure 3 and 4). The



Figure 3- "Metapebblestone - metasandstone" in context of gneissose schist (Kuşadası kuzeyi, Top Tepe, M18-b1)



Şekil 4- "Metapebblestone - metasandstone" in context of gneissose schist (Kuşadası kuzeyi, Top Tepe, M18-b1)

widespread gneissose schists which can be differentiated locally (and sometimes by exaggeration) and shown symbolically, display a general association with the underlying metavolcanics and the overlying metabauxitic marbles. The unit is mapped and defined as "gneissiques schistes" in the context of the Ambelos member on Samos island (Papanikolaou, 1979).

At almost every location the gneissose schist member is conformably overlain by the Ayırıcadağ formation. This member, however, when correlated with the Middle? - Late Triassic metapebbles and Rhetian metaclastics (Konak et al., 1987b) that belong to the Marçal Group (Konak

et al. 1987a), can point out an incompatibility with Meryemana formation.

The apparent thickness of the formation in the study area is more than 500 m.

No determinable fossils were found in the unit. There are undefined coral fossils in the west of the Belenkuyu Hill - Akçakonak Village (Figure. 1a; M18-c1) and fusulin like forms (Figure. 1a; L18-c4, west of Yeniköy). Besides these, the Middle?- Late Triassic age determined at the base of the Ayırıcadağ formation which overlies the unit, implies that the age of the Meryemana formation can be Late Paleozoic - Early Triassic (?). The Permo - Carboniferous age of the simi-

lar or the other correlatable units of the Kavaklıdere group (Konak et al., 1987a), supports this idea. However, the ages of the metavolcanics and the gneissose schists having stratigraphical relations and located at the top of this formation have not yet been clarified. These two rock assemblages must have been of Lower Triassic rather than Upper Paleozoic.

Ayrıcadağ formation (TrJKa)

This formation, which is named as Bozdağ group (Akat, 1980) or Kayaaltı formation (Erdoğan ve Güngör, 1992), or defined as "emery bedded marbles" and silex banded marbles" (Çalapkulu et al., 1982; Gümüş et al., 1983) and "marbles / dolomitic marbles" (Başarır, 1989) in previous studies is comprised of metacarbonates in general.

The Ayrıcadağ formation begins with dirty yellow, pinkish / brownish white, beige colored, fine - very fine crystallized marble and gray, blackish gray dolomite and dolomitic marbles at the bottom. The upper levels are comprised of metabauxite containing, white, grayish / beige, white colored, medium to thick bedded marbles with granoblastic texture (Figure 1b). At its possible highest levels there are gray, grayish white, middle to thin bedded marbles containing chert bands and nodules.

The metabauxites, which are widespreadly observed along a belt to the South of the Menderes Masif and used as one the data in discrimination of the tectono - stratigraphic units are observed towards the lower levels of the Ayrıcadağ formation and they are accounted to be same with the "bauxites formed in time period between Liassic - Lower Cretaceous in Marçal group" (Konak et al., 1987b). To the west of Ahmetli (L18-c4) and to the north of Belevi (L18-c3), however, metabauxite occurrences are observed in the Late Paleozoic marbles of the Meryemana formation. This observation is in contradiction with Mesozoic (Jurassic-Cretaceous) metabauxite findings

in Menderes Massif. Here, maybe a structural and undifferentiated situation is in question rather than stratigraphic position of the metabauxites.

At the lower levels of the formation, the "Kuru-dere member" (TrJKak) comprises of grayish, blackish gray, grayish white dolomite, dolomitic marble and light/dark green, brownish beige phyllites and calcshists which are thick in millimeters and centimeters and pinches out laterally.

The Ayrıcadağ formation conformably overlies the Gneissose Schist member of the Meryemana formation almost everywhere. This relation, on the other hand, is questionable as discussed in "Gneissose Schist Member" section. It is tectonically overlain by the Şirince metaflysch. The upper contact is transitive according to Erdoğan and Güngör (1992), and debatable according to Candan et al., 1997). Besides, the formation is tectonically overlain by the İzmir flysch and Bodrum nappe in a few localities.

The formation is at least 750 m thick. It contains fossils indicating Middle -Late Triassic, Middle - Late Jurassic ages (Akat, 1980; N. Konak, personal comm., 1992). Rudist findings (Özer, 1993; 1998) and their probable equivalents in Samos island (Papanikolaou, 1979) yield Middle? - Late Triassic - Late Cretaceous age.

ŞİRİNCE METAFLYSCH (KŞ)

In the unit the pelitic and basic schists are dominant as matrix and in the matrix, blocks or tectonic slices of metabasics, metaltrabasics, amphibolites, marbles, cherty marbles at different dimensions are found and the unit is named as "Şirince metaflysch". The unit has been presented in Late Permian - Early Triassic "Bafa formation" in the previous works (eg. Akat, 1980). The same unit has been defined also as "mica schists with garnet containing metabasic, serpentinite and marble bands - lenses" (Başarır, 1989); a "paleo - melange" (Candan and Kun, 1989); "me-

tamorphic olisthostrome" (Candan et al., 1997, 1998); and "Selçuk formation" (Erdoğan and Güngör, 1992)

In general, the matrix made up of pelitic origin, dark / light gray, yellowish / bluish metamorphic rocks contains the dominant rock types of muscovite - quartz schist, muscovite - albite - biotite - quartz schist; muscovite - garnet - chlorite - biotite schist, calcschist, chlorite - muscovite schist. The schists with coarse grained garnets concentrate distinctively where the Şirince metaflysch covers.

Beige, pinkish / claret reddish / greenish beige colored, thin to medium bedded, having fine to very fine crystals, marbles containing thin metachert bands are differentiated as "Cherty Marble Member" (Kşç). The metacherts brownish beige / gray in color rarely observed between phyllite and garnet schists display a dissolving cavity structure. The unit reaches to a thickness of 10 m, as lenses locally (north Havutçulu Village, M18 - b2). Based on the lithological features and considering as the equivalent of the Cenozoic units (mostly Campanian - Maastrichtian pink micritic limestones) observed in the west Anatolia frequently, the unit was differentiated by exaggerating (Figure 1a).

In Şirince metaflysch, metabasic rocks "metabasic member" (Kşb) observed as stratigraphic levels have also been mapped as well as blocks. In differentiating the brownish dark / light green, mostly foliation - displaying metabasics, in general the previous works (Candan, 1980; Başarır, 1981, 1989) have been made use of. "The metabasite" or "the metamorphic equivalent of diabasite tuffs formed after seafloor volcanism" (Başarır, 1989), the general paragenesis of the "mafic metavolcanic" member (Erdoğan and Güngör, 1992) is given as "tremolite - albite - epidote - zoisite - garnet - sphene (leucocene) - quartz - muscovite" (Başarır, 1989; Candan and Kun, 1989), "actinolite - chlorite - quartz - albite - epidote - garnet - sphene (Erdoğan and Güngör,

1992). The albites in the unit, in places, are observed as "huge knots" typically (M. Şengün, 1993, pers. comm.).

The ultrabasic rocks that take place as blocks or as tectonic slices in the metaflysch at various dimensions and mostly showing foliation are defined as "metaultrabasic member" (Kşu). The unit of which primary rock is dunite and peridotite has undergone serpentinization by 90 - 100% (Candan and Kun, 1989); besides, in the unit, antigorite and chromite formations were observed too (Başarır, 1989; Candan and Kun, 1989). The "gabbroic originated rocks" (Akat, 1980) in the schists were mapped as "amphibolite" (Başarır, 1989) and the rocks known as "metagabbro" (Candan and Kun, 1989) were mapped as "amphibolite member" (Kşa).

There are various type and size marble blocks (Kşm) in the metaflysch. In general the marbles have saccharoid texture in gray, dirty white and beige color. No fossils have been determined in the massive marbles and sometimes dolomitic marbles. The probable age is Triassic-Late Cretaceous.

The Şirince metaflysch has tectonic relation at the bottom with Meryemana and Ayrıcadağ formations. However, Erdoğan ve Görür (1992), states that the unit has been observed, near the village Belevi, having a neat transition with the overlain Kayaaltı formation; Candan et al. (1997) states that the contact relation of these two units are controversial. On this unit, units of the bodrum nappe and İzmir flysch are located tectonically (Figure 1b).

To the east of the Selçuk where big structures are observed, the thickness of the unit at Boncuk Dağı synclinal is at least 1000 m.

The Şirince metaflysch is an equivalent of a part of "Simav metamorphics" (Akdeniz and Konaç, 1979) which in Simav region includes metabasics and metaultramafics; metabasics and me-

taultramafics between Keçidağ and Gölarmara metabasics and metaultramafics (Konak et al., 1980); to the north of the Çivril "Özbeyli metabasic - metaultrabasics" (Çakmakoğlu, 1986); around Tire a section of Keçidağı Group (Akdenez et al. 1986) containing metaultrabasics; "metaflysch - like rocks" (Konak, 1994); the unit including metaserpentinites and metabasics (Konak et al., 1994); a part of "Doğanbeyburnu metamorphics" (Eşder, 1988) and Selçuk nappe (Ring et al., 1999) observed on Samos Island.

Although no fossils have been determined, it can be said that the age of the unit is Late Cenomanian according to the regional correlations.

BODRUM NAPPE

The Bodrum nappe, which is one of the structural nappes of the Lycian nappes are made up of rocks representing sometimes continental, in general shallow shelf of Lower - Middle Triassic, platform of (Middle?-) Upper Triassic - Liassic (sometimes Upper Triassic - Malm); and passive continental margin Upper Liassic - Upper Cretaceous (sometimes Cretaceous) period and is known with different names ["Köyceğiz series" (Graciansky, 1972; Bernoulli et al., 1974); "Bolkardağ unit" (Özgül, 1976); "Sandak series" (Erakman et al. 1982); "Çökelez Group" (Konak et al. 1986; Konak, 1993); "Ören Unit" (Konak et al., 1987b); "Çökek Group" (Şenel et al. 1989); "Çökek Nappe" (Şenel et al., 1994)] and has been re - defined by Şenel (1997a,b,c). The Bodrum nappe has been formed by units more or less different from each other; the representative of the Bodrum nappe in the study area has been named as "Akçakonak unit" (Figure 1b).

AKÇAKONAK UNIT

The unit is made up of metaclastics (Karaovası formation) at the bottom and metacarbonates at the top (Kayaköy dolomite and Pınaröztepe formation) and overlies the Efes nappe and Şirince metaflysch. It is of Early Triassic and

Cenonian age and is overlain by Late Cretaceous - Early Tertiary (Danian?) İzmir flysch.

Karaova formation (Trk)

It is in general made up of metaclastics and has been named as "Karaova schists" to the south of the study area by Philippson (1915), as "Karaova schist series" by Flügel and Metz (1954), as "Karaova unit (schichten)" by Brinkmann (1967), as "Karaova formation" by Akat et al. (1975), as "Karaova unit (schichten)" by Dür (1975) and as "Güllük formation" by Ercan et al. (1983, 1984). It can easily be correlated by means of its typical lithologic and stratigraphic features throughout the western Anatolia and has a widespread extension. The formation is known as "Çömlekçi formation" (Konak et al., 1980) in Akhisar and its vicinity, "Sazak formation" (Konak et al., 1986; Çakmakoğlu, 1990) in Çal - Çökelez Mountain (Denizli) vicinity, "Sorgunlu formation" (Göktaş et al., 1989) in Balkan, and to the southwest of Denizli "Karaova metasediments" (Çakmakoğlu, 1987) and "Karaova formation" (Okay, 1989; Konak, 2003). The name "Karaova formation" has been adopted for this widely extending unit and has been studied in detail.

The wide spread and typical lithologies of the formation are purple, dark gray, green, olive green, pink, gray colored, thin to medium bedded metapebble, metasandstone and metasiltstone.

Rimele et al. (2004) have determined Fe - Mg carpholite to the south of Ağaçlı (Söke) and "carpholite pseudomorphs and chloritoid" in Kirazlı (Söke) in the reddish - greenish phyllites of the formation.

Karaova formation passes into Kayaköy dolomite with the intercalation of brownish yellow calcschist, light / dark gray colored thin to medium bedded dolomite, gray, white dolomitic recrystallized limestone and metaclastics. This transition unit, which is named as "Yayla formation" in Çal (Denizli) region (Konak et al., 1986)

is differentiated as "Yayla member" (Trky) in this study. It is 0 - 50 m thick and Anisian (probable) age was determined from an equivalent of this unit to the east of Karaova (Muğla) (Çakmakoğlu, 1985; Konak et al., 1987b).

The formation has tectonic contact with the Efes nappe and Şirince metaflysch. However, it is known that in Gökbel Mountain (Muğla) it unconformably overlies Late Permian [(Gökbel formation; Meşhur et al., 1989) Şenel, 1997c]. This is transitively overlain by "Kayaköy dolomite" comprising dolomite and recrystallized limestone. The formation is thought to be 100 - 150 m thick.

No age data was obtained from the clastics of the Karaova formation. Based on its stratigraphical location and correlations, the unit is assumed to be of Early - Middle Triassic (Scitian - Anisian), for Yayla member the age assumed is Anisian.

Kayaköy dolomite (TrJk)

The unit is made up of dolomite and dolomitic recrystallized limestone. Its equivalent in Muğla region is defined as "Gereme calcareous unit" first defined by Philippson (1915), however, the Middle Triassic - Liassic similar lithologies in different tectono - stratigraphic units are also named as "Gereme formation" and for this reason, the unit is re-defined as "Kayaköy dolomite" by Şenel et al. (1994). The dominant lithologies of the formation are the gray, dark / light gray, whitish beige colored, thick to medium bedded, medium to thin crystallized, dissolved recrystallized and dolomites.

The unit conformably overlies the Karaova formation and is tectonically overlain by the İzmır flysch. Its relation with the "Pınaröztepe formation" which most possibly is the upper continuation of the formation was not observed. To the south of the study area, in Muğla region, the is conformably overlain by "Göçgediği formation" (Şenel et al., 1989; Şenel and Bilgin, 1997a,b)

comprised of cherty limestones or by "Ula marble" (Kaaden and Metz, 1954; Şenel and Bilgin, 1997a, b). Its maximum thickness is 300 m.

The local observations in "undifferentiated allochthonous carbonates" in L18 - c3, c4 and d3 sheets show that these units are similar to Kayaköy dolomite, besides, including the Pınaröztepe formation. However, the allochthonous clastics and carbonates appearing as the extensions of these units in the immediate west (L18 - d4) ("Sevincer Tepe sequence" and "Arpacık Tepe limestone" (Başarır and Konuk, 1981) display features of different lithologies and bio - facies characteristics, for this reason, reflect different structural units. These dolomites and limestones have been given different symbols because of the uncertainty in discrimination and for the sake of the detailed study (Figure 1a, 1b).

No fossils have been determined in the study area in the unit, therefore Middle? - Late Triassic-Middle Liassic age is assumed based on the correlations.

Pınaröztepe formation (JKp)

This unit is comprised of cherty crystallized limestones, and its metamorphic and non - metamorphic equivalents located to the south of the study area has been called as "Ula marble" (Kaaden and Metz, 1954), "Mandalıya cherty limestone" (Orombelli et al., 1967), "Bodrum Unit /Schichten" (Brinkmann, 1967), "Çaldağ limestone" (Graciansky, 1972), "Çaldağ formation" (Bernoulli et al., 1974; Dürr, 1975), "Mandalıya formation" (Akat et al., 1975), "Kışladağ formation" (Ercan et al., 1983, 1984) and "Göçgediği formation" (Şenel et al., 1989); however, in regional scale "Göçgediği formation" and its metamorphic equivalent "Ula marble" has been re - defined (Şenel and Bilgin, 1997a, b). In the study area, a section of the Göçgediği formation / Ula marble can be observed, in the other parts of the region, at the lower levels radiolarite, marl, chert, shale, nodular limestone in "ammonitico rosso"

facies and Cenonian micritic limestone at the upper levels are observed. For this reason, the unit is defined and named as "Pınaröztepe formation".

The formation is made up of gray, beige - white colored, middle to thin bedded, fine crystallized limestones and includes chert bands and nodules 2 to 15 cm thick. Its upper (?) levels are turbiditic.

The 15 m thick radiolarite - chert level (TrJKkpr) exaggerated in "undifferentiated allochthonous carbonates" and cherty limestones located in the northwest of the study area are thought to be belonging to this formation.

The formation tectonically overlies (and overlain by slices of) the İzmir flysch. However, in vicinity of Karaova (Muğla) it conformably overlies Kayaköy dolomite and passes to Karaböğürtlen formation (Philippson, 1915) upwards. The thickness of the unit is 300 - 350 m.

Orbitolina (conicorbitolina) cf. conica (d'Archiac), *Salpingoporella* sp. were determined in the formation and based on these fossils, the age is assigned as Albian - Cenomanian. However, considering the stratigraphic position of the widespread Late Liassic (Toartian) - Late Cretaceous Göçgediği formation, Late Jurassic - Late Cretaceous age is envisaged for the unit.

İZMİR FLYSCH (KTi)

The unit which has a wide extension in the frame of "İzmir - Ankara Zone" (Brinkmann, 1966) has been named as "İzmir flysch formation" around İzmir where it is observed widespread (Öngür, 1972) and has been defined as a group by Eşder (1988). In general, it is made up of a matrix comprised of clastics, radiolarite and basic volcanic rocks and blocks of various size, age and lithology in this matrix. In most of the previous works, it was defined as two different formations with the names "Cretaceous flysch /

Belkahve and Kavaklıdere flysch" (Parejas, 1940); "Upper Cretaceous flysch" (Akartuna, 1962); "Flysch" (Verdier, 1963; Oğuz, 1966); "Cretaceous flysch" (Brinkmann, 1966; Brinkmann and İzdar, 1971); "Bornova flysch" (Konuk, 1977); "Ulupınar formation and Erdemirçay formation" (Konak et al., 1980) and in context of "Flysch assemblages" (Yağmurlu, 1980); "Cretaceous - Paleogene flysch" (Başarı and Konuk, 1981); "Belkahve" and "Çaldağ" formations (Akdenez et al., 1986), it was defined as "Bornova complex" (Erdoğan, 1985; 1990a,b; Erdoğan and Güngör, 1992). According to its distribution in the study area, it was named and defined as "Zeytinköy formation" (Akat, 1980), "blocky flysch" (Başarı, 1981, 1989).

The unit is green, brownish green, brownish yellow, pinkish beige colored and the dominant lithologies are sandstone and shale; it includes serpentinite (KTis), radiolarite (KTir), diabase (KTid) and various limestone (KTik) blocks.

The Late Cretaceous flysch / blocky flysch units present in Lycian nappes are collected under the name of "Karaböğürtlen formation" (Philippson, 1915; Şenel, 1997a,b). The Karaböğürtlen formation which has relations with Bodrum nappe units, especially with Göçgediği formation (Mandalya formation / Pınaröztepe formation in the study area), corresponds to İzmir flysch, stratigraphically and from extension and assemblage points of view, which is in context of İzmir - Ankara Zone (Brinkmann, 1966); however, differentiation is based on structural relations.

The unit tectonically overlies the Efes nappe and Şirince metaflysch and is tectonically overlain by the Kayaköy and Pınaröztepe formations of the Alçakonak unit of the Bodrum nappe and by the undifferentiated dolomite - limestone units (TrJKkp), and is observed as blocks in it; besides thrust slices are also observed in these units (Figure 1b).

The age of the İzmir flysch is accepted in general as Late Cretaceous based on the ages ob-

tained from itself / blocks and from its structural - stratigraphical setting. However, the following are the other ages given to the unit: Upper Maastrichtian - Paleocene or younger (Konuk, 1977), end of Cretaceous - Paleocene (Yağmurlu, 1980), Eocene (Düzbastılar, 1980), Campanian - Paleocene (Konak et al., 1980), Turonian - Paleocene (Akdeniz et al., 1982, 1986), Paleocene - Eocene (Başarır, 1989), Campanian - Danian (Erdoğan, 1990a,b). According to these, the Late Cretaceous - Early Tertiary (Danian?) age can be accepted for the unit.

NEOGENE - QUATERNARY

"The terrestrial Neogene sedimentation covering Late Early Miocene - (?) Middle Miocene period in the study area begins with, from bottom to top, the Kösele formation and lacustrine Söke formation and continues with fluvial Dededağ formation which overlies the Söke formation with low angle erosional unconformity and ends with Kuşadası formation. The Miocene volcanism symbolized by dacitic Balatçık volcanics and basaltic andesite - andesite Hisartepe volcanics cuts and overlies the Kuşadası formation. The Great Menderes Group which includes the Late Pliocene - Pleistocene sedimentation related to Great Menderes graben formation is comprised of, from bottom to top, alluvial Kartaltepe formation, fluvio - deltaic and lacustrine Savulca formation, alluvial Ortaklar formation and alluvial Yamaçköy formations." (Göktaş, 1998; Ünay and Göktaş, 1999). It is made up of Holocene, alluvial fan, river - delta, marsh - lagoon and sandy deposits and slope debris.

TECTONIC

In the study area, various tectono-stratigraphic units displaying different lithofacies, environment and metamorphism characteristics overlie each other with thrust contacts. These tectonic units have most probably gained their first structural shapings during the end of Cretaceous - Early Eocene period. As a result of the tensio-

nal tectonic regime developed during the Early Miocene - Quaternary the nappes, even if local, must have moved along the thrust planes and must have gained their present day geometries by the vertical and locally oblique faults.

RESULTS

As a result of this study, some earlier works have been revised and compiled and besides, 1/250 000 scale maps in M18 sheet were completed to finalize the 1/100 000 scale geological map. The pre-Neogene rock units have been differentiated to finalize the L18 1/100 000 scale geological map.

In the study area, from bottom to top, five tectonic units, namely Dipburun nappe, Efes nappe, Şirince metaflysch, Akçakonak unit and İzmir flysch have been differentiated and their stratigraphic relations have been revealed. These tectono stratigraphic units have been correlated with the units on the Samos Island and their continuity, except for some differences, have been indicated.

It has been shown that, the "cover schists" defined in the Menderes Masif, includes different tectono - stratigraphic units in the study area; and data was provided for the units such as "Karaova formation" and "Şirince metaflysch" to study them from the southeastern corner of the masif to the east - southeast corner of the masif in various stratigraphic relations.

Along the extensional area of the probable Early Triassic basic volcanism, stratigraphic similarity between gneissose schists and marbles with metabauxites have been determined.

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