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INTRODUCTION TO THE GEOLOGY OF ARMUTLU PENINSULA

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INTRODUCTION AND GEOLOGICAL SETTING

Armutlu Peninsula is located in NW-Anatolia and forms the western promontory of the Pontides towards the Marmara Sea. Two main strands of North Anatolian Fault Zone border the peninsula. It is approximately situated on a Mesozoic suture zone (Intra-Pontide Suture of Şengör and Yılmaz, 1981), which is suggested to seperate İstanbul and Sakarya Microcontinents. In their geodynamic model Şengör and Yılmaz, 1981) propose that the Intra-Pontide Ocean begins to open in Early Jurassic and closed in Paleocene-Lutetian by northwards subduction. During its final closure an ophiolitic melange is emplaced by back-thrusting towards north and intruded by arc magmatics. Kaya et al (1986, 1988) on the other side disagree with the presence of the İntra-Pontide Ocean in the region. They describe the "melange" of Şengör and Yılmaz (1981) as a slope type sedimentary assemblage of Late Jurassic-Early Cretaceous age. During the closure of the marginal basin, to which the slope assemblage belongs to, the units of the basin are sliced and thrusted onto each other.

During 1984-1986 the MTA-group mapped the area and published the preliminary data (Göncüoğlu et al, 1986, 1987, Erendil et al, 1988, Göncüoğlu and Önder, 1989; Göncüoğlu and Erendil, 1990). This paper is a state-of art report of the field data.

STRATIGRAPHY

The geology of Armutlu comprises (Fig. 1).

I - a pre-Cenomanian metamorphic basement consisting of two main tectonic units: Pamukova Metamorphics (PM) and İznik Metamorphics (İM).

II - a non-metamorphic cover with a discontinious Cenomanian-Pliocene stratigraphic columnn (Fig. 2).

I. Pre-Cenomanian Basement

Two main tectonostratigraphic units, differentiated within the basement are thrusted onto each other. Tertiary cover overlying the thrust contacts as well as neotectonic strike-slip faulting generally obscures the polarity of the primary overthrusting. Limited field observations, however, combined with regional data suggests that PM is thrusted onto IM from N to S (Fig. 3).

İznik Metamorphics (İM)

A belt of low grade metamorphic rocks covering the central part of Armutlu Peninsula are named as İznik Metamorphics by Göncüoğlu et al (1986). This unit comprises three main sequences (Fig. 4). The lowermost lithologies of the Schist-Marble unit are characterised by amphibole-schists, marbles and graphite-bearing micaschists. They are followed by meta conglomerates and metasandstones interlayered with felsic meta-tuffs and meta-agglomerates. Rare lenses of basic volcanics and dolomites are observed. The middle

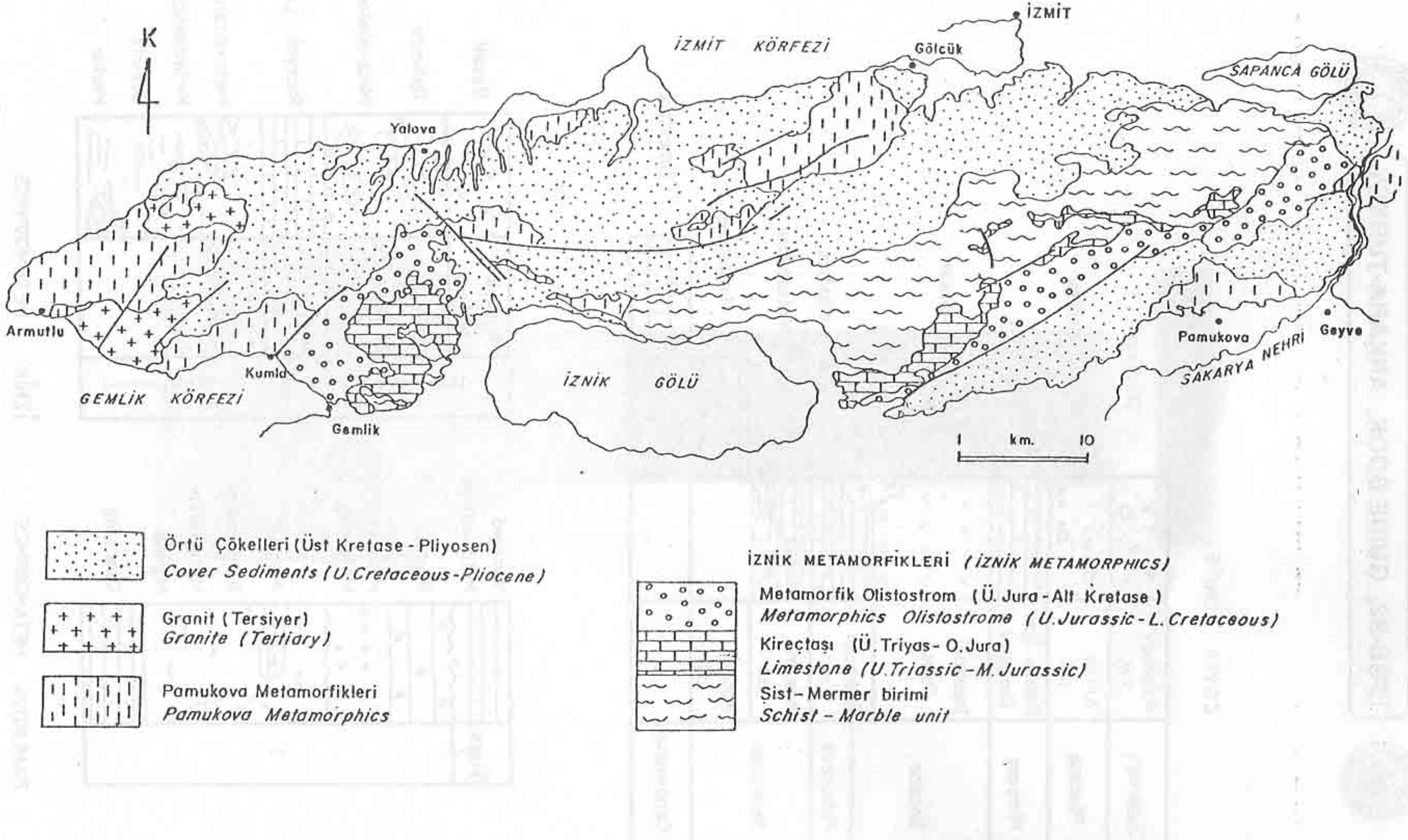

Fig. 1- Simplified geological map of Armutlu Peninsula.

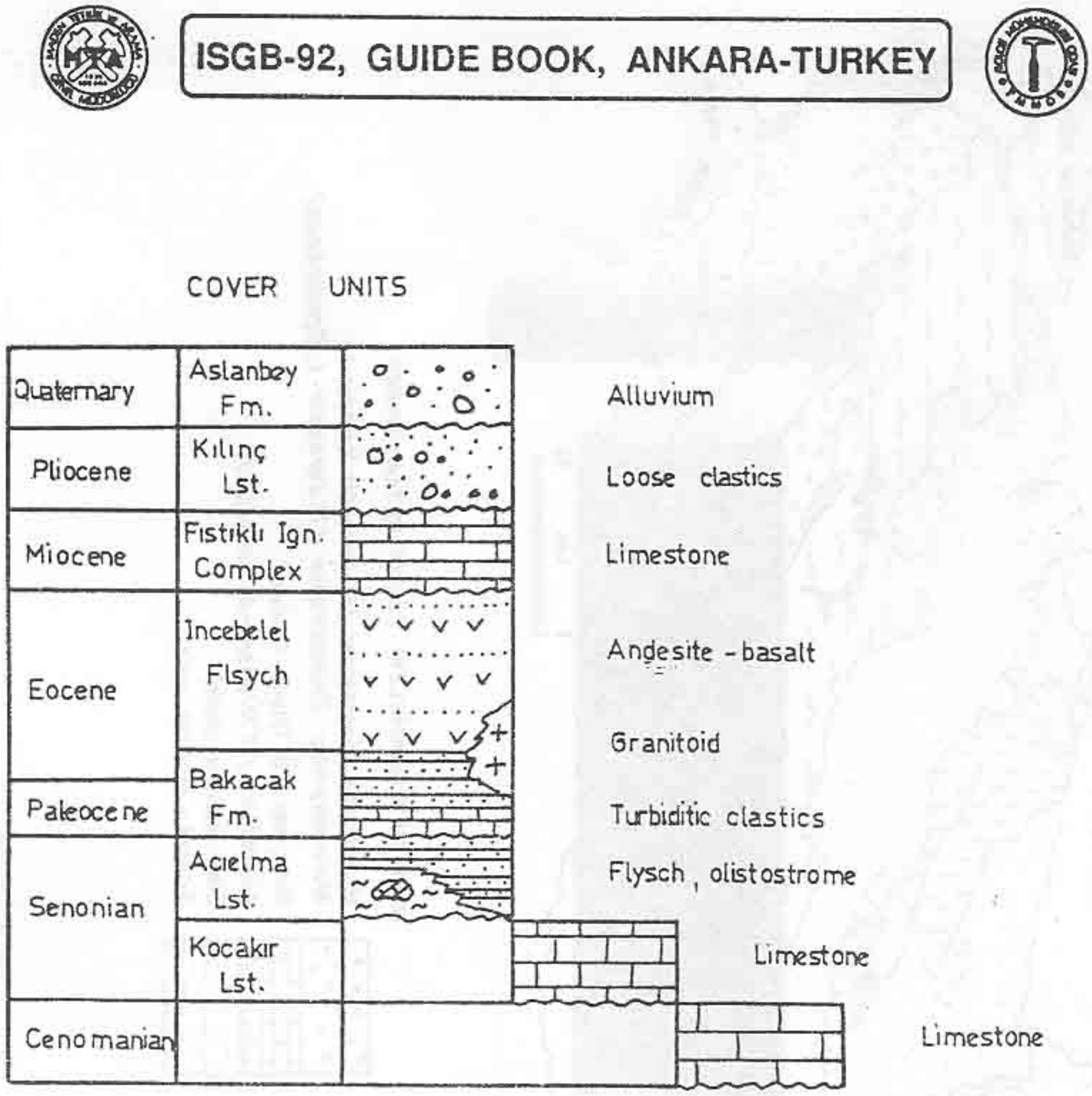

Fig. 2- Correlation chart of the lithostratigraphical units.

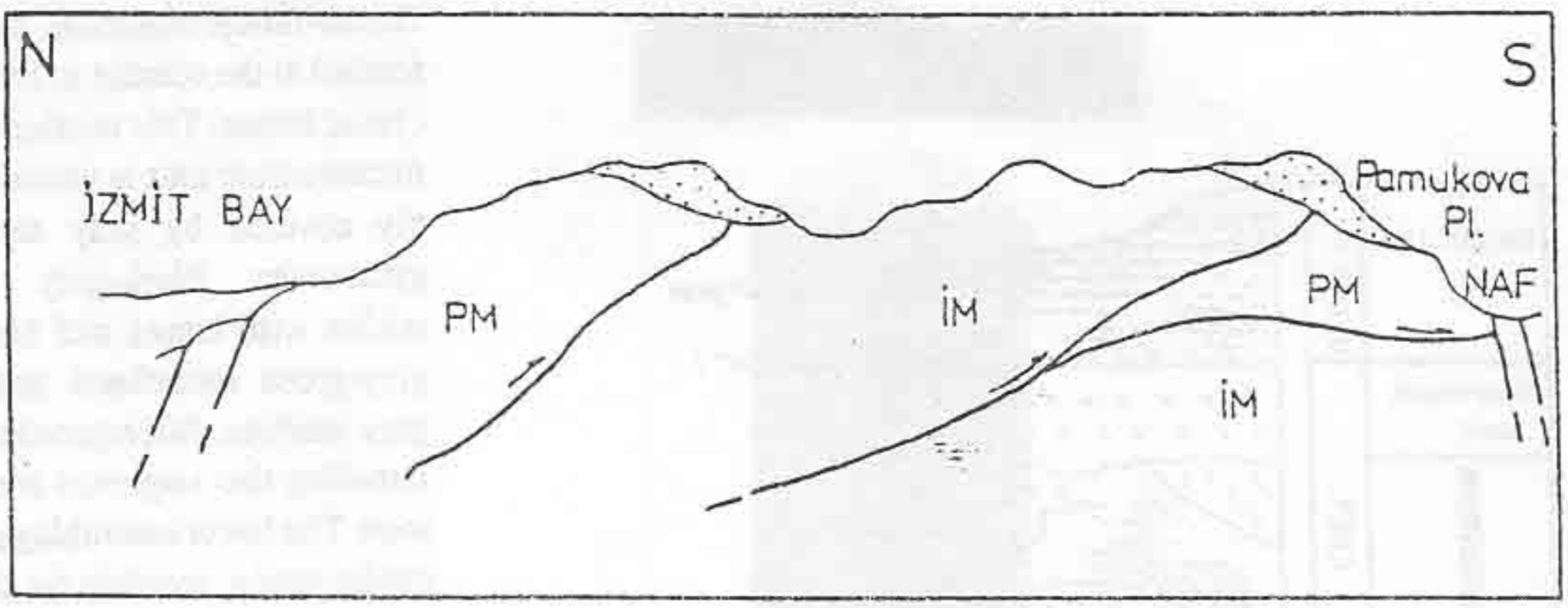

Fig. 3- Structural position of İznik and Pamukova Metamorphics.

part of the Schist-Marble unit consists of metagraywackes with olistostromal conglomerates, calciturbidites and metabasic lavas. Huge blocks of recrystallized limestones are characteristic features of this olistostromal sequence. Thè uppermost part of the sequence comprises conodont bearing purple-red colored mudstones. Önder and Göncüoğlu (1989) report: *Prioniodina* cf *petraeviridis* (Huckriede), *Prioniodina* sp., *Epigondolella* sp. and suggest an Upper Triassic age for the mudstones. Schist-Marble unit can well be correlated with Karakaya Unit (Bingöl et al, 1973). Alıçyayla Limestone conformably overlying the conodont-bearing mudstones consists of white colored recrystallized limestones with cherty recrystallized limestones and micrites. Kaya et al (1988) describe Middle Jurassic fauna from the upper part of this sequence in Gemlik area. The upper most unit of İM in Armutlu is characterised by an ophiolite bearing olistostrome. Olistostromal conglomerates and sandstones make up the lower part of the sequence. The main lithologies are turbiditic clastics with olistolites of radiolarian chert, manganiferous cherts, recrystallized limestone, peridotite, gabbro, basic volcanics and felsic volcanics. Locally, the unit shows a chaotic occurence. A huge slice of ophiolites is thrusted onto the olistostrome to the east of the working area (Fig. 1). Metavolcanic rocks consisting of meta basaltic lava and mafic pyroclastics characterise the uppermost part of the sequence. Kaya et al (1988) and Lin (1988, personel communication) report Upper Jurassic and Upper Jurassic-Lower Cretaceous radiolaria from radiolarite blocks. Considering the age of the Kocakır Limestone, which unconformably overlies the Meta-olistostrome and the age of the radiolarite blocks we suggest a Late Lower Creteceous depositional age for the uppermost unit of İM.

Pamukova Metamorphics (PM)

Pamukova Metamorphics occur as two distinct belts to the soulth and north of the peninsula. The lower part of the unit mainly consists of amphibolites with minor lenses of metaclastics and dolomites. (Fig. 5) A sequence starting with white homogenous quartzites and followed by marbles,

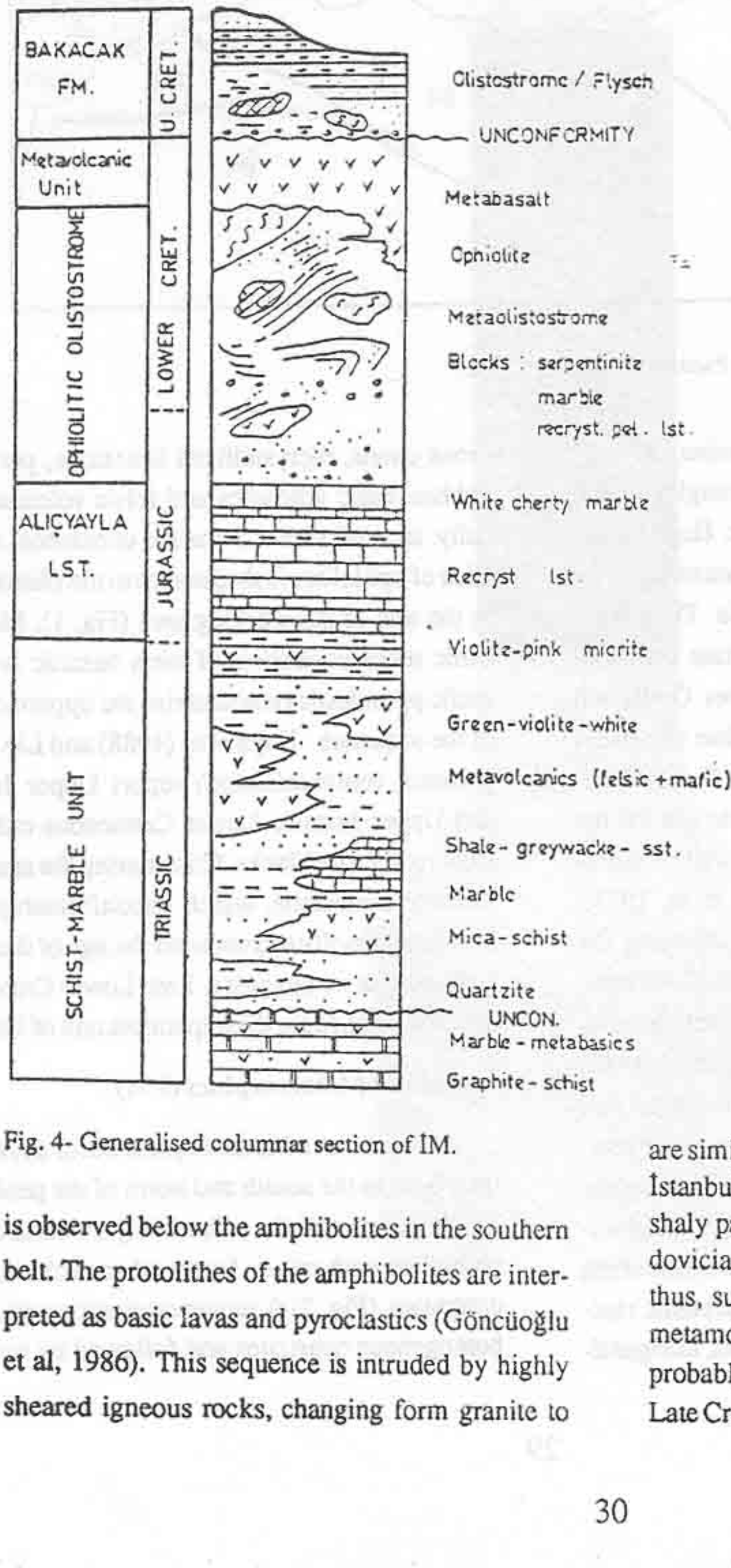

Fig. 4- Generalised columnar section of İM.

is observed below the amphibolites in the southern belt. The protolithes of the amphibolites are interpreted as basic lavas and pyroclastics (Göncüoğlu et al, 1986). This sequence is intruded by highly sheared igneous rocks, changing form granite to quartz-monzonite in composition. Garnet-biotite-staurolite schist is formed at the contact to the metaclastic lenses. This medium grade metamorphic unit is unconformably covered by gray metaconglomerates, black-gray pelitic schists with lenses and bands of grey-green metacherts and dark gray marbles. Microgranite dikes intruding this sequence are common. The lower assemblage is unconformably overlain by clastics containing well-rounded pebbles of granite, quartzite and amphibolite. İn the northern belt the conglomerates are followed by green-grey colored miça-rich sandstones followed by black shales with discontinious dark limestones. The uppermost part of the sequence constitute non metamorphic variagated clastics. In the southern belt however the conglomeratic basal beds are covered by greenish-gray sandstones, sandy limestones and dolomic limestones. The younger lithologies here are limestones with thin chert bands.

No fossils are found in PM. Regionally, the amphibolites at the basement are correlated with Precambrian lithologies of İstanbul Unit. The following meta-pelite and meta-chert bearing units are simiiar to Cambrian rocks (Arpat et al, 1978) of İstanbul Unit in western Pontides. The clastics and shaly parts of Armutlu sequence resemble the Ordovician and Silurian lithologies of İstanbul. We, thus, suggest that PM may represent the low-grade metamorphic equivalent of İstanbul Unit. It is very probably thrusted from N to S onto the İM during Late Cretaceous.

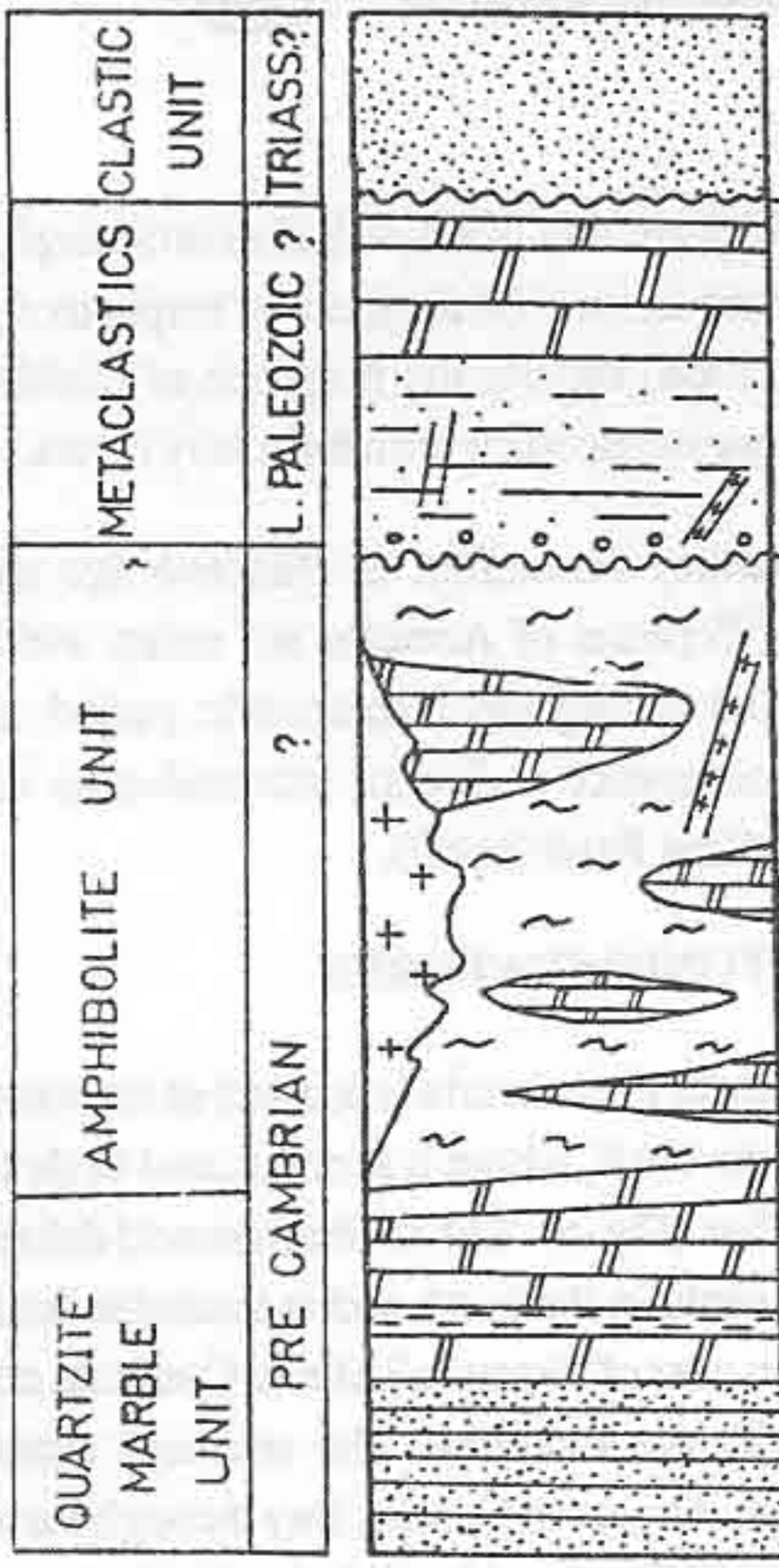

Fig. 5- Generalised columnar section of PM.

II. Cover Units

Non-metamorphic and post-tectonic in relation to the juxtaposition of the metamorphic tectonostratigraphic units, a discontinious sequence of Upper Cretaceous-Pliocene age is observed in Armutlu Peninsula.

Kocakır Limestone

The oldest unit unconformably covering the metamorphics is characterised by grey, medium bedded limestones. The thickness of the unit is about 40 m. The presence of *Cuniolina* sp. and *Coxites* sp. indicates a Cenomanian-Turonian age of deposition.

Acıelma Limestone

Discontinious out crops of gray-pink colored, poorly bedded dolomitic limestones unconformably overlying the metamorphics are named as Acıelma Limestone. These thin-medium grained limestones of back-reef type contain macrofossils such as *Hipuritella* sp and *Sabina* sp., characterising Senonian.

Bakacak Formation

Flyschoidal and olistostromal units of Maastrichtian age cover large areas in the eastern half of Armutlu Peninsula. The lower contact, except a few localities, is commonly characterised by olistostromal conglomerates and calciturbidites grading into flyschoidal sequences. Huge native and exotic blocks are typical features. Native blocks are represented by cherty limestones and micritic limestones, which are incorporated by gravity sliding and slumping. Their age is similar to the age of the matrix. Exotic blocks (megaolistolites) consist of limestones, ranging from Devonian to Lower Cretaceous in age. Blocks of marbles, ultramafic rocks and metabasics are less common. The matrix of the olistostrome is characterised by thin layers of pelagic limestone and siltstone. The pelagic limestones contain. *Globotruncana* cf. *contuse* (Cush), *Globotruncana* cf. *stuarti* (de Lapp.), *Globotruncana* cf. *gansseri* (Bolli.) indicating to Maastrichtian. Siltstones and limestones in the upper part of the sequence yield: *Lepidorbitoides* sp., *Sirtina* cf. *orbitidiformis* Bronn., *Siderolites* sp., *Orbitoides* cf. *medius* (d.Arc). Thus, the age of the matrix should be Maastrichtian.

İncebel Flysch

This unit is characterised by an almost 1000 m thick sequence consisting of turbiditic clastics with pyroclastic interlayers. İncebel Flysch unconformably overlies the metamorphic units, its contact to Bakacak Formation, however, is transitional. The lower part of the unit is dominated by graded, laminated and grain supported turbidites rich in volcanic clasts. The upper part is characterized by an alternation of quartz-rich lime-mudstone and bioclastic limestone with bands and lenses of andesitic agglomerates and felsic tuffs. Following fossils are reported from the lower part: *Discocyclina* sp., *Miscellanea* sp., *Miliolidae, Rotalidae*. The upper part contain: *Nummulites* sp., *Rotalia trochidiformis* Lam., *Assilina* cf. *exponens* (Sowerby), *Discocyclina* sp., *Alveolina* sp. The deposition age is interpreted as Upper Paleocene-Lower-Middle Eocene.

Fıstıklı İgneous Complex

Undeformed granitoides intruding the metamorphic basement units at the western edge of the peninsula (Fıstıklı Granitoide) as well as andesitic-basaltic lavas and pyroclastics (Sarısı Volcanics) of Eocene age are defined as Fıstıklı İgneous Complex.

Fıstıklı Granitoide, granodioritic-quartz dioritic in composition is considered to be genetically related to Sarısu Volcanics, which cover large areas in the central past of the peninsula. Sedimentary layers interfingering with lava contain Lutetian fossils. The unit is interpreted by Şengör and Yılmaz (1981) as an arc complex, related to the closure of the Intra-Pontide Ocean.

Kılınç Limestone

This unit is characterised by lacustrine deposits unconformably overlying the metamorphic basement and Lower Tertiary units, respectively. Akartuna (1968) reports the presence of Middle-Late Miocene ostracoda within the marly layers.

Aslanbey Formation of Pliocene age and Quaternary deposits of Armutlu are units, which are deposited during the Neotectonic period, so that their occurence is directly controlled by the North Anatolian Fault (NAF).

NEOTECTONIC FEATURES

Armutlu Peninsula is located at the western part of the NAF, where it is composed of three main branches (Fig. 6). The northern strand delimits the Peninsula in the north and is traceable from the southern cost of Sapanca Lake to Çınarcık, coinciding with the shoreline. The southern strand extends from Akyazı to Gemlik Bay through Pamukova Plain, Mekece and İznik Lake. Both strands are defined as morphologically distinct and seismically active zones (Erendil et al, 1988; Koçyiğit, 1988). In terms of deformational pattern differences the peninsula can be divided into there large segments. The eastern one with its NE-SW trending structures indicates a NW-SE compression in that area, giving way to a anti-clockwise rotation. This rotation is very probably related to the formation of the Pamukova depression. The westward offset of the main strike-slip fault is likely to result in the formation of this depression as a pull-apart basin. Another pull-apart feature to the west is probably Lake İznik Depression.

CONCLUSIONS

The geology of Armutlu Peninsula comprises a metamorphic basement consisting of two tectonostratigraphic units and a non-metamorphic discontinious sedimentary cover of Upper Cretaceous Pliocene age.

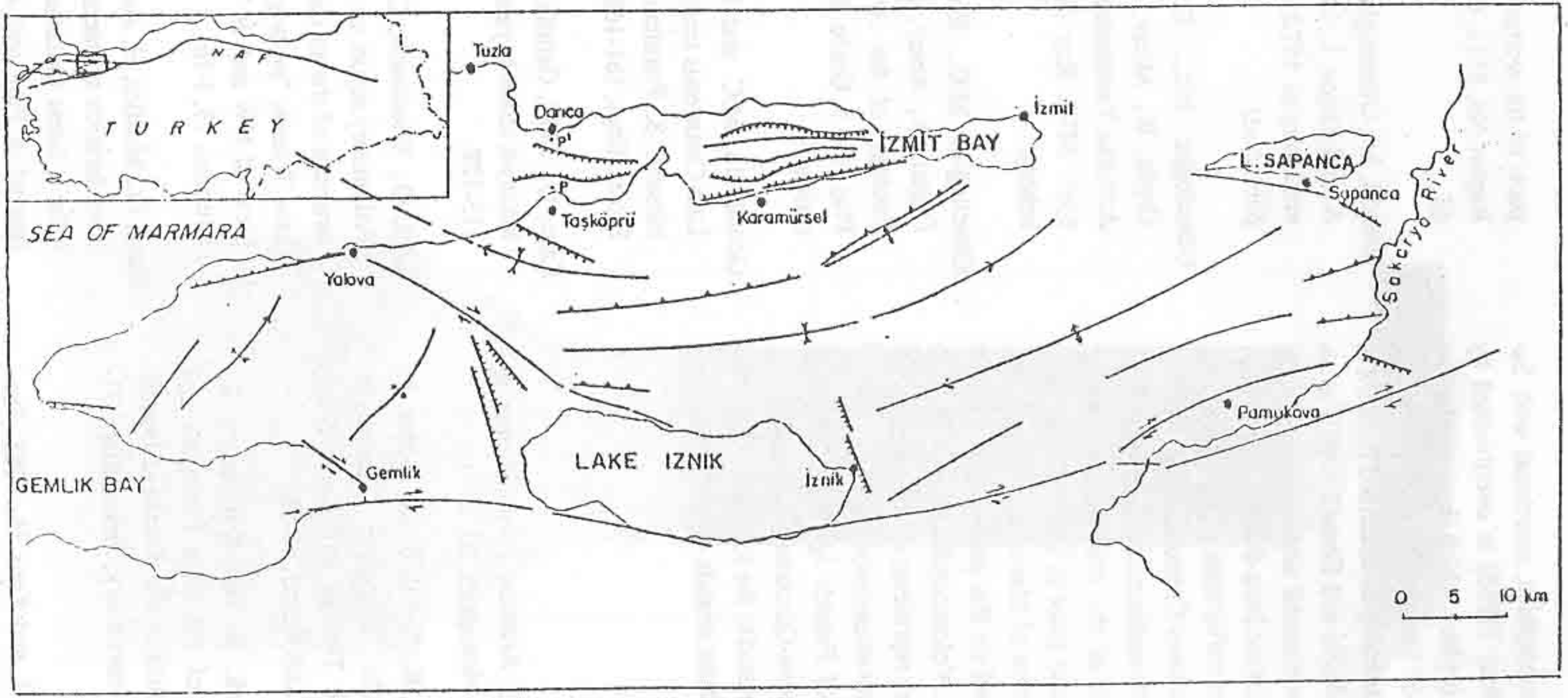

Fig. 6- Neotectonic map of Armutlu Peninsula.

İznik Metamorphics, correlated with Sakarya Zone of Okay (1985) is overthrusted by Pamukova metamorphics, which show similarities to İstanbul Unit of Şengör and Yılmaz (1981). Ophiolite bearing lithologies described from İM is interpreted (Göncüoğlu and Erendil, 1990) as an accreational prism material which is transported during the closure of the Intra-Pontide Ocean onto the passive margin carbonates (Alıçyayla Limestone) of Jurassic-Lower Cretaceous age. İstanbul Unit representing the northern continent must have been amalgamated to the southern continental block (Sakarya Zone) prior to Upper Cretaceous. Bakacak Olistostrome of Maastrichtian age must have been deposited on this amalgamated metamorphic basement. Volcanosedimentary interlayers of Incebel Flysch represents the initiation of an arc related volcanism whose products are very probably lithologies of Fıstıklı İgneous Complex. Middle/Late Miocene-Quaternary deposites on the peninsula are related to the formation of North Anatolian Fault, whose strands delimit the working area.

REFERENCES

Akartuna, M., 1968, Armutlu Yarımadasının jeolojisi: İ.Ü.F.F. Monografi, 20, 120 p.

Arpat, E., Tütüncü, K., Uysal, Ş. and Göğer, E., 1978, Safranbolu Yöresinde Kambriyen-Devoniyen istifi: Türkiye Jeol Kur. 32. Bil. Tek. Kultayı, Bildiri Özleri, 67-68.

Bingöl, E., Akyürek, B. and Korkmazer, B., 1973, Geology of the Biga Peninsula and some characteristics of the Karakaya Formation: MTA 50. Anniversary, Proceedings, 71-77.

Erendil, M., Kuşçu, İ. and Kato, H., 1988. Tectonics of the Armutlu Peninsula (Turkey): aspects of the western NAF Zone: İTİT Project Report No. 8513, Geol Survey of Japan, 59-65.

Erendil, M., Göncüoğlu, M.C., Tekeli, O; Aksay, A. and Kuşçu, İ., 1988, Armutlu Yarımadasının Jeolojisi: MTA Rep No: 42529, 51p (unpublished).

Göncüoğlu, M.C., Erendil, M., Tekeli, O., Ürgün, B., Aksay, A. and Kuşçu, İ., 1986, Armutlu Yarımadasının doğu kesiminin jeolojisi: MTA Rap No: 7786, 43 p (unpublished).

Göncüoğlu, M.C., Erendil, M., Tekeli, O., Ürgün, B., Aksay, A. and Kuşçu, İ., 1987, Geology of the Armutlu Peninsula: İGCP Proj. No 5, Guide Book, 12-18, MTA Publication.

Göncüoğlu, M.C. and Erendil, M., 1990, Pre-Late Cretaceous tectonic units of Armutlu Peninsula: 8. Petroleum Congress of Turkey, Proceedings, 161-168.

Kaya, O., 1977, Gemlik-Orhangazi alanının Paleozoyik temel kayaları: H.Ü. Yerbilimleri, 3, 115-128.

Kaya, O., Wiedmann, C and Kozur, H., 1986, Priliminary report on the stratigraphy age and structure of the so called Late Paleozoic and Low Triassic "melange" or "suture zone complex" of NW and W Turkey: Hacettepe Yerbilimleri, 13, 1-16.

Kaya, O., Mostler, H. and Kozur, H., 1988, Reconsideration of ancestral NAF in NW Anatolia: a latest Cretaceous overthrust: METU, Journal of Pure and Appl. Sci, 211/1-3, 52-64.