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STRATIGRAPHIC AND STRUCTURAL SETTING OF THE ANCHIMETAMORPHIC ROCKS TO THE SOUTH OF TAVŞANLI (KÜTAHYA, WESTERN TURKEY): RELATION TO THE İZMİR-ANKARA ZONE

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ABSTRACT.- In western Anatolia, a belt of anchimetamorphic rocks that are characterized by penetratively developed slaty deavage, extensive mineral overgrowths and formation of new phylosilicate minerals extends between the Izmir-Ankara zone and the northernmost schist and gneiss masses of the Menderes massif In the report area, the anchimetamorphic assemblage is divisible into three stratigraphic units The Middle Triassic lower slate unit consists mainly of slates representing fine-grained silicic and basic tuffs, and subordinately of silicic lava, quartz-conglomerate, quartzofeldspathic sandstone, gray and red limestones. thinly bedded lithic sandstone and red bedded chert. The Middle Triassic to probably Early Liassic upper slate unit consists mainly of slates representing illitic mudrocks and lithic wackes, and subordinately of lithic arenite. lithic conglomerate, gray limestone and coarse-grained mafic tuff. The Middle Liassic limestone unit is made up of gray bioclastic limestones. The Latest Cretaceous (to Paleocene) turbidite-olistostrome unit, which is widely spread in the Izmir-Ankara zone, overlies unconformably the southerly-tying anchimetamorphic rocks and the steep boundary fault separating these rocks from the older entities of the zone. The exposure of the relative allochthon of the anchimetamorphic rocks of a southern origin, the steepening of the fault and the onlap of the turbidite-olistostrome unit onto the anchimetamorphic basement seem to be Latest Cretaceous events.

INTRODUCTION

Separate exposures of penetratively sheared and pervasively recrystallized sedimentary and volcanic rocks between the redefined İzmir-Ankara zone (IAZ) and the northernmost schist and gneiss masses of

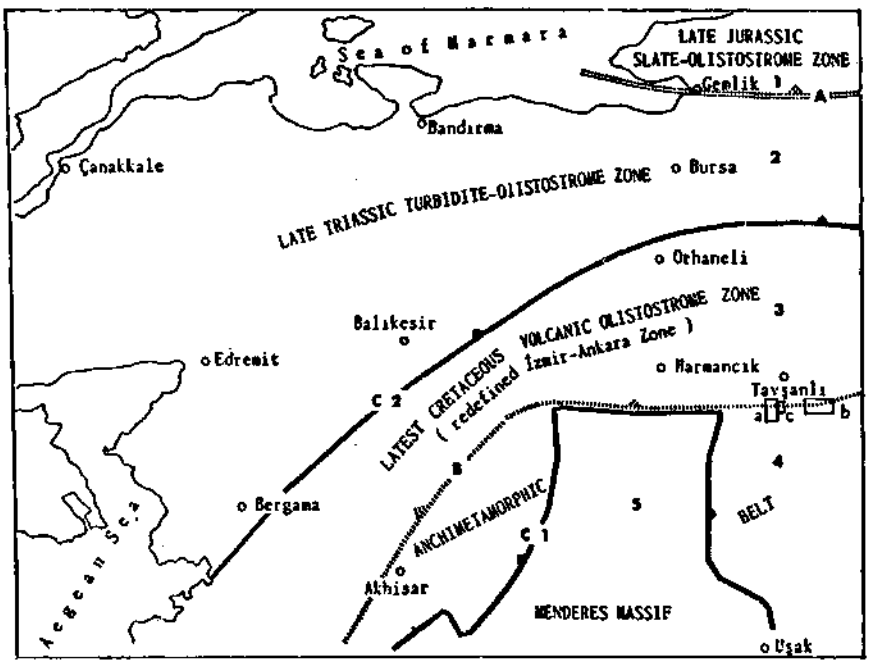


Fig. 1- Major structural-stratigraphic subdivisions of the northwestern parts of Anatolia (Kaya, 1992). 'a'-'c', Report areas.

the Menderes massif are distinguished and delimited as an anchimetamorphic assemblage (Kaya, 1992) (Figs. 1-3).

In the report area, The Latest Cretaceous (to Paleocene) turbidite-olistostrome unit of the Izmir-Ankara zone overlies unconformably the anchimetamorphic rocks and the boundary fault separating the older rocks of the IAZ (i.e. ultramafics, low-grade greenschist and blueschist rocks, and The

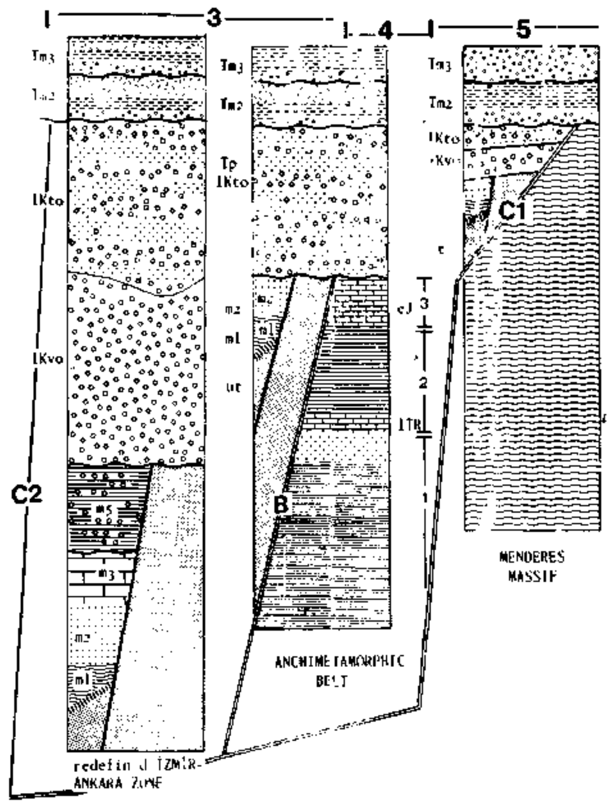


Fig. 2- Structural-stratigraphic setting of the anchimetamorphic rocks in western Anatolia. ITR-eJ, anchimetamorphic assemblage: 1- Lower slate unit, 2- Upper slate unit, 3- Limestone unit, m, Low-grade (greenschist and blueschist fades) metamorphic rocks (1 Amphibolite unit, 2- Metadastic unit, 3- Metacarbonate unit, 4- Metaolistostrome unit), ut, serpontinized ultramafic tectonites. 1Kvo, Latest Cretaceous volcanic olistostrome unit. 1Kto, Latest Cretaceous (to Paleocene) turbidite olistostrome unit. Tm2, Middle Miocene; Tm3, Late Miocene. B, Boundary fault of an implied Latest Cretaceous age, seperating the redefined Izmir-Ankara zone from the anchimetamorphic assemblage. C1, Late Paleocene thrust fault bounding the anchimetamorphic assemblage against the relative allochthonous crystalline masses of the Menderes massif. C2, Thrust fault defining the northern boundary of the redefined İzmir-Ankara zone, contemporary with C1.

Latest Cretaceous volcanic olistostrome unit) from the anchimetamorphic assemblage (Kaya, 1972,1992).

The anchimetamorphic rocks were first described by Canet and Jaoul (1946) in the surroundings of Akhisar and called "the probably Permo-Carboniferous Akhisar schist". Arpat and Norman (1961) recorded these rocks as "least metamorphic schists". Kaya (1972) reported the anch metamorphic rocks to the south of Tavşanlı, dated them as Jurassic on the basis of inconclusive evidence and established a lower clastic unit (Üyücek fm.) and an upper limestone unit (Kayaardı lms.) He suggested that the lower clastic unit rests unconformably a low-grade metamorphic sequenca (İkibaşlı fm.) of an implied Paleozoic age. Bingöl (1977) recognized the anchimetamorphic rocks to the east of Gediz and assigned a Middle to Late Jurassic age on the basis of foraminifera. In the surroundings of Akhisar, Akdeniz et al. (1980) and Akdeniz (1985) subdivided the anchimetamorphic succession into Triassic clastic and carbonate rocks, Jurassic clastic rocks with lenses of metavolcanics and carbonates, and thickly developed Jurassic to Late Cretaceous carbonates. The basal clastic rocks were said to rest unconformably on the Paleozoic metamorphics. Erdoğan (1990) considered the relevant Mesozoic sequence to be conformably gradational into the underlying low-grade metamorphics of the Menderes massif, and to have an early termination of Maastrichtian age. To the south of Kütahya, Göncüoğlu et al. (1992) recorded a conformable succession of Early Scythian mudrocks and Triassic to Late Cretaceous limestones, in parts probable correlatives of the anchimetamorphic assemblage. They reported that this succession overlies unconformably a Carboniferous to Permian metamorphic basement, and is overlain gradationally by a Late Cretaceous (Middle to Late Maastrichtian) to Early Paleocene sedimentary melange. Okay (1980) considered the relevant areas of anchimetamorphic rocks as being constituted of greenschist-amphibolite facies rocks.

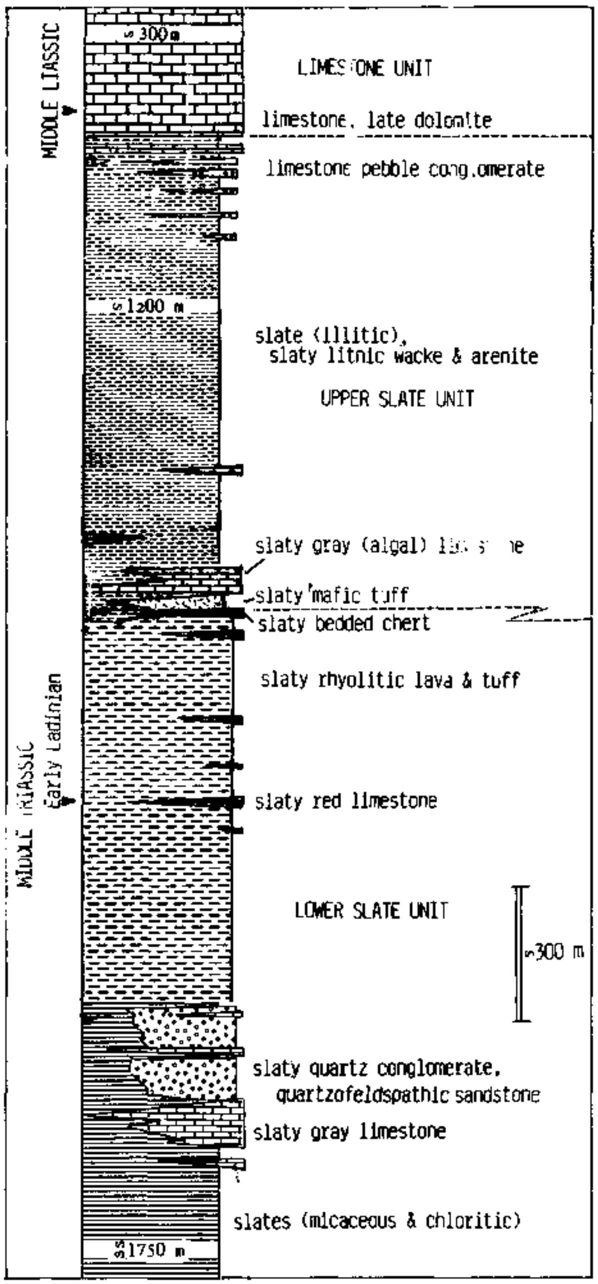
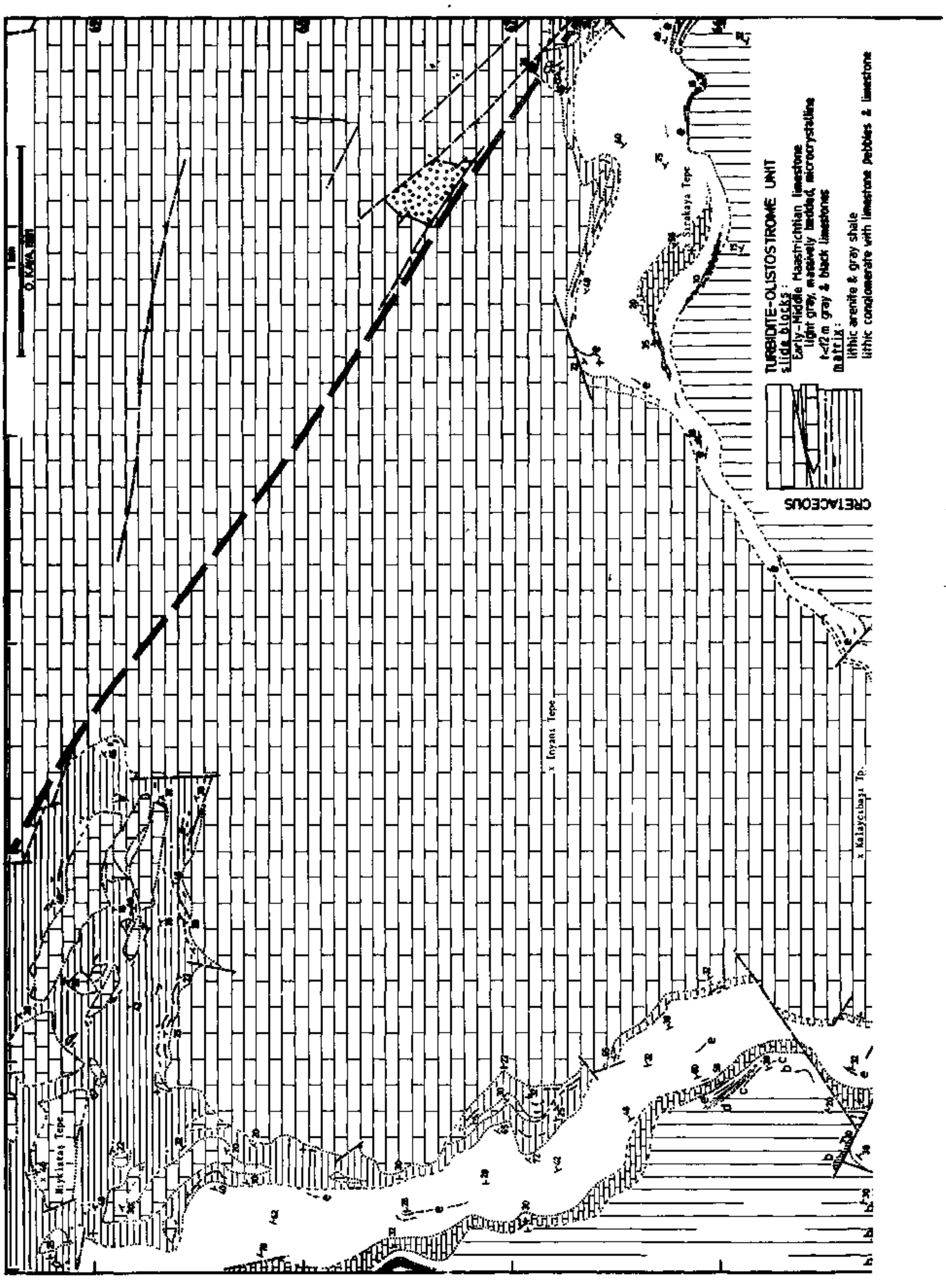


Fig. 3- Generalized order of rock succession of the anchimetamorphic rocks.

The present report, which is concerned with the upper part of the anchimetamorphic assemblage, (I) revises the stratigraphy and inconclusive Jurassic age proposed by Kaya (1972), in the light of new exposures and fossil findings and recent accumulation of regional data (Kaya, 1992); and, (2) documents new age data on the turbidite-olistostrome unit of the Izmir-Ankara zone, which has a significant bearing on the understanding the structural setting of the anchimetamorphic rocks. Authors have contributed this paper as follows: O.Kaya, field work and text; W. Sadeddin, conod-


TURBIDITE-OLISTOSTROME UNIT
slide blocks:
Early-Middle Maastrichtian limestone
light gray, massively bedded, microcrystalline
matrix:
lithic arenite & gray shale
lithic conglomerate with limestone pebbles & limestone
CRETACEOUS

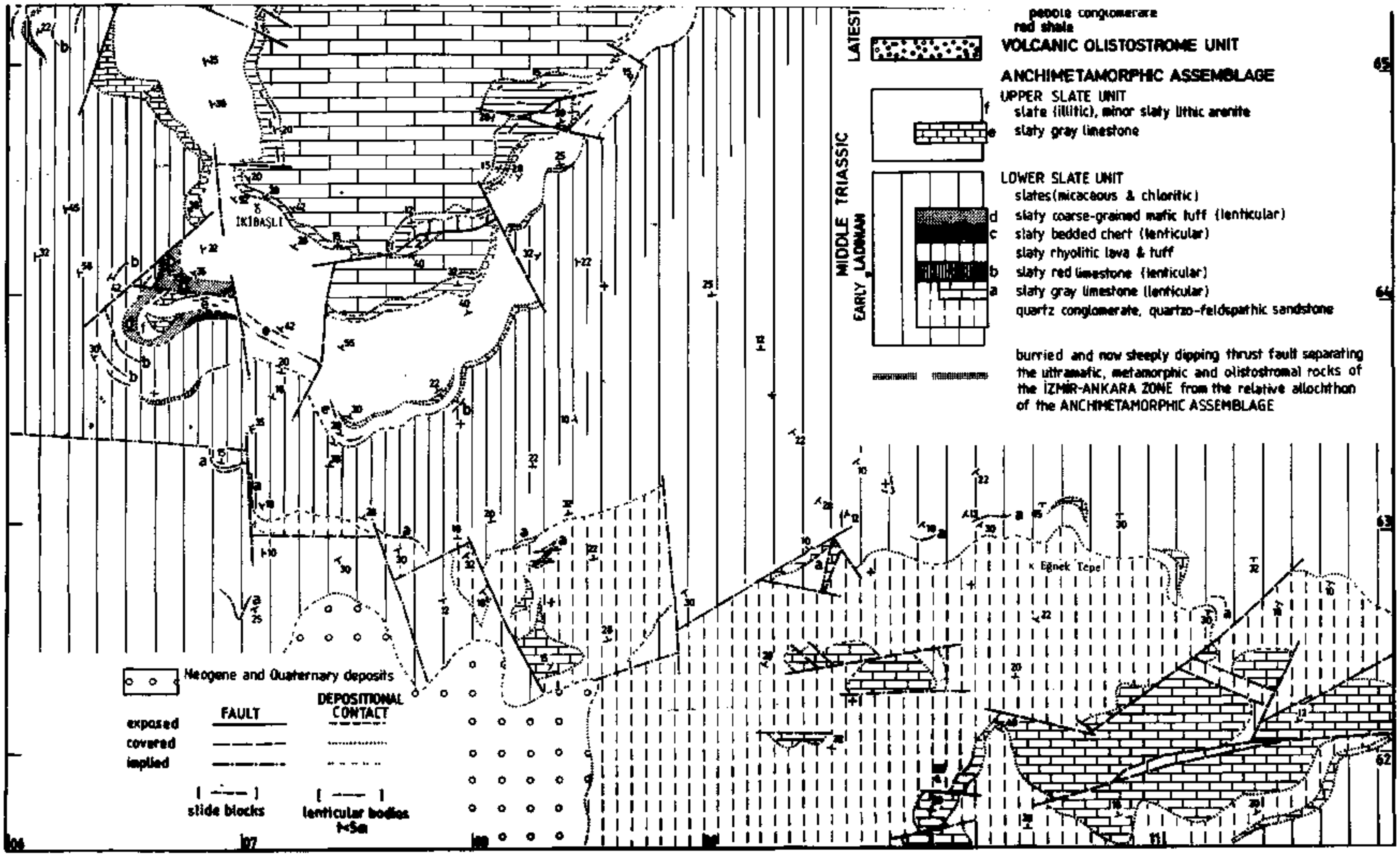


Fig. 4- Distribution of the anchimetamorphic rocks immediately adjoining the İzmir-Ankara zone along a now steeply dipping thrust fault (thrust fault B in Fig. 1). Map area: 35 km SW of Tavşanlı, sheet J22-b2; 'a' in Fig. 1.

onts; D. Altıner, Triassic and Jurassic forammifers and algae; E.Meriç and İ.Tansel Cretaceous foraminiters; and, A Vural, recovery of conodonts.

ANCHIMETAMORPHIC ASSEMBLAGE

Lower slate unit

This unit (İkibaşlı fm., Kaya. 1972) consists primarily of volcanogenic slate, and subordinately of volcanic, epiclastic and carbonete rocks all with slaty cleavage. The lower siate unit is divisible into three parts, in ascending order: (1) micaceous slate with sporadic chloritic slate interlayers; (2 quartz conglomerate, quartzofeldspathic sand stone and gray limestone; and, (3) micaceous slate, rhyolitic lava and tuff, red and gray limestones, and bedded chert (Fig.4).

The gray micaceous and greenish gray chloritic slates show affinity, respectively, with silicic and basic fine-grained tuffs. The quartz conglomerates are light gray, massively bedded, and gram and matrix-supported. The clasts are up to 8 cm in size, round to subround and strongly strained in most cases. They include primarily white vein quartz, and in minor amounts silicic volcanic rocks, pink and gray chert and quartzofeldspathic sandstone. The matrix consists of finer-grained versions of the pebbles, and white mica and chlorite. The quartzofeldspathic sandstones are white, thickly bedded and, together with the quartz conglomerates, represent upward-coarsening sequences. The gray limestones, which are lenticular bodies on all scales, are microcrystalline and pervasively recrystallized into sparry patches. The rhyolitic lava and tuff are composed of the mineral assemblage of quartz, albite, minor oligoclase, muscovite (2M), chlorite and minor talc. Quartz and plagioclase which are mostly rotated,occur as stubby crystals up to 5 mm in length and give a knotty appearance to the cleavage plane. Quartz exhibits a moderately undulose extinction and alpha-quartz pseudomorphs after beta-quartz. Plagioclases are mostly euhedral and show overgrowths in pressure shadows. Along the cleavage planes, quartz and plagioclase are thickly sheated by white mica and chlorite. A late formation of chlorite is associated with widely spaced parallel fractures across S1. The red limestones are up to 3 m in thickness and several tens of m in lateral extension, and severely recrystallized. The red brown cherts occur at the top of the unit and are laterally discontinuous They are recrystallized into fine-grained quartz mosaic.

The base of the lower slate unit is not exposed. The quartz conglomerates and quartzofeldspathic sandstones are locally successively channelized into the slates. This channel system, ntervened by lanket limes ones, cuts into the lower uniformly mıcaceous and chloritic slate part of the unit, and defınes a vary broad SE-NE trend. The rhyolitıc lava, which represents the upper part of the unit,rests gradationally on the micaceous slate and shows lateral variations in thickness and texture.

The red limestones contain conodont (Plate I) *Gondolella basisymmetrica* (Budurov and Stefanov), *Paragondolella navicula* (Huckriede), *Gladigondolella cf. tethydis* (Huckriede), *Prioniodina* (Cypridodella) *muelleri (Tatge*), P. spengleri (Huckriede), *P. sp*.. *Prioniodalla s*p., *Hindeodella suevica* (Tatge), H. sp., *Neospathodus* cf *discretus* (Müller), *N. newpassensis* (Mosher). *N.* sp., *Cornudina* sp., *Cratognathodus* sp , *Enantiognathus* sp., ?Ozarkodina-type unit and *O* sp., G. *basisymmetrica* places the top strata of the lower slate unit in the early Ladinian (Fassanian)

Upper slate unit

This, unit (Üyücek fm.; Kaya, 1972) consists primarily of illitic slate and pervasively cleaved lithic wacke, and subordinately of lenticular lithic arenite, limestone, limestone conglomerate, lithic conglomerate and coarse-grained mafic tuff, all with slaty disposition. The unit is essentially gray in color, but pale red to purple gray slates, and lithic sandstones and conglomerates occur increasingly to the top of the unit (Fig. 5).

The slate and lithic wacke, which intergrade, present massive sections, and are locally calcare ous. The lithic arenites are thin to thick-bedded, and include micaceous and feldspathic versions. The limestones, which occur mainly in the lower part of the unit as extensive lenses, are algal and crinoidal micrites. They are pervasively racrystallized; and fossils are strongly distorted and variably micritized, or replaced by sparry calcite. The lime-

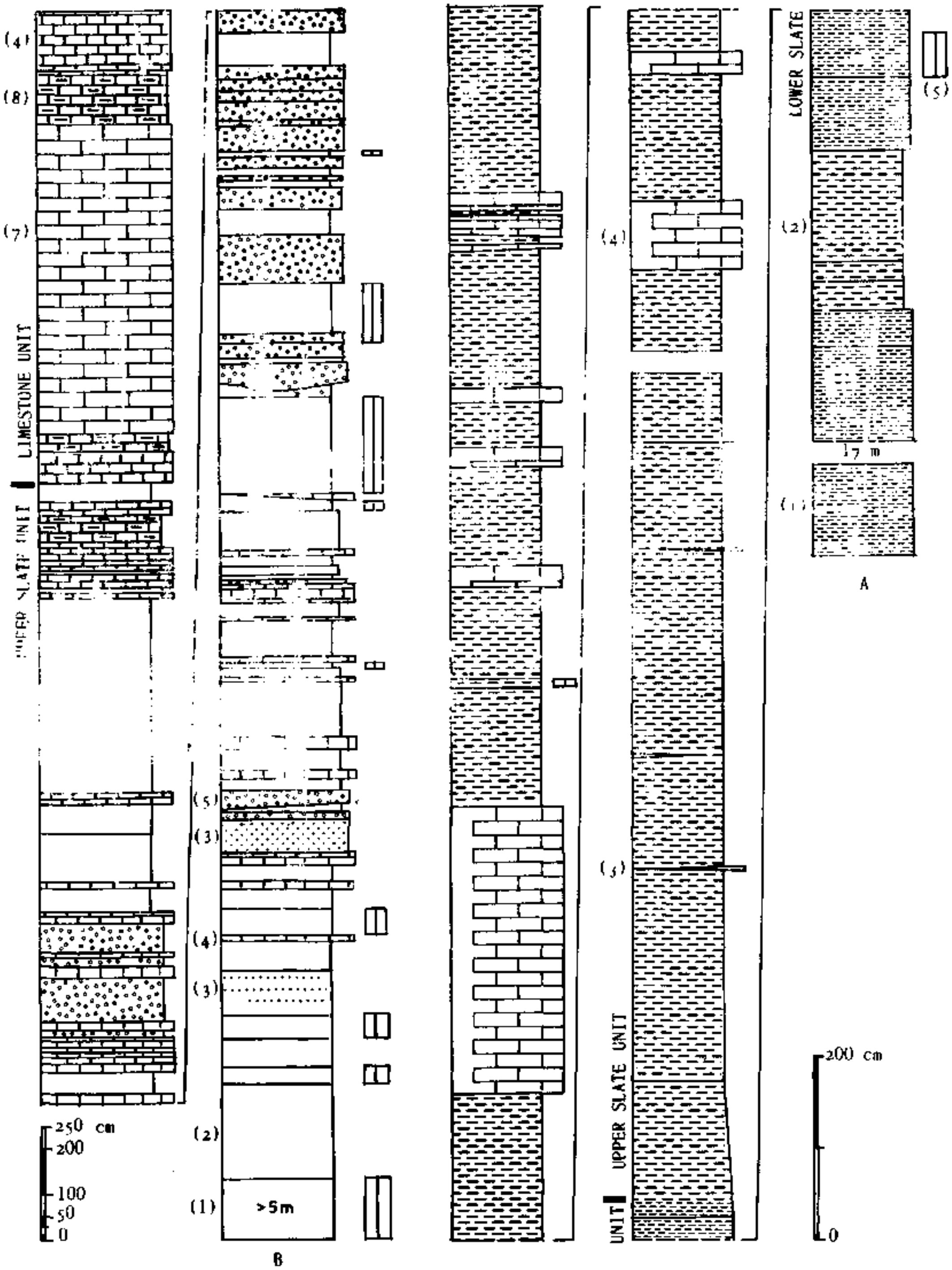


Fig. 5- Contact relationships between the major units of the anchimetamorphic assemblage. A: J22-b2, 12.63:65.79; B, J23-a1, 25.21: 69.28. A1, Gray rhyolitic tuff; A2, gray chloritic slate; A3, gray (grayish yellow weathering) illitic slate; A4, gray limestone; A5, purple gray slate. 81, Purple gray illitic slate; B2. gray (grayish yellow weathering) illitic slate; B3. gray lithic arenite; B4, gray limestone; B5, gray limestone pebble conglomerate; B6, gray limy slate; B7, gray dolomitized limestone; B8. gray clayey limestone.

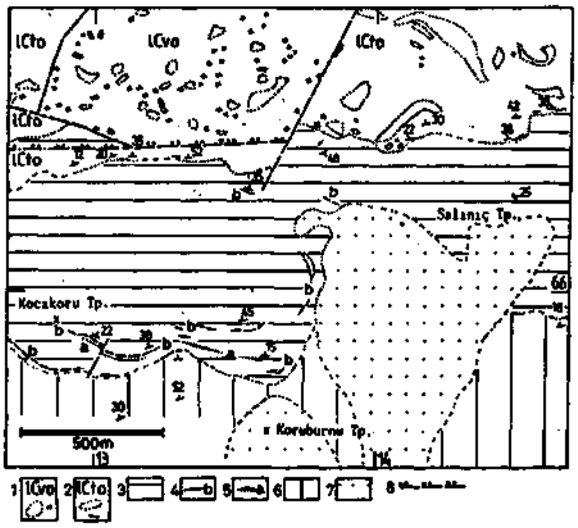


Fig. 6- Bedded chert lenses in the basal part of the upper slate unit suggest an interfingering contact relationship between the lower and upper slate units (Sheet J22-b2). 1- Latest Cretaceous turbidite-olistostrome unit; 2- Latest Cretaceous volcanic olistostrome unit; 3- Upper slate unit; 4- Lenticular gray limestone (upper slate unit); 5- Lenticular bedded chert (upper slate unit); 6- Lower slate unit; 7-Paleo-alluvium; 8- Boundary fault overlain by the Latest Cretaceous turbidite-olistostrome unit, and reactivated.

stone conglomerates occur as thin to medium-thick intercalations in the uppermost part of the unit (Fig. 5). They are composed of fine to medium-sized pebbles of light gray recrystalfized limestones, which are slightly strained. The supporting matrix is calcareous mudstone and, less commonly, limestone.- The coarse-grained mafic tuff consists of chlorite, chloritized rock fragments, and minor relic pyroxene, epidote series minerals and white mica. Locally it contains thin interlayers of mafic lava, and interlayers and rows of nodules of marble-like recrystallized limestone.

Both the lower slate and upper slate units exhibit a good diversity of rock types and strong lateral variations near their mutual contacts. However, the contact between the bulk rocks of micaceous slate and illitic slate is conformable and gradational (Fig.5). The presence of the bedded chert in the very base of the upper slate unit (Fig. 6.), several km away from its occurrenqe at the top of the lower slate unit, may suggest a diachronous contact relationship between the two units.

Lenses of recrystallized algal limestone, at the lowermost part of the upper slate unit have

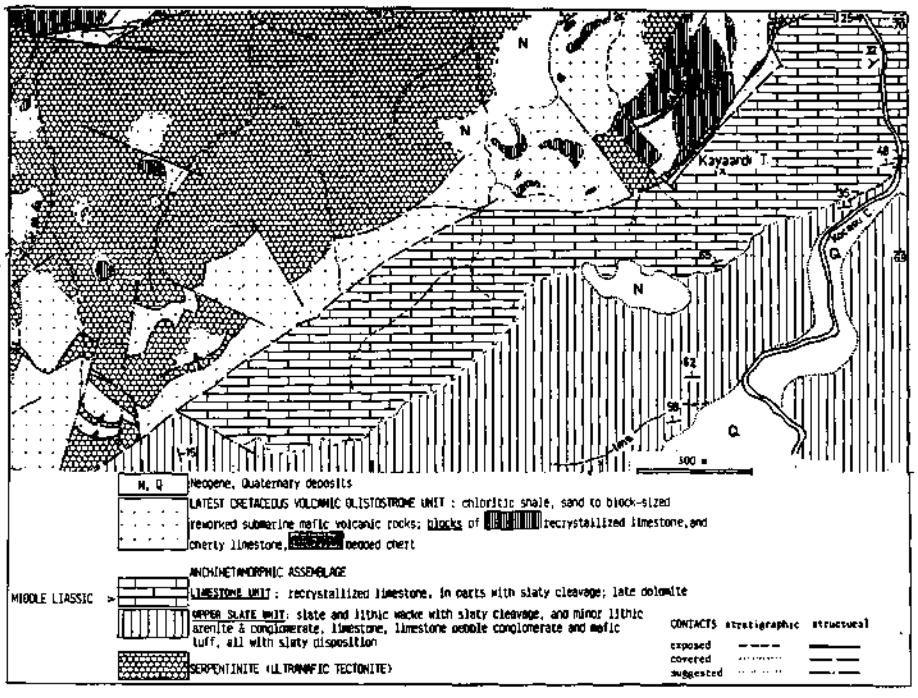


Fig. 7- Exposed Major Fault (Line B in Figs. 1 and 2) which defines the southern boundary of the İzmir-Ankara zone against the anchimetamorphic belt (Sheet J23-a1).

yielded an inconclusive foraminiferal fauna including *Aulotortus* sp. (gr. *sinuosus), Ophthalmidium?,* Auloconus?, Duostominidae, galeanellid foraminifers and involutinidis, which may tentatively suggest a Middle to Late Triassic age. The conodonts, which are poorly preserved, include *Prioniodina muelleri* (Tatge) and *Hibardella* cf. *magnidentata* (Tatge). *P. muelleri* is Middle Triassic in age and indicates an upper age limit of latest Ladinian. This assigns a Ladinian age to the base of the unit. The upper slate unit should reach as far as Early Liassic, because it is conformably and gradationally overlain by the Middle Liassic limestone unit.

Limestone unit

This unit (Kayaardı Limestone: Kaya, 1972) consists primarily of bioclastic limestones, which are white to light gray, medium to thick-bedded and pervasively recrystallized (Fig.7). Widespread dolomitization has obliterated the original texture and stratification. Shearing becomes gradually less distinct to the core of the unit.

The limestone unit lies gradationally on the upper slate unit (Fig.5). The lenticular bodies of limestone conglomerates, in the contact interval seem to be intrabasinal in origin.

In the lower part of the limestone unit recrystallized limestone patches, which locally escaped dolomitization, contain algae *Thaumatoporella parvovesiculifera* Rainer, *Paleodasycladus mediterraneus* (Pia) and *P. elongatulus* (Praturlon), and foraminifers *Lituosepta recoarensis* Cati, *Orbitopsella primaeva* (Henson), *O. praecursor* (Guembel), *Haurania deserta* Henson, *Mayncina termieri* Hottinger, *Pseudocylammina liassica?* Hottinger, *Valvulinasp., Siphovalvulina* sp. and Ataxophragmiidae, which indicate as a whole a Middle Liassic age.

İZMİR-ANKARA ZONE

The redefined İzmir - Ankara zone (İAZ) is characterized by The Latest Cretaceous volcanic olistostrome unit overlying unconformably an older structural system of ultramafic and low-grade metamorphic (greenschist and blueschist) rocks (Kaya, 1992). The Latest Cretaceous (to Paleocene) tucbidite-olistostrome unit which conformably but abruptly overlies the volcanic olistostrome unit, extends across the boundaries of the IAZ, well into southwest (Bernouilli et al., 1974) and northwest Anatolia (Eroskay, 1965), and consequently is not characteristic for the IAZ (Kaya, 1992).

Latest Cretaceuos (to Paleocene) turbidite-olistostrome unit

This unit (Karaçalı fm.; Kaya, 1972) consists of turbiditic megasequences of shale and sandstone-shale, pebbly mudrocks of debris-flow origin, and blocks primarily of platform-type limestones, submarine mafic volcanic rocks and pelagic rocks incorporated in olistostromes with a supporting matrix of the above type of strata. In the study area (Fig. 4), for most part the unit is represented by an Early Campanian to Early Maastrichtian platform-type limestone slab (tabular block) more than 7 km long in a S-N direction (the Budağan limestone slab). The matrix rocks underlying the Budağan limestone slab include regularly stratified, gray, thickly bedded to massive, finely pebbly and coarse-grained lithic arenites, gray and red-brown shales, and minor lithic conglomerates. Those overlying the slab are gray lithic arenites and gray shales which exhibit everywhere soft-sediment deformation features to the degree of sandstone-shale melange.

The unit contains Permian, probably Triassic, Jurassic and Early Cretaceous limestone blocks and pebbles. The apparently basal part of the Budağan limestone slab, and many other clasts as well, contain *Orbitoides medius* (d'Archiac), *O. concavatus* Rahaghi, *Pseudosiderolites vidali* (Douville), *Praesiderolites dordoniensis* Wannier, *Lepidorbitoides* cf. *campaniensis* van Gorsel and *Sulcoperculine* sp., as a whole indicating a Late Campanian to Early Maastrichtian age. The pelagic limestone blocks carry *Globotruncana bulloides* Vogler, *G.* cf. *area* (Cushman), *G.* sp. (gr. *lapparenti), Globotruncanita* cf. *stuarti* (de Lapparent) and *Abathomphalus?* sp., indicating an Early, to probably Middle Maastrichtian age. A small limestone block of higher stratigraphic position than the Budağan limestone Slab yields a youngest age of Late Maastrichtian. The relevant microfauna consists of *Globotruncanita stuarti* (de Lapparent), *Abathomphalus mayaroensis* Bolli and *Rosita contusa* (Cushman).

In the western parts of Turkey Maastrichtian

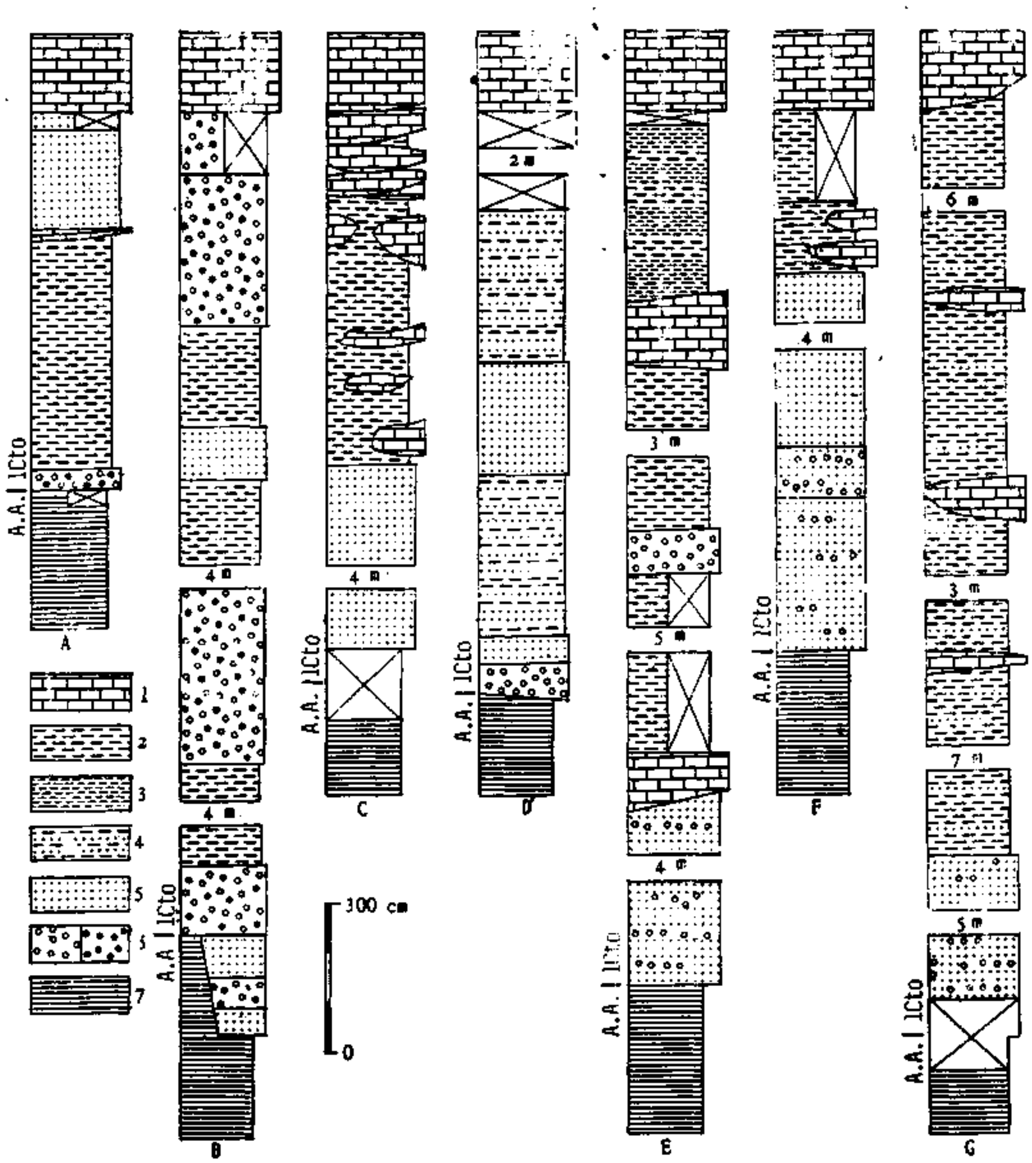


Fig. 8- Unconformity between the Latest Cretaceous turbidite-olistostrome unit (1 Cto) and the upper slate unit of the anchimetamorphic assemblage (A.A.). 1 - Light gray, microcrystalline, medium-bedded to massive limestone block of gigantic proportions; 2- Gray shale with minor thin interlayers of lithic arenite; 3- Pale red shale; 4- Thin to medium-bedded interstratification of shale and lithic arenite; 5- Gray, thickly bedded to massive, in places, finely pebbly coarse to very coarse-grained lithic arenite; 6- Gray lithic conglomerate with limestone pebbles (left), gray limestone pebble conglomerate (right); 7- Illitic slate and slaty lithic arenite. A, 11.30:66.60; B, 07.77:64.00; C, 07.15:6436; D, 07.03:64.46: E, 07.12:64.77; F, 07.08:65.10; G, 06.38:68.70.

to Early Pateocene ages (e.g. Eroskay, 1965; Bernouilli et al., 1974; Brinkmann, 1976; Konuk, 1977; Erdoğan, 1990) were assigned to the rock assemblages corresponding to the turbidite-olistostrome unit, in and outside the IAZ In the report area, the carbonate clasts indicate a lower age limit of Late Maastnchtian for the seemingly sterile matrix rocks. There, a Latest Cretaceous age can be suggested tentatively for the turbidite-olistostrome unit which is represented by its stratigraphically lowermost part

STRUCTURAL SETTING OF THE ANCHIMETAMORPHIC ASSEMBLAGE

The Latest Cretaceous (to Paleocene) turbidite-olistostrome unit rests unconformably on the anchimetamorphic rocks (Fig. 8). The basal lithic sandstones contain pebbles derived from the underlying lower slate unit.

The near-vertical boundary fault (Kaya, 1972, 1992) delimits the mutual extent and relative positions of the IAZ and the anchimetamorphic belt (Fig. 1). In places, the fault is exposed between the ultramafics and/or volcanic olistostrome unit of the IAZ and the anchimetamorphic assemblage (Figs. 6 and 7). In Budağan dağ (Fig. 4), the fault passes under the turbidite-olistostrome unit. The buried fault is expressed at the surface by the zones of severe strain recystallization in the Budağan limestone slab and a fault-bounded block of the volcanic olistostrome pierced through the slab.

The northward underthrust of the anchimetamorphic assemblage is a regional implication (Kaya, 1981,1992). Biogeographic evidence, such as *Orbitopsella* species in the Middle Liassic limestone unit supports a southern origin (Altıner, 1989). A tectonic transport towards NNW can be suggested tentatively, on the grounds of one-fold structural elements such as strain-related pebble elongation in the quartz conglomerates.

The shearing confined to the basal part of the turbidite-olistostrome unit appears to be related to Tertiary compressional movements in the sense of recurrent northward tectonic transportations.

CONCLUSIONS

1- The anchimetamorphic assemblage is a coherent structural-stratigraphic entity. Penetrative and polyphase shearing affected the assemblage. However, in most places slaty cleavage is subparaltel to the bedding. Recrystallization is confined to new formation of phyllosilicates and extensive overgrowths.

The rock composition of the report and contiguous areas is not compatible with Okay's (1980) "Afyon zone" consisting of greenschist-amphibolite facies rocks.

2- The anchimetamorphic assemblage is divisible, with respect to major rock types, into (i) the lower slate unit consisting of silicic and (minor) mafic volcanogenic rocks, and silicic volcanic rocks; (ii) the upper slate unit consisting of epiclastic rocks; and, (iii) the limestone unit.

An unconformable setting on a so-called low-grade metamorphic basement, as it was implied by Kaya (1972) between the micaceous slates of the lower slate unit and illitic slates of the upper slate unit, is not justified by recent field evidence based on new exposures.

3- The uppermost part of the lower slate unit and the lowermost part of the upper slate unit are Middle Triassic (Ladinian) in age, on the basis of conodont evidence (first introduced in this report). The limestone unit is Middle Liassic in age. A Late Triassic to Early Liassic age can be suggested for the upper part of the upper slate unit, which presents a lithic uniformity and an apparent continuity in succession. As yet no conodont or foraminifer is obtained from the relevant strata.

4- The Latest Cretaceous (to Paleocene) turbidite-olistostrome unit, which is represented by its basal part in the report area, may have a minimum age of Late Maastrichtian. It rests unconformably on the upper slate unit and overlies the boundary fault between the older rocks units of the Izmir-Ankara zone and the anchimetamorphic assemblage.

The Budağan limestone slab and blocks intimately admixed with it are of different Late Cretaceous ages. This invalidates a lithostratigraphic setting accepted by Kaya (1972) and others (e.g.Göncüoğlu et al., 1992) for the Budağan limestone slab.

The suggestion of conformable and gradational contact relationship between the anchimetamorphic rocks (or their correlatives) and the "Late Cretaceous melanges" of the İzmir-Ankara zone, which is widely accepted in previous work (see Introduction), is not tenable.

5- A pre-Latest Cretaceous fault, actually an (under) thrust, separates the Izmir-Ankara zone and the southerly-lying anchimetamorphic belt. The steepening of the fault, exposure of the anchimetamorphic rocks and the onlap of the turbtdite-olistostrome onto the anchimetamorphics are Latest Cretaceous events.

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PLATE

PLATE -I

Fig. 1 *Gondolella basisymmetrica* (Budurov ana Stefanov)

a) Upper view, X100, b) lower view, X130

Fig. 2- *Paragondolella navicula* (Huckriede), lateral view, X88

Fig. 3- *Gladigondolella* cf. *tethydis* (Huckriede)

a) Upper view, X150, b) lower view, X168

Fig. 4- *Prioniodina (Cypridodella) muelleri* (Tatge), iateraJ view, X180

Fig. 5- *Prioniodina* spengleri (Huckriede), lateral view, X84

Fig. 6- *Prioniodina* sp., lateral view, X180

Fig. 7- *Prioniodina sp.,* lateral view, X148

Fig. 8- *Prioniodina* sp., lateral view, X119

Fig. 9- *Hindeodelia suevica* (Tatae), lateral view, X95

Fig. 10- *Hindeodella* sp., lateral view, X100

Fig. 11- *Neospathodus* cf. *discretus* (Müller), lateral view, X180

Fig. 12- *Neospathodus newpasensis* (Mosher), lateral view, X177

Fig. 13- *Neospathodus sp.,* lateral view,

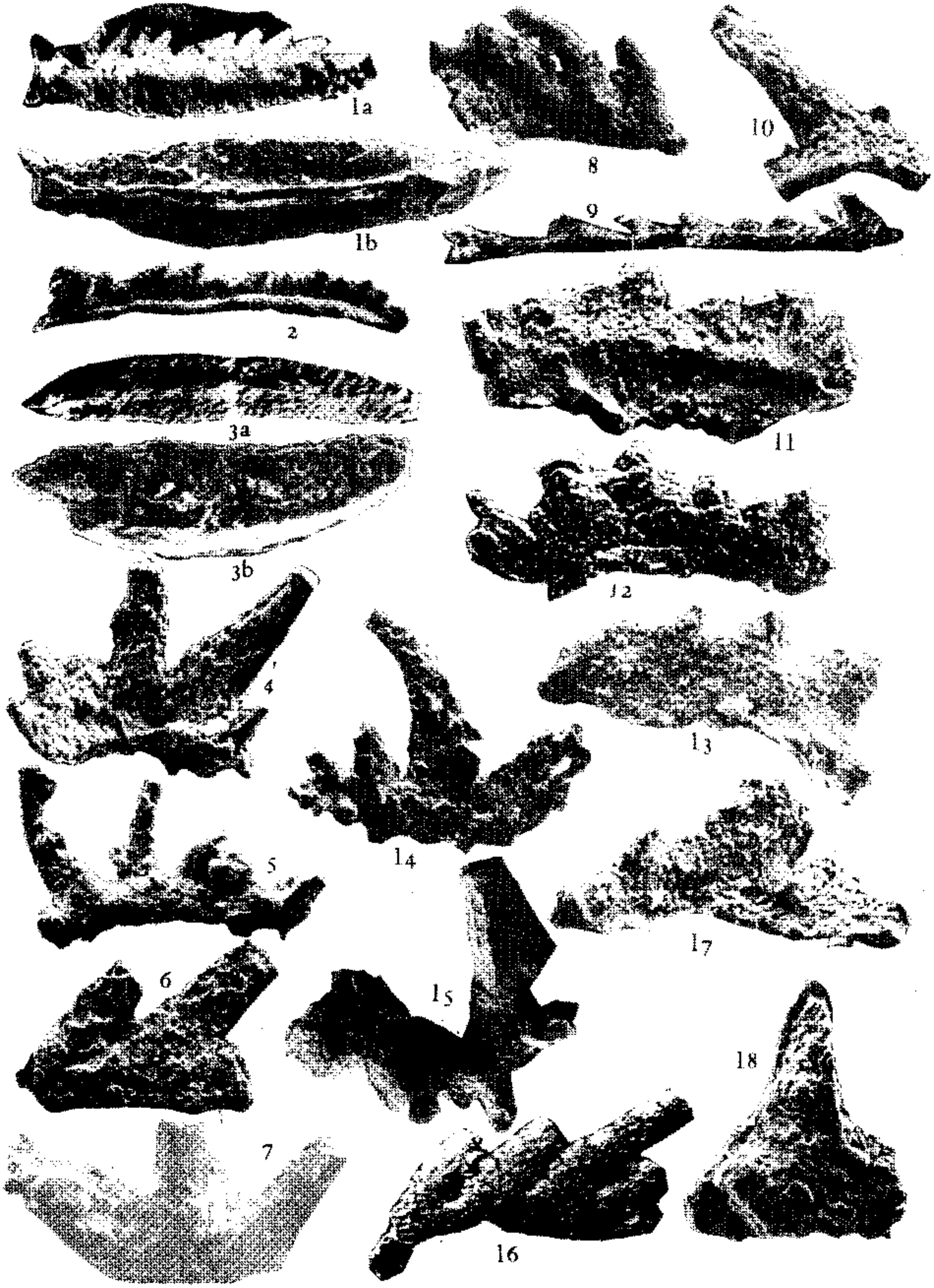
Fig. 14- *Comudinasp.,* lateral view, X100

Fig. 15- *Cratognathodussp.,* X117

Fig. 16- *Enantiognathus* sp., X100

Fig. 17- ?*Ozarkodina-type* unit, lateral view, X120

Fig. 18- *Ozarkodina* sp., lateral view, X184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