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New Stratigraphic and Palaeogeographic Results from the Palaeozoic and Early Mesozoic of the Middle Pontides (Northern Turkey) in the Azdavay, Devrekani, Küre and Inebolu Areas: Implications for the Carboniferous - Early Cretaceous Geodynamic Evolution and Some Related Remarks to the Karakaya Oceanic Rift Basin

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Key words: Pelagic Upper Carboniferous and Permian, Middle Triassic oceanic crust, Upper Triassic to Middle Jurassic accretionary complex, Hallstatt Limestone, *Torlessia*, Microfauna, Northern Turkey, Middle Pontides, Paphlagonian Ocean, Küre Ocean and Karakaya oceanic rift basin.

Abstract

The Küre Complex of the Middle Pontides, northern Turkey, is not a remnant of the Palaeotethys but consists of three different units with differing geological history, the Küre Ridge Unit, the Küre Ocean Unit and the Çalça Unit. The Küre Ridge Unit consists of the Serveçay Group, a pre-Permian, low-grade metamorphic Variscan oceanic sequence, and the Sırçalık Group, a Lower and Middle Triassic shallow-water sequence of North Alpine facies and event succession which disconformably overlies the Serveçay Group. Following a hiatus, the Sırçalık Group is overlain by marginal parts of the Akgöl Group with olistoliths of local origin which were derived mainly from the Sırçalık Group. The Küre Ocean Unit consists mostly of the Akgöl Group (siliciclastic turbidites and olistostromes of the Karadağtepe Formation, which is a middle Carnian to Middle Jurassic accretionary complex from the southern, active margin of the Küre Ocean, and mainly Middle Jurassic molasse type shallow-water sandstones, siltstones and shales of an unnamed formation) and of thick oceanic basalts (İpsinler Basalt). Tectonic slices of Middle Triassic to lower Carnian ophiolites and basalts are also present. The Karadağtepe Formation contains numerous Middle Triassic exotic olistoliths and blocks of shallow-water and predominantly slope and basinal limestones, ocean-floor deep-sea sediments (shales and radiolarites), basalts and small clasts of ophiolites or ophiolitic detritus. The Çalça Unit consists of deposits from the northern, passive margin of the Küre Ocean with many Pelsonian to upper Norian Hallstatt Limestones and Rhaetian - Lower Jurassic (?Middle Jurassic) deep-water shales and marls. All three units are overlain following a period of non deposition by the Upper Jurassic Bürnük Formation (red conglomerate, sandstone) and İnaltı Formation (shallow-water platform carbonates).

The Küre Ridge Unit was split away from the Variscan Sakarya Continent by the opening of the Karakaya oceanic rift basin during latest Permian (Dorashamian) and became a continental splinter between the Karakaya oceanic rift basin and the Küre Ocean (opened during the late Scythian).

Southward subduction began in the Küre Ocean during the middle Carnian (beginning of the Karadağtepe siliciclastic turbidites), whereas at the northern passive margin the deposition of Hallstatt Limestones continued until the latest Norian. The deposition of siliciclastic turbidites and olistostromes (Diskaya Unit) began in the entire Karakaya oceanic rift basin during the middle Carnian, and ocean basin deposits (radiolarites, pelagic limestones) and slope deposits form the passive margin (e.g., Hallstatt Limestones) are no more present in the Karakaya oceanic rift basin indicating that this basin was very narrow (only a few hundreds of kilometres). During the late Norian, the Karakaya oceanic rift basin closed, whereas subduction at the southern (active margin) of the Küre Ocean continued. At the northern margin of the (Upper Triassic?) Jurassic - Lower Cretaceous Beykoz - Çağlayan turbidite basin (north of the Küre Complex) the accretionary complex of an older ocean, the Late Palaeozoic Paphlagonian Ocean, was exposed that yielded clasts in the Beykoz - Çağlayan turbidite basin. Among these clasts Carboniferous to Middle Permian (Capitanian) pelagic rocks (pelagic limestones, radiolarites) could be dated. A Middle to Late Permian southward-directed subduction is assumed for the Paphlagonian Ocean. Its closure occurred either at the end of the Permian or during the Scythian.

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1. INTRODUCTION AND GENERAL GEOLOGICAL SETTING OF THE MIDDLE PONTIDES AND IMMEDIATELY ADJACENT AREAS

The Küre Complex of the Middle Pontides south of Inebolu, northern Turkey (investigated area, Fig. 1) plays an important role in the palaeogeographic reconstructions of the Late Palaeozoic and Early Mesozoic of Turkey and adjacent areas. Two conflicting palaeogeographic models were developed by the ŞENGÖR school (e.g., ŞENGÖR & YILMAZ, 1981; ŞENGÖR, 1984, 1985; ŞENGÖR et al., 1984; GENÇ & YILMAZ, 1995; YILMAZ et al., 1997) on one side, and OKAY and co-authors (e.g., OKAY & MOSTLER, 1994; OKAY et al., 1996) as well as ROBERTSON and co-authors (e.g., PICKETT et al., 1995; USTAÖMER & ROBERTSON, 1995, 1997, 1999; PICKETT & ROBERTSON, 1996) on the other.

The first model regards the Küre Complex as a remnant of the southwards subducting Late Palaeozoic - Triassic Palaeotethys, and the Karakaya oceanic rift basin as a latest Permian - Triassic back-arc basin that was closed during the Upper Triassic by southward subduction.

The second model regards the Karakaya Basin as the large, Devonian to Triassic Palaeotethyan Ocean and the Küre Basin as a short-lasting, small, oceanic basin which opened as a back-arc basin by the northward subduction of the Karakaya oceanic lithosphere.

Some authors considered the Karakaya oceanic rift basin as a Triassic ocean or rift basin (as in the first model) without regard to the age of the Küre Complex (OKAY, 1991; ALTINER & KOÇYIGIT, 1993), whereas YİĞİTBAŞ et al. (1999) regarded the Küre Complex as the remnants of a persistent Palaeotethyan ocean (as in the first model) without regarding the Karakaya Complex. These papers also support the first model.

A third model regarding the relation of the Karakaya oceanic rift basin and Küre Ocean was presented by OKAY & TÜYSÜZ (1999) and OKAY (2000). According to these authors both oceanic basins represent the same large Palaeotethyan ocean and the present separation is a later feature. The HP/LT metamorphic Nilüfer Unit of the Karakaya Complex was regarded as an oceanic plateau despite the fact that the lower half contains shallow-water (?algal) limestones with mafic metatuffs and also in the upper half the water-depth was (according to the fauna) probably not below 100-200 m.

The view of Robertson and co-authors of a Carboniferous-Triassic age of the Karakaya oceanic rift basin is for the Palaeozoic (pre-Dorashamian) part based only on an assumption which is in conflict with the fact that in the post-Bashkirian pre-latest Dzhulfian interval only shallow-water limestones are known and dated (KOZUR & KAYA, 1994; LEVEN & OKAY, 1996; KOZUR, unpubl. data). These Permian shallow-water rocks were regarded by Robertson and co-authors as sea-mount deposits. However, in this case the seamounts of this age interval must be more than 1,000 km long and had filled the entire ocean because basinal and even slope sediments are unknown in this time interval. Moreover, these seamounts had to be persistent (throughout most of the Pennsylvanian, the entire Early and Middle Permian and the lower part of the Late Permian) and covered by a facially stable carbonate platform. Contemporaneous mafic volcanics and volcaniclastics are not known from the Moscovian to middle Dzhulfian interval. All these features are in total contrast with well-documented Permian seamounts in Panthalassa studied by one of the authors (H.W. KOZUR) and also different from Palaeotethyan seamounts (KOZUR & ŞENEL, 1999).

The assumption of a large Carboniferous - Permian (and Triassic) Karakaya Ocean by Okay and co-authors was based on the fact that the youngest olistoliths of the largely broken Variscan basement are cherty limestones of early Bashkirian age (OKAY & MOSTLER, 1994; KOZUR, 1999), whereas red radiolarites of the Dorashamian to Middle Triassic Çal Unit (OKAY et al., 1991) were erroneously dated as Sakmarian-Artinskian in one locality (OKAY & MOSTLER, 1994). Re-examination of this locality SE of Çan in the Biga Peninsula, northwestern Turkey (for precise locality data see OKAY & MOSTLER, 1994) by KOZUR (1999) yielded a rich late Dorashamian radiolarian fauna in all exposed radiolarites confirming the former conodont-based dating of the opening of the Karakaya oceanic rift basin by KOZUR & KAYA (1994). The assumed Late Permian mafic volcanics, mainly tuffs (OKAY & MOSTLER, 1994), were dated as post-latest Scythian because they contain inclusions of conodont-bearing latest Scythian limestones (KOZUR, 1999).

The formerly assumed latest Permian opening of the Karakaya oceanic rift basin (first model, see above) during the Dorashamian Stage could be confirmed palaeontologically by KOZUR & KAYA (1994), KOZUR (1999) and KOZUR et al. (1999). Pelagic uppermost Dzhulfian and Dorashamian limestone olistoliths from the upper Diskaya Unit (KAYA et al., 1986; junior synonym: Hodul Unit, OKAY et al., 1991) and late Dorashamian red radiolarites of the Çal Unit are the oldest pelagic rocks of the Karakaya Complex. The oldest dated mafic volcanics have a Scythian age (Table 1). The missing geochemical signals for subduction related mafic rocks in the Nilüfer Unit of the Karakaya Complex (within plate basalts, USTAÖMER & ROBERTSON, 1999) is no evidence for a large Late Palaeozoic-Triassic Palaeotethyan Karakaya Ocean, as assumed by USTAÖMER & ROBERTSON (1995, 1997, 1999), PICKETT et al. (1995), OKAY et al. (1996) and PICKETT & ROBERTSON (1996), but indicates early rifting in a shallow-water carbonate platform. The Karakaya oceanic rift basin was not even a moderately wide back-arc basin, such as the Küre Ocean, but a very narrow oceanic rift basin which probably never extended beyond the width of the Red Sea. This is also indicated by the fact that from the middle Carnian beginning of

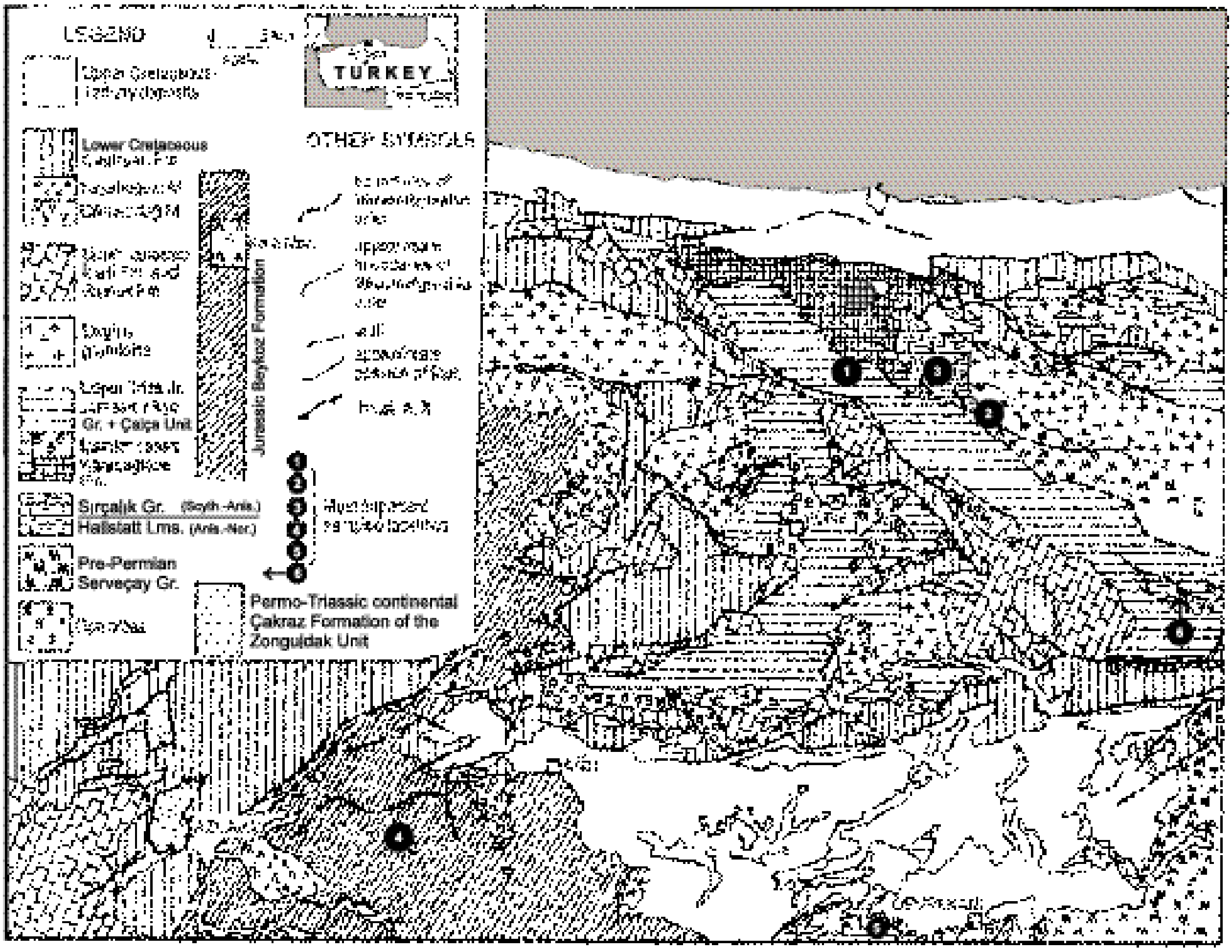

Fig. 1 Geological map of the investigated area. Modified after AYDIN et al. (1995). Legend: 1-6) Most important sampled localities. 1 - outcrop in the middle to upper Carnian turbiditic-olistostromal part of the Akgöl Group at the Küre - Inebolu road. 2 - Outcrop in the Zerveçay creek valley south of Gemiçiler (Evrenye) at the Gemiçiler - Haramidağ road. Serveçay Group overlain by tectonically reduced Scythian (basal conglomerate - sandstone - Werfen marls and limestones) and Anisian "Gutenstein" Limestone. 3 - Outcrops along the road between the villages of Aha and Sırçalık. Scythian with well exposed Werfen beds (partly assigned to the Ladinian on the basis of "*Daonella*", which is a Scythian *Eumorphotis*) overlain by hypersaline beds with "rauhwacke", "Gutenstein" Limestone and Steinalm Dolomite, both Anisian shallow-water platform carbonates of North Alpine character. Some outcrops of the Akgöl Group, partly stratigraphically overlying the Sırçalık Formation, partly tectonic slices of the Karadağtepe Formation. 4 - Outcrop at Kircalla village E of Azdavay. Beykoz Formation with an olistostrome that contains shallow-water and pelagic Permian limestones blocks; the largest one is an almost matrix-free Permian debris flow. 5 - Roadcut at the Kastamonu - Inebolu road, about 3 km west of Devrekani, olistostrome with many olistoliths, consisting mainly of Anisian pelagic, subordinately also shallow-water and slope limestones. About 300 m north of this outcrop, the blocks of Anisian, often ammonoid-bearing pelagic limestones within Akgöl debris flows are several metres in diameter. 6 - Large outcrops of Hallstatt Limestones in the Çalça Unit south of Çalça village.

the siliciclastic turbidite-olistostrome deposition (Diskaya Unit) no turbidite-free pelagic sedimentation continued in the Karakaya oceanic rift basin (neither an Upper Triassic passive margin sequence with Hallstatt Limestones nor Upper Triassic ribbon cherts, shales and pelagic limestones of an ocean floor sequence are known).

As mentioned above, the recent biostratigraphic data have shown that the Karakaya oceanic rift basin existed between the latest Permian (Dorashamian) and Upper Triassic in agreement with the first model (view of the ŞENGÖR school). The southward subduction of the Küre Ocean and the time of the closure of this ocean is also in agreement with the first model. However, the Küre Ocean is not the persistent large Palaeotethys, but a short-lasting latest Scythian to Middle Jurassic back-arc basin as assumed in the second model. Therefore, both former models are partially incorrect. The latest Permian - Late Triassic Karakaya oceanic rift basin is not the back-arc-basin of the Late Palaeozoic - Middle Jurassic Palaeotethyan Küre Basin, because the Küre Basin is a latest Scythian to Middle Jurassic back-arc basin. On the other hand, the Küre Basin is not the back-arc basin of a Devonian - Triassic Palaeotethyan Karakaya Ocean because the Karakaya oceanic rift basin is also a very short lasting basin (Dorashamian to middle Norian). None of the two oceans correspond to the Lower Devonian to Carnian (Upper Triassic) Palaeotethys, the remnants of which (both oceanic crust, MORB and OIB, and well-dated sediments) were

Age	Unmetamorphic Units	Metamorphic Units
middle Norian-middle Carnian	**Diskaya Unit (junior synonym: Hodul Unit)** Siliciclastic turbidites, quartzo-feldspathic sandstones, greywackes, rare authochthonous sediments consisting mainly of black shales and siltstones with middle Carnian to middle Norian fossils. Olistostromes with blocks of Middle and Upper Silurian shallow-water limestones, Upper Silurian to Devonian pelagic limestones, Mississippian black cherts, pelagic, reef and reef slope limestones, lower Bashkirian cherty limestone, upper Bashkirian, Moscovian, late Gzhelian to Sakmarian and Kungurian to Dzhulfian shallow-water limestones, Dorashamian to early Carnian pelagic limestones, Middle Triassic red radiolarites, mafic volcanics, metamorphic limestones, the youngest of early Carnian age, but many of them are undated. The olistoliths are dominated by Wordian and Capitanian shallow-water limestones, Scythian to Middle Triassic pelagic sediments and mafic volcanicc.	
early Carnian-early Anisian, ? Late Scythian	**Çal Unit** Internally disrupted unit (broken formation to melange) of mafic volcanics, pyroclastic flows, debris-flow conglomerates, volcanogenic sandstones, shales and red mudstones. Minor amounts of calciturbidites, pelagic limestones, and red, greenish or grey radiolarites. Blocks of Middle Permian to Middle Triassic shallow-water limestones, Dorashamian pelagic limestones, upper Dorashamian red radiolarites, Lower and Middle Triassic pelagic limestones and undated metamorphic limestones.	**Madradağ Unit** Low-grade metamorphic. In the upper part phyllites, mafic metatuffs, marbles, red phyllitic mudstones, green and red metacherts, debris-flow conglomerates with blocks of pelagic and shallow-water limestones. In the middle part thick mafic metatuffs. In the lower part thick phyllites, with some marbles and litharenites.
middle Scythian		
early Scythian Late Permian		**Nilüfer Unit** In the upper part very low grade, in the lower part HP/LT metamorphic unit, with blueschists. In the upper part shales, siltstones and pelagic limestones. In the largest part mafic metatuffs, metabasalts, with recrystallised pelagic and shallow-water limestones. In the lower part massive, strongly recrystallized shallow-water carbonates with mafic metatuff intercalations. Repititions at internal thrusts and upright isoclinal folds.

Table 1 Units of the Karakaya oceanic complex

recently found in the composite Tavas nappes (Lycian nappes, KOZUR & ŞENEL, 1999; GÖNCÜOĞLU et al., 2000; KOZUR et al., in press c).

The third model (OKAY, 2000), which regarded the Küre Basin and the Karakaya oceanic rift basin as parts of a single ocean, the huge Carboniferous to Middle Jurassic Palaeotethys, is also incorrect. It can be easily proven that the assumed northward subduction of this united Karakaya-Küre Ocean is a wrong assumption not supported by any field data. The northern (Laurasian) margin of the assumed unified Karakaya - Küre Ocean was a passive margin with condensed middle Anisian to late Norian Hallstatt Limestones without any terrigenous input, and Rhaetian - Liassic shales and marls. Therefore, the deposition of Hallstatt Limestones continued at the northern margin of the assumed Karakaya-Küre Ocean after the beginning of siliciclastic turbidites and olistostromes at its active southern margin and even after the closure of the Karakaya rift basin at the end of the middle Norian or within the late Norian. Moreover, uniting two Early Mesozoic oceanic basins do not create a Carboniferous to Middle Jurassic ocean.

The age of the Küre Complex was based on assumptions in all previous models. Either the units (metamorphic and non-metamorphic), like the non-metamorphic Akgöl Group have not yielded stratigraphically important fossils or their age was misinterpreted. Thus, different or very imprecise ages were given even for the non-metamorphic units. For instance, the age of the Akgöl Group is said to be pre-Middle Jurassic (OKAY 2000), Early Triassic to Early-Middle Jurassic (USTAÖMER & ROBERTSON, 1997), Permian to Middle Jurassic (YİĞİTBAŞ et al., 1999), Carboniferous to Liassic (YILMAZ & ŞENGÖR, 1985; AYDIN et al., 1986; ÖNDER et al., 1987; YILMAZ et al., 1997) or Upper Palaeozoic to Early Mesozoic (USTAÖMER &

ROBERTSON, 1999). According to USTAÖMER & ROBERTSON (1999) "southward subduction of the Küre oceanic lithosphere is inferred to have started in Early Triassic time, the oldest well established age of the Küre marginal basin". Lower Triassic fossils are unknown from the oceanic Akgöl Group and the subduction began in the Middle Carnian (see below). As shown in this paper, the oldest pelagic limestones known from olistoliths in the Akgöl Group (and from the entire Küre Complex), are of earliest Middle Triassic age. Thus, the opening of the Küre Ocean began either in the earliest Middle Triassic or during the latest Scythian. Thus, the "well established age" of the beginning subduction was even before the Küre Ocean opened. The age of the metamorphic units of the Küre Complex is much more uncertain than the above mentioned different age ranges for the fossiliferous oceanic Akgöl Group.

It is obvious that exact stratigraphic dating of the oceanic Akgöl Group and the continental units of the Küre Complex is necessary before the former tectonic models can be evaluated and a new model can be established to explain the geological evolution of this complex and the adjacent oceanic units where all previous hypotheses have failed. Therefore, the main topic of the present paper is the dating of the Küre Complex and adjacent units. The basis of this work was the careful mapping and detailed lithostratigraphic subdivision of the units by AYDIN et al. (1995). In the terminology of that paper, the Küre Complex consists of the Bekirli Group (Serveçay Group of the present paper), the Sırçalık "Formation" and the Akgöl "Formation" (the formations are in reality groups subdivided below into different formations and units).

Many important biostratigraphic results were obtained both from the matrix and from olistoliths in different turbidite-olistostrome units which allow to make new palaeogeographic reconstructions. The upper age limit of the metamorphic units within the Küre Complex could be determined by the dating of transgressively overlying units. These results did not confirm the three afore-mentioned models of the geological evolution of the Küre Complex and adjacent oceanic and continental units.

2. TECTONOSTRATIGRAPHIC UNITS OF THE KÜRE COMPLEX, THEIR LITHOLOGIES AND AGES

The Küre Complex includes three main tectonostratigraphic units: the Küre Ridge Unit, the Küre Ocean Unit and the Çalca Unit, and a tectonic inlayer, the Devrekani Metamorphics. The names of the lithostratigraphic units, except for the Bekirli Group, are overtaken from AYDIN et al. (1995). Some modifications are necessary in the assumed mutual relations and above all in the assumed ages. The ages are partly also discussed under biostratigraphic results.

2.1. DEVREKANI METAMORPHICS

The Devrekani Metamorphics (Ebrek Metamorphics of YILMAZ, 1981) occur as a tectonic inlayer within the Küre Complex, and consist of gneisses, amphibolites, calc-schists and marbles. The rock-units are too highly metamorphosed (amphibolite facies) for palaeontological or palynological investigations. Only relative age dating is possible. However, gneisses taken 6 km east of Devrekani village, were dated as 311 ± 6.2 my (AYDIN et al., 1995) indicating a Middle Carboniferous age and giving an upper age limit for these metamorphics. We regard the Devrekani Metamorphics as Variscan metamorphics. A Precambrian age of the Devrekani Metamorphics assumed or tentatively assumed by several authors (e.g. USTAÖMER & ROBERTSON, 1995) is not probable for facies reasons (mainly pelagic platy limestones with shale intercalations and olistoliths and blocks of shallow-water limestones). But older Precambrian units within the Variscan Devrekani Metamorphics may be present. This question can only be solved by further radiometric dating.

2.2. KÜRE RIDGE UNIT

The metamorphosed Variscan basement of the Serveçay Group and the overlying unmetamorphosed but deformed Sırçalık Group (and the partly present cover of marginal parts of the Akgöl Group) built up the Küre Ridge Unit of the Küre Complex (Fig. 2). The Küre Ridge Unit was during the Triassic the common shelf of the Küre Ocean and the Karakaya oceanic rift basin (southern shelf of the Küre Ocean and northern shelf of the Karakaya oceanic rift basin). As direct biostratigraphic dating is only possible for the Sırçalık Group and the upper age limit of the Serveçay Group metamorphics depends on exact age determination of the Sırçalık Group and its structural position to the Serveçay Group, the younger Sırçalık group is firstly discussed.

2.2.1. Sırçalık Group

The Sırçalık Group (in the rank of Sırçalık Formation) was regarded as a sedimentary intercalation within the upper part of the metamorphics of the Bekirli Group (Serveçay Group in the present paper, see below) by AYDIN et al. (1995). However, the intercalation of Middle Triassic shallow-water platform carbonates within the uppermost "Bekirli Metamorphics" (Serveçay Group) could not be confirmed in the Zerveçay creek valley section south of Gemiçiler (Evrenye) at the Gemiçiler - Haramidağ road (locality 2 in Fig. 1), where this "intercalation" of the Sırçalık "Formation" within the upper Serveçay Group with "gradual transition" to the Serveçay Group was established. The deformed, but unmetamorphosed shallow-water carbonates, without any siliciclastic input are there tectonically sliced with low-grade metamorphic siliciclastic sediments of the Serveçay Group. Carbonate intercalations within the Serveçay Group always occur as strongly recrystallized

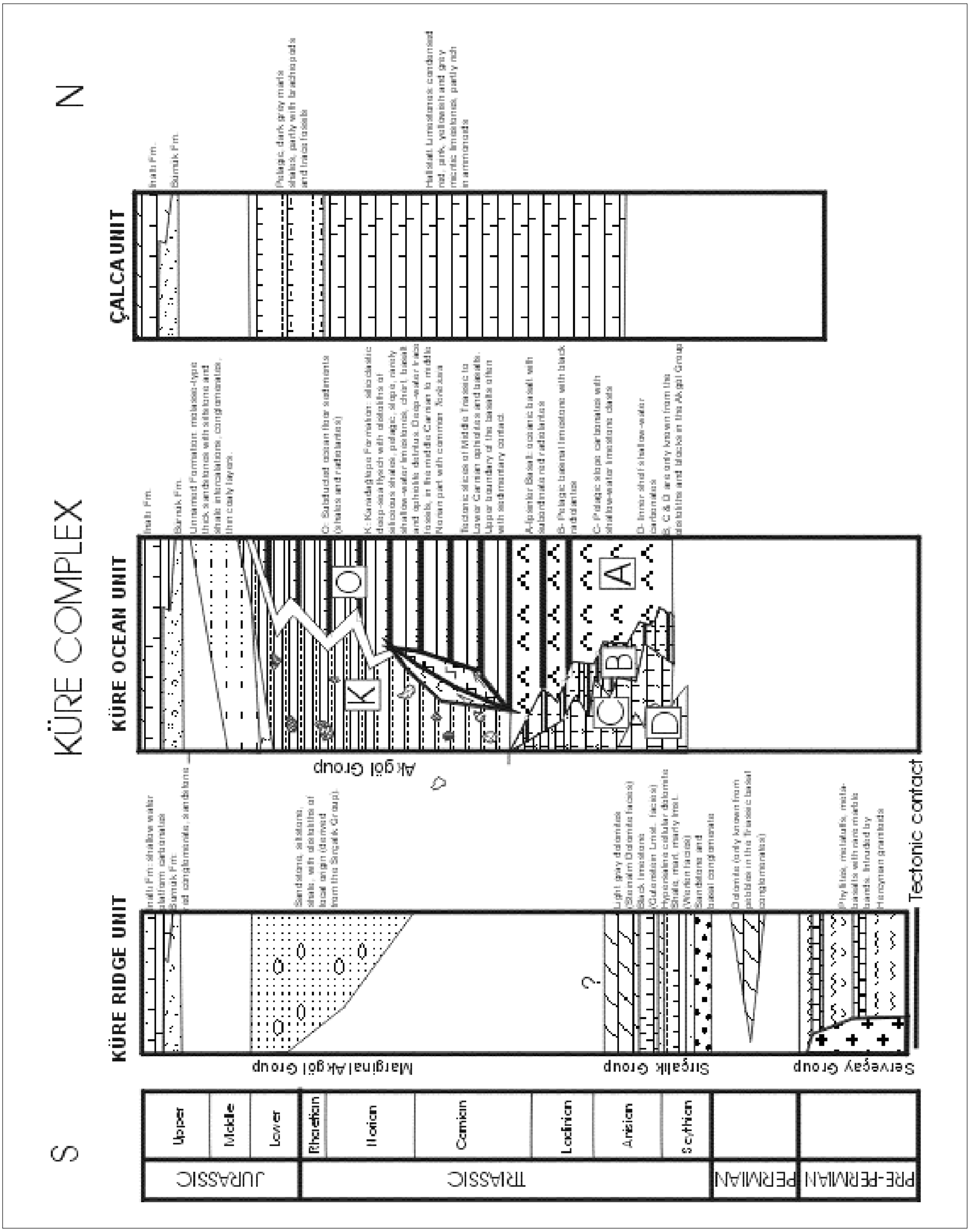

Fig. 2 Lithological successions in the three units of the Küre Complex.

marbles, so strongly metamorphosed that no determinable fossils are preserved. In the deformed but unmetamorphic carbonates of the Sırçalık Group not only microfossils (foraminifers, *Spirorbis*) but also determinable macrofossils (bivalves) are present.

The discovery of tectonically reduced Scythian rocks beneath the Middle Triassic shallow-water limestones in Zerveçay creek valley section was important as they stratigraphically, but disconformably overlie the Serveçay Group and begin with a quartz conglomerate derived from the metamorphic rocks of the Serveçay Group. This basal conglomerate also contains scarce pebbles of a beige, unmetamorphosed dolomite of pre-Scythian/post-Variscan age, apparently indicating reworking of Late Carboniferous or more probably Permian shallow-water carbonates. This basal conglomerate is overlain by continental or shallow-marine sandstones in the typical facies of the Alpine Buntsandstein that are overlain by Werfen Beds (upper Scythian yellowish-brown weathered marls, siltstones and limestones). After a hypersaline horizon with "rauhwacke" (yellowish-brown cellular dolomite and dolomitic marl, which is also common close to the Olenekian-Anisian boundary of the Alps and Western Carpathians) typical Alpine shallow-water Anisian deposits are present (Gutenstein Limestone and Steinalm Dolomite, see below).

Such varied lithostratigraphic units as conglomerates, sandstones, siltstones, marls and marly limestones with the facies type of the Alpine Buntsandstein and Werfen Beds, as well as shallow-water platform carbonates (Gutenstein Limestone and Steinalm Dolomite) cannot be assigned to one formation, but only to several formations. Therefore, the Sırçalık "Formation" is regarded as a group. Special formation names were not proposed but the North Alpine terms, such as Werfen Beds, Gutenstein Limestone and Steinalm Dolomite has been preliminarily applied.

The Middle Triassic age dating of the shallow-water carbonates (AYDIN et al., 1995) has been confirmed. The shallow-water carbonates in the above mentioned section and in adjacent areas (e.g. at the roadcut between the villages of Aha and Sırçalık, locality 3 in Fig. 1) consist mainly of Gutenstein Limestone and Steinalm Dolomite that is lying partly with erosive contact on the Gutenstein Limestone.

The shallow-water carbonates and underlying typical Werfen facies sediments (well exposed and not tectonically reduced along the road between Aha and Sırçalık) were previously dated as Middle Triassic on the basis of *Meandrospira pusilla* (HO), *Meandrospira dinarica* KOCHANSKY-DÉVIDÉ & PANTIĆ and *Daonella taramelli* MOJSISOVICS by AYDIN et al. (1995). However, *M. pusilla* is very characteristic for the Upper Scythian and confirms the late Scythian (late Olenekian, Spathian) age of the typical Werfen Beds in this area. *Daonella taramelli* from a slightly different position in the same beds is an incorrect determination. The densely ribbed bivalve that Dr. M. Aydin found from these beds during a joint excursion of the authors, is a Scythian *Eumorphotis*, and surely not a *Daonella* that is, moreover, restricted to a totally different (pelagic) facies, whereas these Werfen Beds are shallow-water sediments. Moreover, *Daonella* is not present during the Scythian.

As typical for Scythian shallow-water limestones, the thin-sections of the "*Daonella*" limestones are very poor in microfossils but contain *Spirorbis phlyctaena* BRÖNNIMANN & ZANINETTI as a typical microfossil of Scythian shallow-water limestones and *Meandrospira pusilla* as a characteristic Spathian foraminifer. Also by dissolving of the material no pelagic Ladinian microfossils were found that are always very common in *Daonella*-bearing limestones. Instead, pyritised microgastropods and some (non-*Daonella*) small bivalves are common, as are also typical for the shallow-water Werfen facies. The pyritised fossils were oxidised into iron oxide.

On the other hand, the Anisian age for the shallow-water carbonates indicated by *M. dinarica* has been confirmed by the characteristic lithofacies of these beds. They consist mostly of Gutenstein Limestone (black micritic, partly dolomitic limestones, very poorly fossiliferous, a restricted shallow basin facies), and Steinalm Dolomite that overlies the former partly with erosive contact. Exactly the same facies succession and relations of these lower to middle Anisian rocks can be found at the shelves of the Cimmerian Meliata-Hallstatt Ocean in the Western Carpathians and Eastern Alps. This facies association was present there before the opening of the Meliata-Hallstatt Ocean in the uppermost lower Anisian to Pelsonian and, consequently, can be found in the lower part of the shelf sequences on both sides of that ocean (KOZUR, 1991a, b).

The transition between the Werfen Beds and the Anisian shallow-water carbonate platform is developed in exactly the same manner as in the Northern Calcareous Alps and Western Carpathians, the hypersaline horizon at the Olenekian-Anisian boundary with intensively yellowish brownish weathered dolomitic marls and cellular dolomite ("rauhwacke") is also present at the road cut between the Aha and Sırçalık villages (locality 3 in Fig. 1).

This typical shallow-water development of the Scythian to Middle Triassic Sırçalık Group is a characteristic North Alpine facies shallow-water succession, widely distributed in the Eastern Alps and Western Carpathians.

2.2.2. Serveçay Group

The Serveçay Group consists of low-grade metamorphic phyllites, mafic metatuffs, calcituffites, metadiabases and crystalline limestones (marbles). Radiolarites are absent but silicified metasediments are present. The type locality is the Zerveçay creek valley section south of Gemiçiler (Evrenye) at the Gemiçiler - Haramidağ road (locality 2 in Fig. 1). At the type locality, the oceanic, low grade metamorphic Zerveçay Group is disconformably overlain by the Scythian part of the deformed but unmetamorphosed Sırçalık Group beginning with a basal conglomerate. This discovery is decisive important for the upper age of the Serveçay Group that must be of pre-Triassic age, probably a Variscan metamorphic basement. As unmetamorphosed pre-Triassic, probably Permian dolomite pebbles occur in the Lower Triassic basal conglomerate, a pre-Permian age for the Serveçay Group is indicated. Therefore, the Middle Triassic upper age range for the "Palaeotethyan" metamorphics of the Küre Complex (AYDIN et al., 1995) cannot be confirmed.

The Serveçay Group was assigned to the Bekirli Group by AYDIN et al. (1995), but they also included the unrelated and unmetamorphic Sırçalık Group in their Bekirli Group, the type locality of which is at Bekirli village in the Elekdağ Massif (YILMAZ & TÜYSÜZ, 1988). The original Bekirli Unit was described by YILMAZ & TÜYSÜZ (1988, p. 79) as "a tectonic unit with basic lava-pelitic sediment alternation, starts with garnet-glaucophane-bearing basic lavas grading into basic lava-pelitic schist alternation. Towards top, metamorphism decreases and sedimentary rocks dominate over volcanic rocks. The uppermost part is a typical flysch sequence." Furthermore YILMAZ & TÜYSÜZ (1988, p. 81) pointed out: "considering the stratigraphy and lithologies, it corresponds to the epiophiolitic cover of the Palaeotethyan oceanic crust". Flysch sediments are not present in the Serveçay Group of the Küre Complex. The metamorphic overprint is also different; glaucophane is not present in the Serveçay Metamorphics. The so-called "Palaeotethyan oceanic crust" of the Middle Pontides is Middle Triassic oceanic crust with back-arc geochemical character and therefore not Palaeotethyan oceanic crust. If the geological situation of the Bekirli Unit in its type area is correctly interpreted, the type Bekirli Metamorphics should be of Mesozoic age. Subsequently, TÜYSÜZ et al. (1990) regarded the Berkirli Unit as a formation which overlies the Elekdağ ophiolites (in the north), and the Triassic Kunduz mélange and the Aktaş "Formation" (sensu YILMAZ et al., 1997) or Aktaş "metamorphic association" (YILMAZ et al., 1997, p. 198) (assumed Upper Palaeozoic marbles and Lower Triassic mélange) of the Karakaya Complex (in the south). This also means that the type Bekirli Unit is an Early Mesozoic unit. According to YILMAZ et al. (1997) there is a stratigraphic succession of metamorphic rocks which starts with the Aktaş Formation that contains Upper Carboniferous and Permian fossils at its base. It is overlain by the Gümüşoluğu Formation which consists of metapelites and metavolcancis with some marbles and ophiolite and marble blocks at the top. This formation is gradually overlain by the Bekirli Metamorphics which consists of metashales and metaflysch. According to YILMAZ et al. (1997) the Aktaş-Bekirli succession indicates a transgressive Triassic sequence above continental basement. "This sequence represents continental rifting and rupture of a Permo-Carboniferous continental platform, and then the rift evolved into a deep basin" (YILMAZ et al., 1997, p. 199). According to this view, the Bekirli Metamorphics in the sense of YILMAZ et al. (1997) are also Mesozoic in age. However, what is interpreted as a stratigraphic succession may also be a structural succession and in this case the age of the Bekirli Metamorphics is unknown. However, the consensus from all papers on the Bekirli Metamorphics in its type area is that it seems to be an Early Mesozoic Unit and, therefore, this name cannot be applied to the metamorphics of the Küre Complex which are clearly pre-Permian in age.

In silicified metasediments radiolarians are common in few thin-sections, but because of their bad preservation they cannot be determined. Nevertheless, Nassellaria are totally missing indicating a Palaeozoic age. We regard the Serveçay Group as a Variscan basement.

As discussed above, the assumed upper age of the Serveçay Group as Middle-Upper Triassic (AYDIN et al., 1995) could not be confirmed. This age was not assumed on the base of palaeontological/palynological or radiometric data, but on the erroneous assumption that the Sırçalık "Formation" is a sedimentary intercalation within the upper "Bekirli" Metamorphics (see under Sırçalık Group). The only date of the metamorphics of the Serveçay Group (311±6.2 Ma) presented by AYDIN et al. (1995) indicates a Carboniferous age in agreement with our assumption that the Serveçay Group represent a Variscan basement. This is confirmed by Variscan granitoids which intrude the metamorphic rocks of the Serveçay Group. They were dated by TERZIOĞLU & SATIR (1997) as 308 Ma by single zircon evaporation technique.

2.3. KÜRE OCEAN UNIT

This unit includes the Akgöl Group (largest part of the former Akgöl Formation sensu lato of KETİN, 1962, which had been revised several times - e.g. AYDIN et al., 1995; KOZUR et al., 1997, 1999) as well as ophiolites and related oceanic assemblages (İpsinler Basalt and ophiolites) which were previously also assigned to the Akgöl Formation *s.l.*

2.3.1. İpsinler Basalt and ophiolites

The İpsinler Basalt mainly consists of pillow lavas, without essential sedimentary intercalations. It is part of a dismembered ophiolite that comprises serpentinised peridotite, layered cumulate gabbros, isotropic microgabbros, a sheeted dyke complex and pillow lava (GÜNER, 1980; USTAÖMER & ROBERTSON, 1995). The ultramafics consist of serpentinised harzburgite of tectonite origin and and lerzolites which form small intrusive bodies in gabbros and basalt. Trondhjemite-granophyres and altered plagiogranites are also present (TERZIOĞLU et al., 2000). If the basalts are not olistoliths, the observed lower contact of the ophiolites is tectonic, as pointed out by USTAÖMER & ROBERTSON (1995). The upper contact may also be tectonic (e.g., slices of pillow lava within the Akgöl Group), but according to USTAÖMER & ROBERTSON (1995), the upper contacts are commonly undeformed sedimentary contacts.

According to USTAÖMER & ROBERTSON (1995), the basalts belong to an ophiolitic sequence with supra-subduction chemical composition. They interpreted them as supra-subduction ophiolites of the northwards subducting Karakaya Ocean. However, this interpretation cannot be confirmed because there is no Middle Triassic - lower Carnian or older accretionary complex in the Karakaya oceanic rift basin. The mafic volcanics and rarely also the ultramafics of the Küre Complex are already present as olistoliths in the middle Carnian part of the Karadağtepe turbidites. Thus, these volcanics are pre-middle Carnian and, therefore, cannot be related to the subduction of this very narrow oceanic basin. We regard them either as related to the northward subduction of Palaeotethys which was situated south of the later Izmir-Ankara Belt or the subduction signal is inherited from former southward subduction of the Paphlagonian Ocean.

A similar situation is known from Triassic rift-related basalts at the southern margin of Tethys despite the fact that there is no southward (Gondwana-) directed subduction at that time (DIXON & ROBERTSON, 1999). According to these authors, the arc-type geochemical signature is generally believed to have been inherited from an earlier subduction-induced metasomatism and to reside in the lithospheric mantle. This explanation of a relatively recent inherited arc signature can be well applied for the İpsinler basalts because the Küre Ocean opened during the Triassic on Variscan basement and, moreover, the northward adjacent Paphlagonian Ocean was subducted southward during the Middle - Late Permian.

The age of the İpsinler Basalt is difficult to establish. Sedimentary intercalations (dark shales), reported by USTAÖMER & ROBERTSON (1995) have not yielded fossils. All such sedimentary intercalations that we have seen are unfossiliferous tectonic slices of black shales. Their age would not necessarily give the age of the volcanics. Olistoliths of red radiolarites (found by M. Aydin in the Küre area), that could belong to primary sedimentary intercalations, are not exposed at present.

K-Ar dating yielded a Dogger (Bajocian) age for the basalts (170±6 Ma, AYDIN et al., 1995, and 168±5 Ma, TERZIOĞLU et al., 2000) or an age close to the Berriasian/Valanginian boundary (137±3 Ma, 136±6 Ma, TERZIOĞLU et al., 2000). The Bajocian age is not reliable because olistoliths of these basalts and of ultramafics are present in the middle to upper Carnian part of the siliciclastic turbidites of the Karadağtepe Formation. Thus, they must be older than middle Carnian. Also USTAÖMER & ROBERTSON (1997) did not consider the 170±6 Ma date (AYDIN et al., 1995) as reliable in view of the low potassium content and hydrothermally altered nature of the basalts. The younger set was put into the upper Tithonian by TERZIOĞLU et al. (2000), but in recent papers, the Tithonian-Berriasian boundary was placed at 144.2±2.6 Ma (e.g. GRADSTEIN et al., 1994; MENNING, 1997) and the Berriasian-Valanginian boundary at 137.0±2.2 Ma (e.g. GRADSTEIN et al., 1994) or around 136 Ma (MENNING, 1997). They are therefore much younger than any rock of the Küre Complex, which is unconformably overlain by the Upper Jurassic Bürnük Formation and İnaltı Formation and, consequently, must be older than these formations. Therefore, these basalts cannot belong to the Küre Complex. However, they may belong to the Kadi Member, basalts within the uppermost Beykoz Formation.

The oldest pelagic sediments from olistoliths which accompany the olistoliths of mafic and ultramafic rocks within the Karadağtepe Formation of the Akgöl Group are earliest Anisian in age. Very rare olistoliths of Scythian sediments are pre-rift shallow-water sediments. Thus, the age of the ophiolite and basalt olistoliths in the middle-late Carnian part of the Karadağtepe Formation is Middle Triassic, probably Ladinian (Ladinian sediments are not dated among the olistoliths of the Karadağtepe Formation and may be represented by the above mentioned red radiolarites and shales).

A Middle Triassic age is also assumed for those ophiolites or pillow lava that have a tectonic lower and sedimentary upper contact within the Karadağtepe Formation (as shown by USTAÖMER & ROBERTSON, 1995). These ophiolites and pillow lavas are regarded as synsedimentary (during the Upper Triassic subduction) obducted parts of the ocean floor within the accretionary complex.

Kimmeridgean basalts (AYDIN et al., 1995) may indicate an extensional regime in the Jurassic-Early Cretaceous turbidite basin (Beykoz-Çağlayan Basin). These basalts are unrelated to the previously discussed basalts (and ophiolites).

After completion of these investigations, ophiolite slices were found in black deep-water shales west of Esentepe (east of locality 6 outside of the mapped area in Fig. 1). They are accompanied by slices of pelagic limestones that yielded some foraminifers (under study). The immediately eastwards adjacent rocks of the Karadağtepe Formation yielded Upper Triassic *Torlessia*.

2.3.2. Akgöl Group

Previously, four different entities were placed into the Akgöl "Formation", three of which (the İpsinler Basalt and ophiolites, Karadağtepe Formation and an overlying unnamed formation) belong to the Küre Ocean Unit of the Küre Complex, whereas the newly established Çalça Unit, which was also included into the Akgöl "Formation", is an independent passive margin unit of the Küre Complex (Fig. 2). Only the Karadağtepe Formation and the overlying unnamed formation belong to the Akgöl (Fig. 2) which has to be elevated to group rank.

2.3.2.1. Karadağtepe Formation

This formation consists of dark siliciclastic turbidites with olistostromes. Very few fossils (some badly preserved sporomorphs of Triassic age) were previously reported until now from the matrix of this formation (ALIŞAN et al., 1992; AYDIN et al., 1995) but sporomorphs from the turbidites are mostly reworked. Moreover, except the long-ranging *Vitreisporites pallidus* (REISSINGER) NILSSON, all other forms are only determined to genus level or the species determination was indefinite (cf.).

Rich associations of the enigmatic fossil *Torlessia* and trace fossils (Pl. 15) were discovered in the matrix. Two different species of *Torlessia* are present in the Karadağtepe Formation. Both species also occur in New Zealand (KOZUR, unpubl.), where they can be dated by radiolarians. *Torlessia* n. sp. (Pl. 15, Fig. 1) has a middle to late Carnian age (KOZUR et al., in press b) and *T. mackayi* BATHER (Pl. 15, Fig. 2) is of lower to middle Norian age. This age of *T. mackayi* is also confirmed by an early to middle Norian age of *Torlessia mackayi* in the Antalya nappes, where this species is very common in beds which could be dated by conodonts (KOZUR, 1998).

Both species can be partly found in stratigraphic superposition in the Karadağtepe Formation, *Torlessia* n. sp. in the lower part and *T. mackayi* in the middle part of the Karadağtepe Formation. Therefore, for the first time, exact dating of the lower and middle Karadağtepe Formation is possible. A middle Carnian to middle Norian age for this part of the Karadağtepe Formation is indicated.

The upper Karadağtepe Formation and the overlying molasse type shallow-water part of the Akgöl Group are not yet dated. This interval is younger than middle Norian and older than the overlying Upper Jurassic rocks.

The rich trace fossil associations of the Karadağtepe Formation (e.g., *Chondrites*, few *Helminthoida*, *Psycosiphon*, several new ichnotaxa, but no *Paleodictyon*) indicate deep-water, but probably a water depth above the CCD, probably around 1,000 to maximum 2,000 m.

The olistoliths of the Karadağtepe Formation are exotic pebbles, consisting of small clasts of Middle Triassic basalts (see above) and a few ultramafics, mainly small clasts of marginal ocean-floor sediments (black radiolarites, partly with sporomorphs of early Anisian age, Pl. 1, Figs. 7-10; few red radiolarites), and above all of partly large blocks of a fossil-rich Middle Triassic oceanic slope sequence consisting of shallow-water, and mainly slope and basinal limestone (Pl. 3, Figs. 1-3, 5, 6; Pl. 4; Pl. 5, Figs. 1-11; Pls. 6-10; Pl. 11, Figs. 1-9; Pls. 11-13; Pl. 14, Figs. 1-10). The oldest pelagic rocks contain conodonts and other microfossils of the *Chiosella timorensis* Zone of the basal Anisian (Pl. 7, Figs. 12-15; Pls. 8, 9; Pl. 10, Figs. 1-3). Palaeopsychrosphaeric ostracods of the cold oceanic bottom water are present from the upper Aegean (lower Anisian) *Neogondolella ? regalis* Zone onwards (Pl. 12, Figs. 6-10; Pl. 13; Figs. 1-9). Olistoliths of the Sırçalık Group and Serveçay Group are generally not present in the Karadağtepe Formation, except for small olistoliths of metamorphics from the Serveçay Group and a single olistolith of a red continental, probably Lower Triassic sandstone from locality 5 west of Devrekani (Fig. 1). Thus, the olistoliths in the Karadağtepe Formation were mainly derived from an ocean slope north of the Sırçalık shallow-water platform (with its Serveçay Metamorphics Variscan basement). Clasts of obducted ocean floor are also present. This is typical for an active margin setting.

2.3.2.2. Unnamed lithostratigraphic unit

It consists of mainly thick sandstones with siltstone and shale intercalations, some thin coaly layers and also some conglomeratic layers. Land plant remains are present. These beds have a molasse character and are distributed beyond the Karadağtepe Formation. These shallow-water sediments overlie the Sırçalık Group or the Serveçay Group and contain a lot of reworked local material. Similar rocks of the Akgöl Group also overlay the Karadağtepe Formation, but a gradual contact has not been observed anywhere. They may overlie the Karadağtepe Formation either discordantly or tectonically. A formal formation name has not yet been established for these shallow-water deposits of the Akgöl Group but these rocks are genetically very different (no turbidites of an accretionary complex, but shallow-water clastics on a carbonate platform or metamorphic basement and partly also covering the accretionary complex) from the Karadağtepe Formation (siliciclastic turbidites and olistostromes of an active margin).

2.4. ÇALÇA UNIT

This unit is the passive margin sequence of the Küre Ocean and consists of Pelsonian to Upper Norian or lowermost Rhaetian Hallstatt Limestones, overlain by grey to dark-grey marly siltstones and shales of Rhaetian to at least Early Jurassic age with large slided blocks of Hallstatt Limestones of North Alpine type. These rocks, well exposed around the Çalça village are not only sedimentologically, but also different in the age from the Akgöl Group. The Akgöl Group consists of middle Carnian to Middle Jurassic, carbonate-free siliciclastic rocks without a shelly macrofauna. In its largest part (Karadağtepe Formation) it consists of turbidites and olistostromes. The Çalça Unit also consists of deep-water deposits (but well above the CCD), but turbidites are not present. However, the Çalça Unit begins at least during the middle Pelsonian (until now oldest dated Hallstatt Limestone), whereas the upper age range is seemingly the same as for the Akgöl Formation. During deposition of the siliciclastic turbidites of the Karadağtepe Formation at the active southern margin of the Küre Ocean, the deposition of condensed Hallstatt Limestones without any clastic input continued throughout the pre-Rhaetian Upper Triassic at the passive, opposite (northern) margin of the ocean. Only during the Rhaetian and Lower Jurassic did the sedimentation of marls with shelly macrofaunas begin, and shortly before the closure of the ocean during the Middle Jurassic, as the active southern margin was close to the passive northern margin, deepening and tectonic unrest caused the sliding of blocks from the northern outer shelf and slope into the basin. They contain large masses of Hallstatt Limestones that are unknown from the Akgöl Group. The lithological differences between the Akgöl Group and the formations of the Çalça Unit exclude the Çalça Unit from the Akgöl Group (or even formation, as in AYDIN et al., 1995). The obviously different depositional environments at the opposite margins of the ocean does not allow the placing of both units into one tectonostratigraphic unit. Lithology, depositionary history and age are different.

The Çalça Unit and the blocks of Pelsonian to Norian Hallstatt Limestones in it will be discussed in an independent paper by KOZUR et al. (in prep.).

2.5. UPPER JURASSIC - LOWER CRETACEOUS COVER UNITS

The post-orogenic cover units (with respect to the Cimmerian orogeny) of the Küre Complex and adjacent units area are represented by the Bürnük, İnaltı, Beykoz and Çağlayan formations.

2.5.1. Bürnük and İnaltı formations

The Bürnük Formation consists of mainly red coloured conglomerates and sandstones of a transgressive series. It is overlain by the İnaltı Formation consisting of Upper Jurassic platform carbonates that are thin-bedded in the lower part and thick-bedded in the upper part.

The Bürnük Formation overlies with angular unconformity the accretionary complex of the Akgöl Group, and also rocks of the Zonguldak Terrane that was originally far north of the depositional area of the Akgöl Group. The Bürnük and İnaltı formations belong therefore to a typical post-orogenic (with respect to the Cimmerian orogeny) cover unit. The Late Jurassic age of the İnaltı Formation is well documented by fossils (AYDIN et al., 1995). In the entire investigated area, the Bürnük-İnaltı cover unit is only missing in the Azdavay-Ağlı-Dikmendağ area, where an extensional turbidite basin (Beykoz-Çağlayan turbidite basin) opened above marginal parts of the Küre Complex or north of it. According to AYDIN et al. (1995) the Beykoz Formation, deposited within Beykoz-Çağlayan turbidite basin, interfingers with the İnaltı Formation both in the north and in the south.

2.5.2. Beykoz Unit

In this study the Beykoz Formation and the overlying Çağlayan Formation are united to the Beykoz Unit. The relation of the Beykoz Unit to the Küre Complex was not investigated. However, the original position of the Beykoz Unit was north of the Küre Complex or/and it overlies its northern margin.

2.5.2.1. Beykoz Formation

Deep-water black shales and turbidites of a previously assumed Upper Triassic to Malm age in the Azdavay-Ağlı-Dikmendağ area has been discriminated by DEMIR & ÖZÇELIK (1987) and AYDIN et al. (1995) as the Beykoz Formation. They were deposited in an extensional basin above marginal parts of the Küre Complex or north of it, rather than in a compressional remnant basin of the Küre Ocean. The Beykoz Formation is overlain by Lower Cretaceous turbidites of the Çağlayan Formation. A new impulse of extensional tectonics is indicated in the uppermost Beykoz Formation by mafic volcanics (Kadi Member) and by an olistostromal conglomerate in the lower part of the overlying Çağlayan Formation.

The age range of the Beykoz Formation is difficult to establish and is not the topic of the present paper. DEMIR & ÖZÇELIK (1987) and AYDIN et al. (1995) assumed a Late Triassic to Malm age. However, we did not find any evidence for Late Triassic age. The *Helminthoida* dominated trace fossil association does not contain any of the characteristic new Upper Triassic ichnotaxa (KOZUR & YAKAR, in prep.; AYDIN & DEMIR, in prep.) which are common in all Upper Triassic deep-water turbidites of the Akgöl Group. The ichnofauna of the "*Helminthoida* flysch" in the Beykoz Unit is rather characteristic for Jurassic and younger turbidites. The Upper Triassic *Torlessia*, which is very common in the Karadağtepe Formation of the Akgöl Group, is missing even in the oldest beds of the Beykoz Formation. The youngest age of conglomerates and olistoliths in the Beykoz Formation is Late Jurassic. This is in agreement with the late Malm age of the Kadi Basalt Member and accompanying red marls in the upper Beykoz Formation (AYDIN et al., 1995). In those successions, in which the Çağlayan Formation begins during the Valanginian or Barremian, the Beykoz Formation may range into the lowermost Cretaceous.

As there are no fossil data for the lower Beykoz Formation that indicate a Late Triassic age, the Beykoz Formation is restricted to the extensional basin deposits of Jurassic-earliest Cretaceous age at present.

The source area for the olistoliths and clasts of the conglomerates within the Beykoz Formation was quite different (north) from that of the Akgöl Group. There are clasts from the Zonguldak Terrane that is according to GÖNCÜOĞLU & KOZUR (1998) and KOZUR & GÖNCÜOĞLU (1999, 2000) the northernmost terrane of Turkey which was after the closure of an Ordovician-Silurian deep-water trough a marginal part of the East European Platform. Thus, the Jurassic-Early Cretaceous Beykoz-Çağlayan turbidite basin was south of stable Europe adjacent to the Zonguldak Unit. In this position no remnants of the southern active margin of the Cimmerian Küre Ocean should be present stratigraphically below the deposits of the Jurassic-Lower Cretaceous extensional Beykoz-Çağlayan turbidite basin. This excludes the presence of Late Triassic flysch in the Beykoz Formation that was reported by AYDIN et al. (1995) independent from the fact that the presence of flysch would be in contrast to the correct statement by AYDIN et al. (1995) that the Beykoz Formation was deposited in an extensional basin. However, it is possible that the Beykoz Unit (Beykoz Formation and Çağlayan Formation) is partly thrust from the north over the Akgöl Group of the Küre Complex. As the Akgöl Group and the Beykoz Formation are lithologically similar and often not well exposed, such a thrust may be difficult to recognise.

Olistoliths of Middle Triassic grey pelagic deep-water limestones and cherts which are common in the Akgöl Group, are not present in the Beykoz Formation. Especially important is the presence of deep-water pelagic rocks (black radiolarites, pelagic limestones) of Carboniferous, Early and Middle Permian age. In one locality east of Azdavay (locality 4 in Fig. 1) a larger block is present that contains clasts of different sizes of Upper Carboniferous, Lower and especially Middle Permian shallow-water, slope and basinal carbonates. Moreover, clasts of Permian debris flows are present that themselves contain clasts of Carboniferous to Middle Permian pelagic and shallow-water rocks. Obviously, in the source area of the Beykoz clasts, a suture zone of a Late Palaeozoic ocean (the Paphlagonian Ocean), was exposed. The name Paphlagonian Ocean is derived from the ancient name of the area, in which these Late Palaeozoic deep-water sediments were found.

2.5.2.2. Çağlayan Formation

This formation consists of shales, marls, silty marls, calciturbidites, turbiditic sandstones and olistostromes. It unconformably overlies with a thick conglomerate (Kayaboğazi Member) the carbonate platform of the İnaltı Formation. Towards the Beykoz-Çağlayan turbidite basin this conglomerate changes character, becoming a much thinner olistostromal conglomerate which overlies the Beykoz Formation without hiatus (AYDIN et al., 1995). Often the Çağlayan Formation begins with andesitic volcanics (Dikmendağ Member).

The age of the Kayaboğazi Member is not definitely known. Sporomorphs from a marly intercalation within the conglomerates indicate a Late Jurassic age, but they may be reworked. Overlying turbidites have an Early Cretaceous (Valanginian to Aptian) age (AYDIN et al., 1995).

Andesitic volcanics (Dikmendağ volcanics) of the Çağlayan Formation have a K-Ar age of 121±3 my (AYDIN et al., 1995), indicating a latest Barremian-earliest Aptian age. According to AYDIN et al. (1995), these volcanics erupted from extensional fractures and faults. This view seems to be correct because the Çağlayan Formation does not only overlie the basinal Beykoz Formation in the Beykoz-Çağlayan turbidite basin, but also overlies transgressively and unconformably the Upper Jurassic İnaltı carbonate platform north and south of the Beykoz-Çağlayan turbidite basin after breaking up and subsidence of the İnaltı shallow-water carbonate platform.

The base of the Çağlayan Formation is diachronous, oldest in the central part of the basin and younger toward the marginal parts. With the exception of the Upper Jurassic sporomorphs of the Kayaboğazi Member that may be reworked, all other data give an Early Cretaceous age with Valanginian or Barremian for the lowermost sediments or volcanics of the Çağlayan Formation.

3. BIOSTRATIGRAPHIC RESULTS

3.1. AGE OF THE MATRIX OF THE KARADAĞTEPE FORMATION (AKGÖL GROUP)

The more than 1500 m thick siliciclastic turbidite and olistostrome succession of the Karadağtepe Formation previously has not been precisely dated. The only reported fossils are very rare, badly preserved and tentatively determined sporomorphs (ALIŞAN et al., 1992; AYDIN et al., 1995) that indicate roughly a Middle-Upper Triassic age. However, in such turbidites the badly preserved sporomorphs are mostly reworked such as the Permian sporomorphs in Upper Jurassic turbidites of the Beykoz Formation. The very thick, but lithologically monotonous Karadağtepe Formation cannot be subdivided by lithostratigraphic characteristics.

Ammonoids. conodonts, foraminifers, ostracods and radiolarians are absent from the matrix of the Karadağtepe Formation, and also pelagic bivalves (halobiids) which are often present in such facies, do not occur. However, we found a rich fossil association in the Karadağtepe Formation which allows both facies interpretation and stratigraphic dating and subdivision of the Karadağtepe Formation. Trace fossils are most common (Pl. 15, Figs. 3-6). *Chondrites* is dominating, whereas *Helminthoida* and *Psycosiphon* are rare. Several new and very characteristic ichnotaxa are present (KOZUR & YAKAR, in prep.; AYDIN & DEMIR, in prep.) and some of these forms occur outside the Middle Pontides in the Antalya nappes, where they are restricted to Upper Triassic turbidites. The absence of *Paleodictyon* in the deep-water ichnofacies of the Karadağtepe Formation indicates either poor water circulation or a depositional depth at the oxygen minimum zone (around 2,000 m water depth). It rather excludes abyssal water depth.

The enigmatic fossil *Torlessia*, white or beige slender hollow cones with a fine-grained, siliceous, rather thick shell (see KOZUR et al., in press b) is very common. Two different associations of *Torlessia* were found. The lower association contains strongly curved forms (Pl. 15, Fig. 1), whereas the upper association consists of the straight or only slightly curved *Torlessia mackayi* BATHER (Pl. 15, Fig 2). *Torlessia* was for a long time only known from New Zealand (e.g., BATHER, 1906; WEBBY, 1967; HANNAH & COLLEN, 1995; HANNAH & CAMPBELL, 1996). MONOD (1977, Pl. 10) illustrated *Torlessia* for the first time outside New Zealand from the Antalya nappes of southern Turkey, but he did not recognise that it was *Torlessia* and regarded it as a fossil inc. sedis. Subsequently, Prof. Dr. John Douglas Campbell, Lower Hutt, recognised *Torlessia mackayi* in the Antalya Nappe. Using his determination, ŞENEL et al. (1996) reported the presence of *Torlessia* in the Antalya Nappe for the first time. In 1997, Kozur studied with the help of Dr. J.E. Simes, Lower Hutt, the Red Rock locality (Sinclair Head) at Wellington, New Zealand, where both *Torles* -

sia mackayi and radiolarians were formerly reported (e.g., HANNAH & CAMPBELL, 1996; GRAPES et al., 1990). The well illustrated radiolarians (GRAPES et al., 1990) occur in a horizon with phosphorite nodules. They are late Carnian in age. Kozur recognised two horizons with *Torlessia* at Sinclair Head, the lower one stratigraphically below the radiolarian horizon contains strongly curved forms as in the lower *Torlessia* horizon of the Karadağtepe Formation. These forms were figured by HANNAH & COLLEN (1995) and HANNAH & CAMPBELL (1996) under *Torlessia mackayi* but belong to a new species (KOZUR et al., in prep.). In a newly discovered horizon with *Torlessia* stratigraphically above the radiolarian horizon at the Red Rock locality the straight or very slightly curved *T. mackayi* and a further new species (CAMPBELL & KOZUR, in prep.) are present. From this stratigraphic position in the section and the fact that *T. mackayi* occurs only below the Upper Norian *Monotis*-bearing beds, an early to middle Norian age for *T. mackayi s.s.* in New Zealand can be concluded.

Despite the fact that MONOD (1977) did not recognise that this fossil inc. sedis is *T. mackayi* he discovered that this fossil is restricted to the Norian of the Antalya nappes. KOZUR (1998) found numerous well preserved *T. mackayi* in the Antalya nappe exclusively in beds that can be dated by conodonts as lower and middle Norian. Thus, *T. mackayi* is from New Zealand to Turkey a lower to middle Norian indicator, whereas *Torlessia* n.sp. seems to be a middle to upper Carnian indicator. Unfortunately, its lower range is unknown. However, in upper Ladinian siliciclastic beds with *Daonella lommeli* (WISSMANN) of Burma, *Titahia birminica* THEIN is common which seems to be a *Torlessia*. This species is distinctly different from the Upper Triassic *Torlessia* of New Zealand and Turkey. Thus, obviously, *Torlessia* n.sp. does not yet occur in the Late Ladinian. Consequently, it begins either in the lower or in the middle Carnian.

Therefore, the lower and middle Karadağtepe Formation can be assigned to the middle Carnian-middle Norian interval and already in the field, the middle-late Carnian and the early-middle Norian part of the Karadağtepe Formation can be easily distinguished. In the upper Karadağtepe Formation no *Torlessia* is present. This part is late Norian and younger.

3.2. AGE OF THE OLISTOLITHS IN THE AKGÖL GROUP

The lithologic character, facies and age of the olistoliths in the olistostromes within the Karadağtepe Formation are very important for the reconstruction of the geological evolution at the southern margin of the Küre Ocean in the Middle Pontides. Moreover, these data are important for establishment of the lower boundary of the Karadağtepe Formation. We have investigated numerous limestone olistoliths and one lydite olistolith from the Karadağtepe Formation turbidites (with middle-upper Carnian *Torlessia* n.sp. and Upper Triassic trace fossils in the matrix) at the Küre-Inebolu road (locality 1 in Fig. 1) and from a roadcut at the Kastamonu-Inebolu road 3 km west of Devrekani (and an outcrop 300 m north of it; both outcrops are locality 5 in Fig. 1).

At locality 1, the olistoliths consist of pelagic and shallow-water limestones (Pl, 3, Figs. 1-3, 5, 6; Pl. 4), black radiolarites, basalts and small clasts (mainly detritus) of ultramafics. The grey limestone olistoliths can be subdivided into two groups, shallow-water carbonate platform limestones and pelagic limestones (slope limestones, partly with reef or other shallow-water debris, and basinal, marly limestones). Both the shallow-water platform carbonates and the pelagic limestones are of Anisian age. The shallow-water limestones are partly sediments of a shallow-water platform (in the lower Anisian) with a very restricted fauna, and partly backreef deposits with a richer and more diversified fauna and flora (foraminifers, ostracods, algae).

The pelagic limestone olistoliths include limestones from the upper slope with a strong input of shallow-water bioclasts (especially in the lowermost Anisian), and basinal deposits (mainly toe of slope), in which bioclasts and sedimentary clasts from the slope and shelf are rare or missing (this facies is very common in olistoliths from the upper part of lower Anisian through Pelsonian and Illyrian). The youngest pebbles (exclusively pelagic limestones) are of late Illyrian (latest Anisian) age. No younger pre-Akgöl sediments have been found in these pebbles despite the fact that every microfacies has been sampled and investigated. The age of the pelagic and slope facies olistoliths was mainly determined by conodonts and holothurian sclerites, the age of the shallow-water limestones by foraminifers, mainly according the data by BAROZ et al. (1990), RETTORI (1994, 1995), RETTORI et al. (1994), UROŠEVIĆ (1988) and ZANINETTI et al. (1987, 1994).

As there is no evidence for a Ladinian part of the Akgöl Group, Ladinian clasts of the shelf margin and slope did not reach the marginal part of the ocean that was probably covered by shales, a few red cherts and mafic volcanics; the latter are common in the clasts. Black shale and turbidite clasts could not be dated but they are facially very similar to the Karadağtepe Formation of the Akgöl Group and probably represent reworked lowermost Karadağtepe Formation.

The rich microfauna of the Anisian pelagic limestones consists of conodonts, holothurian sclerites, foraminifers, silicified ostracods (Pls. 8, 9; Pl. 10, Figs. 1-9; Pls. 11-13; Pl. 14, Figs. 1-10) and radiolarians (the latter could not be dissolved from the rocks because they are calcified). The rich occurrence of conodonts allows an exact dating of all pelagic limestone samples, whereas the ostracods yield important biofacial data. Palaeopsychrosphaeric deep-water ostracods (Pl. 12, Figs. 8-10; Pl. 13, Figs. 1-9) begin in the second conodont zone of the Anisian (*Neogondolella* ? *regalis* Zone). They indicate that cold oceanic bottom-water currents reached this area during that time.

The only investigated small lydite pebble was very rich in radiolarians which could not be extracted from the chert by dissolving with HF. However, the lydite only contains a monotonous Spumellaria and Entactinaria fauna with very few species indicating that it is probably not younger than early Anisian. This black radiolarite contains sporomorphs (Pl. 1, Figs. 7-10), an exceptional facies that is also known from upper lower Anisian black radiolarites of the South-Rudabányaicum (southern slope of the Meliata-Hallstatt Ocean) in Hungary. According to Dr. C. ALIŞAN, Ankara, the sporomorphs indicate a Late Carboniferous to Early Permian age (investigation in the TPAO). According to the determinations by Kozur, the sporomorph association with *Platysaccus leschiki* HART, *Striatoabieites balmei* KLAUS, *Triadispora epigona KLAUS* and *Triadispora* sp. indicates a Middle Triassic, most probably early Anisian age.

Locality 5, about 3 km west of Devrekani (Fig. 1) has no *Torlessia* in the matrix, and Upper Triassic trace fossils are also absent. Thus, the matrix of the Akgöl Group is in this area younger than middle Norian.

The debris-flow is almost free of matrix and several metres thick in places. The olistoliths contain no mafic volcanics, ultramafics and radiolarites. Therefore, in contrast to locality 1, no remnants of obducted ocean floor are present among the olistoliths. The olistoliths consist mostly of grey limestones, relatively few shallow-water platform carbonates, mainly slope, toe of slope and basinal marly, nodular filamentous limestones that are sometimes very rich in ammonoids, bivalves and crinoids, and also contain a few brachiopods. A single olistolith of a red (Permo-)Scythian sandstone and few very small metamorphic olistoliths of the Serveçay Group as well as black shale and turbidite olistoliths of the lower Karadağtepe Formation are also present.

From these olistoliths it can be concluded that the source area of the debris flow was mainly a carbonate-rich slope deposit with a rich macrofauna (ammonoids, bivalves, brachiopods, crinoids), partly already covered by sediments of the lower Karadağtepe Formation. Additional clasts were transported from a metamorphic source area and its (Permo-) Scythian cover, indicated by abundant clastic mica in the matrix, small metamorphic clasts and a continental red sandstone olistolith.

As in locality 1, all limestone olistoliths have an Anisian age, but the lowermost two conodont zones of the Anisian (*Chiosella timorensis* Zone and *Neogondolella* ? *regalis* Zone) are either not represented by pelagic limestones or olistoliths of this age were not processed.

The analyses of the pebbles from the Karadağtepe Formation led to the following interpretation: the Küre Ocean opened by the breaking up of a pre-existing carbonate platform on a low-grade metamorphic Hercynian basement. This platform yielded shallow-water material into the basin until the middle or even upper Anisian. The oldest pelagic rocks are from the lowermost conodont Zone of the Anisian, the *Chiosella timorensis* zone. The representatives of *Chiosella* in this sample are still very primitive indicating an age at the Scythian-Anisian boundary. The limestone is a shallow pelagic sediment with a very rich fauna. It indicates an early stage of the breaking up of the carbonate platform that began in the uppermost Scythian. Rapid deepening is indicated for the following lower Anisian zones (*Neogondolella* ? *regalis* to *N. bulgarica* zones in ascending order), where the input of bioclasts from the shelf and slope drastically decreased and in the *Neogondolella* ? *regalis* Zone (upper Aegean, lower Anisian) palaeopsychrosphaeric ostracods appeared for the first time, which indicate a broad connection to the world ocean (cold oceanic bottom water currents reached the depositional area). Therefore, the Küre Basin was since the early Anisian no longer a narrow rift basin, but already an oceanic basin. In the upper Anisian calciturbidites are also present.

3.4. AGE OF THE OLISTOLITHS OR PEBBLES IN THE BEYKOZ FORMATION

Olistostromes and conglomerates of the Beykoz Formation contain three groups of olistoliths and pebbles: (1) rocks from the originally adjacent Zonguldak Terrane, (2) Upper Jurassic shallow-water limestones of the İnaltı Formation, (3) exotic rocks. Only the latter rocks were investigated. However, the other olistoliths and pebbles are also important for palaeogeographic interpretation and for the age of the matrix, in which the exotic olistoliths or pebbles are present. Taking into consideration that the overlying Çağlayan Formation is well dated as Early Cretaceous (Valanginian to Aptian), the presence of Upper Jurassic olistoliths or pebbles indicate that the matrix of the Beykoz Formation in the investigated area is latest Jurassic to earliest Cretaceous (Berriasian) in age. However, in those outcrops, where we found the exotic deep-water Carboniferous and Permian rocks, we could not date the matrix of the Beykoz Formation. All Triassic biostratigraphic indicators of the Akgöl Group are missing and therefore, we conclude that the matrix of the Beykoz Formation in these localities is Jurassic. However, Late Jurassic shallow-water limestone olistoliths are also missing. At locality 4 (see below), beside dominant olistoliths of exotic pelagic and shallow-water Late Palaeozoic a few olistoliths of Permo-Triassic red sandstones from the Zonguldak Unit are present. This indicates that during the deposition of the Beykoz Formation in this locality the continental Permo-Triassic rocks of the Zonguldak Unit were not yet covered by the Upper Jurassic carbonate platform. This probably indicates a Liassic to Dogger age for the matrix of the Beykoz Formation at this locality. A little north of locality 4, N and NE of the Bilâlbağiköy village, where we found Carboniferous black radiolarite, blocks of shallow-water limestones are also present that previously were regarded as Upper

Jurassic in age. However, the investigated 5 samples from these blocks yielded Permian shallow-water fossils. Thus, the age of the matrix of the Beykoz Formation in that locality is also unclear. When really no Upper Jurassic shallow-water limestone blocks are present, then a Lower and Middle Jurassic age of the matrix of the Beykoz Formation is most probable also at that locality.

Our investigations have concentrated on an outcrop north of Dağ Mahallesi east of Azdavay (locality 4 in Fig. 1). In this section a 5 x 1.5 m large block is exposed that consists of a nearly matrix-free debris flow that contains bioclastic shallow-water limestones with numerous Permian algae, foraminifers and partly also small ammonoids, dark-grey, pelagic, marly limestones, and rarely grey bioclastic limestones with crinoids and brachiopods. Additionally, smaller pelagic limestone olistoliths and a few olistoliths of red continental Permotriassic sandstones are present in this locality.

The limy matrix of the debris flow block is not yet dated because it consists only of millimetre-thin limestone between the clasts. However, it is not identical to the surrounding siliciclastic matrix of the Beykoz Formation. Thus, it is a lithified pre-Beykoz debris flow. Its age is as young as or younger than the youngest dated clast of Capitanian age; a Late Permian age is most probable. Some of the clasts themselves are lithified debris flows with clasts of pelagic and shallow-water rocks.

Most of the olistoliths have a Guadalupian (Roadian to Capitanian) age; the pelagic deep-water rocks have mostly unspecific faunas of Carboniferous to Permian age (Pl. 1, Figs. 1-6; Pl. 2). Conodonts are very rare and with one exception only ramiform elements of gondolellids were found. They are more advanced than Carboniferous forms but a Triassic age can be excluded according to the foraminiferal fauna. Therefore, most of the pelagic rocks have a Permian age. This age is also supported by the pelagic ostracods mostly comprised of cypridinids which are more advanced than Middle Carboniferous ones and more primitive than Lower Triassic cypridinids (mostly *Permocypridina mocki* n. gen. n. sp., Pl. 10, Fig. 10), indicating a Late Carboniferous to Permian age.

One investigated olistolith (sample 1966/148) of Wordian age is a clast of a lithified debris flow with clasts of shallow-water and pelagic limestones. It is a rudstone with micritic matrix and components of wackestone and mudstone. Fossils from the insoluble residues and from thin sections include: *Tubiphytes obscurus* MASLOV (algae), bryozoans, reworked juvenile *Streptognathodus* sp. ex gr. S. *ruzhencevi* KOZUR, echinoderm remains, small foraminifers *Diplosphaerina* sp., *Globivalvulina* sp., *Lunucammina* sp., *Pachyphloia* sp., *Tolypammina* sp., fusulinids (a *Neoschwagerina* fragment), gastropods and ostracods (partly pelagic). The depositional environment of this clast is the proximal slope (pelagic with transported contemporaneous, mostly broken, shallow-water fossils and reworked older material, Pl. 1, Fig. 4; Pl. 14, Fig. 11). This sample is very interesting for the interpretation of the facies of the source area. It indicates that pelagic deposition in the source area of the block was present at least from the Late Carboniferous (*Streptognathodus* ex gr. *S. ruzhencevi* is a Gzhelian conodont) up to the Capitanian or rather post-Capitanian time. Debris flows on the steep margin of the basin were present at least from the Wordian to Capitanian / post-Capitanian time.

A further very interesting facies is represented by the olistolith of sample 1996/140. It is a well-washed bioclastic grainstone with a little pelmicritic matrix, mostly sparitic cement and partly incrusted bioclasts. The insoluble residues yielded only indeterminable shallow-water fossils, mainly algae and bryozoans. The following fossils were determined in thin-sections: Algae: *Tubiphytes carinthiacus* (FLÜGEL), *Archaeolithoporella* sp., *Mizzia* sp., ammonoids (Pl. 1, fig. 3; Pl. 3, Fig. 4), brachiopods, bryozoans, small foraminifers: *Globivalvulina vonderschmitti* REICHEL, Palaeotextulariidae indet., Geinitzinidae, *Diplosphaerina* sp., lower Guadalupian types of fusulinids (*Parafusulina* ? sp.), gastropods and ostracods. This limestone was deposited at the shelf edge. It is a shallow-water limestone, but contains drifted small ammonoid shells.

600 m NE and 400 m N of the Bilâlbağiköy village, a little north of locality 4, olistoliths or pebbles occur in the badly exposed Beykoz Formation which comprise Permian shallow-water limestones, Permian pelagic limestones and black radiolarites of Carboniferous age. Unfortunately, the radiolarian fauna of the radiolarites is badly preserved and it consists exclusively of Entactinaria of Carboniferous character which do not allow a more specific age determination, but it is older than Late Pennsylvanian. These samples have not been investigated and, therefore, the localities are not indicated in Fig. 1.

As a whole, the olistoliths and pebbles of exotic rocks in the Beykoz Formation indicate the following: most of the shallow-water Permian clasts are from the shelf edge or from the upper reef slope; coral debris is often present. In addition pelagic micritic limestones with bathypelagic deep water ostracods are common. All transitions between the shallow-water and basinal facies were found that are represented by different slope facies, from pelagic toe of slope facies with only a few transported shallow-water clasts to upper slope sediments with large shallow-water clasts.

The age of the shallow-water and slope limestone could be determined from foraminifers including fusulinids as Guadalupian (all 3 stages, Roadian, Wordian and Capitanian are present, but Roadian and Wordian rocks are most common). The pelagic deep water sediments yielded only new species (and mainly new genera) of bathypelagic Cypridinidae and rather unspecific foraminiferal faunas of Late Carboniferous to Permian age. Most probably, these fully pelagic beds are also mainly of Guadalupian age as are most of the slope deposits, but some are older. Part of the slope deposits are themselves debris flows. They contain clasts of shallow-water and pelagic limestones. The latter are as old as Gzhelian (Upper Carboniferous) as indicated by the conodont *Streptognathodus* sp. ex gr. *S. ruzhencevi*. This indicates both persistent pelagic conditions (Carboniferous to at least Capitanian) and repeated debris flows over a long time interval (at least from the Wordian to the Capitanian or rather post-Capitanian time). These facts and the common occurrence of bathypelagic cypridinid ostracods indicate a persistent Late Palaeozoic basin environment.

However, the scarcity or absence of conodonts even in favourable slope facies is striking. This was also observed in blocks from the Eskiorda tectonic complex of SE Crimea, in which no conodonts were discovered despite analysing several kg of ammonoid-bearing limestones. In contrast, the facially similar Permian limestones from Palaeotethys in the Crete Islands and Sicily yielded very rich conodont faunas. In the Middle and Upper Permian of Neotethys (Oman, Iran and Sicily) conodonts are very common, sometimes >1,000 specimens per kg sample. Thus, obviously, this northernmost Permian ocean at the SE-margin of the East European Platform had no direct N-S deep-water connection to other Permian oceans of western Tethys and may be in the Permian already a rather restricted basin.

4. COMPARISON OF SOME UNITS OF THE MIDDLE PONTIDES WITH ASSUMED EQUIVALENTS IN SE CRIMEA, AND THE PALAEOTETHYS PROBLEM

The correlation of the Middle Pontide units with the SE Crimea units is difficult because the latter are neither stratigraphically nor structurally well investigated. MARCOUX et al. (1993), MARCOUX & BAUD (1996), ROBINSON & KERUSOV (1997) and KOTLYAR et al. (1999) correlated the Akgöl "Formation" with the Taurida flysch *s.l.* (Tauric flysch, Tavric flysch, Tauridian flysch: different spelling by different authors; as Taurida is the old name of Crimea, we prefer the term Taurida flysch as used by KOTLYAR et al., 1999). However, as pointed out by KOTLYAR et al. (1999), the Akgöl Group contains only Triassic olistoliths, but no Late Palaeozoic blocks (olistoliths). Our new results have solved this contradiction. Our discovery of olistoliths of Carboniferous and Permian pelagic rocks in the Beykoz Unit, has proven for the first time the existence of these olistoliths of exotic Late Palaeozoic also in the Middle Pontides. In the Permian, mainly Guadalupian of SE Crimea shallow-water and pelagic, ammonoid-bearing limestone olistoliths and Bashkirian and younger Carboniferous shallow-water olistoliths are present (TUMANSKAYA, 1916, 1931, 1937, 1941; MIKLUCHO-MAKLAY & MIKLUCHO-MAKLAY, 1966; POPADYUK & SMIRNOV, 1996; KOTLYAR et al., 1999). Olistoliths of this age and facies are also common in the Beykoz Unit of the Middle Pontides. Additionally, Gzhelian (Late Pennsylvanian) pelagic limestones with conodonts and Carboniferous radiolarites have been found in the Middle Pontides, but radiolarite olistoliths were probably not investigated in SE Crimea and may also be present there. In the SE Crimea Dzhulfian and Dorashamian olistoliths were directly dated by small foraminifers. Olistoliths of this age were not yet proven in the Middle Pontides, but post-Capitanian Late Permian olistoliths may also be present in the Middle Pontides, e.g. the undated matrix of an olistolith, which consists of a debris flow with pelagic and shallow-water Upper Carboniferous to Capitanian clasts.

The occurrence of an exceptional Permian facies of shallow-water limestones with small ammonoids (see above) that were obviously post-mortally drifted shells is especially interesting. Such olistoliths occur both in the SE Crimea and in the Middle Pontides.

Olistoliths of exotic pelagic Late Palaeozoic rocks do not occur in the Akgöl Group. Despite the fact that they were reported from the Taurida flysch in SE Crimea, they obviously do not occur in the Taurida flysch *s.s.* They are only present in the Eskiorda tectonic complex (Eski-Odra Formation sensu POPADYUK & SMIRNOV, 1996, a misspelling for the second part of the word, and Eskiorda Unit sensu KOTLYAR et al., 1999; the spellings Eski-Orda or Eskiorda are correct) in SE Crimea.

Generally, the Eskiorda tectonic complex is regarded as part of the Taurida flysch and dated as Middle Triassic to Middle Jurassic. However, according to KOTLYAR et al. (1999), the north dipping Eskiorda Unit, a composite and dismembered tectonic complex, lies north of the Taurida flysch *s.s.*, but also occurs in two places (Bodrak and Marta River valleys) overthrust southward on the Taurida flysch. They assigned the Eskiorda tectonic complex to the Ladinian-Bathonian interval. According to POPADYUK & SMIRNOV (1996) the "Eski-Odra Formation" is part of the Taurida flysch (Taurian Group according to POPADYUK & SMIRNOV, 1996). They regarded the "Eski-Odra Formation" and with it their Taurian Group as Early Cretaceous on the base of an earlier discovery of Hauterivian-Aptian ammonoids in the "Eski-Odra Formation". Formerly reported pre-Cretaceous fossils were assumed to be derived from olistoliths.

The Taurida flysch *s.s.* (without the northward adjacent and partly overthrust Eskiorda tectonic complex) is unconformably overlain either by Upper Jurassic rocks, very similar to the Bürnük and İnaltı formations of the Middle Pontides (south and east of the Kacha uplift) or by Lower Cretaceous deposits in the north and west. Thus, at least that Taurida flysch *s.s.* which is overlain by Upper Jurassic rocks is surely older than Late Jurassic. Its facial development and known fossils indicate a Late Triassic to Middle Jurassic age, but mostly it is unclear whether the fossils are from the matrix or from olistoliths. Nevertheless, the Taurida flysch *s.s.* and its Upper Jurassic cover are very similar to the Akgöl Group of the Middle Pontides and its Upper Jurassic cover. Both units can be well compared in agreement with former correlations by MARCOUX et al. (1993), MARCOUX & BAUD (1996), ROBINSON & KERUSOV (1997) and KOTLYAR et al. (1999). Carboniferous and Permian exotic olistoliths are not present in this part of the Taurida flysch *s.s.*, as they are not present in the Akgöl Group.

The Eskiorda tectonic complex, which contains the exotic Carboniferous and Permian blocks, obviously corresponds to the Beykoz Unit. It is situated north of the Taurida flysch *s.s.* (and partly overthrust on it) as the Beykoz Unit is situated north of the Küre Complex. Regarding this structural setting, the age of the Eskiorda tectonic complex cannot be transferred to the Taurida flysch *s.s.* and, therefore, the Early Cretaceous age assigned to the Taurida flysch on the base of the assumed Early Cretaceous age of the Eskiorda tectonic complex by POPADYUK & SMIRNOV (1996) cannot be accepted, independently from the question, whether the Eskiorda tectonic complex is regarded as a part of the Taurida flysch (upper Taurida flysch) *s.l.* or as an independent unit as in KOTLYAR et al. (1999). We prefer the latter solution. The age of the Eskiorda Unit is not clear. Generally, a Liassic (Sinemurian to Toarcian) age has been assumed, and late Sinemurian to Pliensbachian fossils were reported, but they may be at least partly reworked. POPADYUK & SMIRNOV (1996) reported Early Cretaceous (Hauterivian to Aptian) ammonoids from the Eskiorda tectonic complex which would indicate an Aptian upper age range of this unit (as for the Çağlayan Formation of the Beykoz Unit in the Middle Pontides). According to Dr. A.M. Nikishin, Moscow (pers. comm.), these ammonoids do not occur inside the Eskiorda tectonic complex, but in a mélange-like zone at its margin. This left the age of the Eskiorda tectonic complex open.

We do not correlate the Eskiorda tectonic complex with the Akgöl Group as has been done previously (as a part of the Taurida flysch or also as an independent unit by KOTLYAR et al., 1999), but with the Beykoz Unit. Both units are shallower than the Akgöl turbidites (Karadağtepe Formation) and Taurida flysch turbidites, and contain exotic, partly deep-water Carboniferous and Permian blocks. Both are situated north of Upper Triassic - Lower/Middle Jurassic siliciclastic deep sea flysch of the Akgöl Group and Taurida flysch *s.s.* respectively which contain only olistoliths of Triassic exotic rocks.

The mirroring of some tectonic units in the Middle Pontides and SE Crimea (Akgöl Group - Taurida flysch *s.s.*, Beykoz Unit - Eskiorda tectonic complex) indicates that these units were subsequently separated by the Black Sea that opened a little obliquely to the strike of the Beykoz-Eskiorda tectonic complex and Akgöl Group - Taurida flysch *s.s.*, leaving part of it in the SE Crimea (Taurida flysch *s.s.* and Eskiorda tectonic complex) and the other part at the opposite side of the Black Sea, in the Middle Pontides (Akgöl Group and Beykoz Unit) - Fig. 3.

The olistoliths of pelagic Upper Carboniferous to Permian rocks in the Jurassic Beykoz Formation of the Middle Pontides and in the Eskiorda tectonic complex of SE Crimea are good evidence for the existence of a Late Palaeozoic northern “Palaeotethys” in the sense of the ŞENGÖR school (e.g., ŞENGÖR & YILMAZ, 1981; ŞENGÖR, 1984, 1985; ŞENGÖR et al., 1984; GENÇ & YILMAZ, 1995; YILMAZ et al., 1997). The accretionary complex of this ocean was obviously one of the source areas of the clasts in the Beykoz Formation of the Middle Pontides and in the Eskiorda tectonic complex of SE Crimea. An other source area of the clasts in the Beykoz Formation was the Zonguldak Terrane (Fig. 3) which was a marginal part of the East European Platform (stable Europe) since the Devonian according to GÖNCÜOĞLU & KOZUR (1998), KOZUR & GÖNCÜOĞLU (1999, 2000) and KOZUR & STAMPFLI (2000). Consequently, the “Palaeotethys” in the sense of the ŞENGÖR school was situated at the southern margin of stable Europe (Zonguldak Terrane), north of the Variscan chain.

KAHLER (1939) established the Palaeotethys as an ocean and its shelves north of the later Tethys. The axis (suture zone) of the Tethys sensu KAHLER (1939) was shown along the Zagros Zone and from there toward the east to an area roughly between the Indian craton and Tibet. It corresponds to Neotethys *s.s.* (STÖCKLIN, 1974, 1977; STAMPFLI, 1978; KOZUR, 1999), a term which was established by STILLE (1944a, b) in his geosynclinal concept (Lower Pennsylvanian to Tertiary geosyncline, not an ocean) which cannot be applied in any mobilistic reconstruction. Therefore we use the plate tectonic Neotethys concept by STÖCKLIN (1974, 1977) and STAMPFLI (1978) because it has priority among the plate tectonic concepts of Neotethys.

The Palaeotethys concept of KAHLER (1939) was too wide. Whereas the southern margin of his Palaeotethys was well defined (immediately north of Gondwana and after the Middle Permian opening of Neotethys, north of the Cimmerian continent as a splinter of Gondwana), the northern margin of his Palaeotethyan shelf was drawn with the northern occurrence of Permian shallow-marine deposits. Therefore, both STÖCKLIN (1974, 1977) and STAMPFLI (1978) on one side, and ŞENGÖR (1979) on the other side presented a restricted scope of Palaeotethys within the original Palaeotethys of KAHLER (1939). The revised Palaeotethys sensu STÖCKLIN (1974, 1977) and STAMPFLI (1978) has priority and represents an ocean and not a geosyncline as in concept by STILLE (1944a, b). Consequently, it is used here.

The Palaeotethys sensu ŞENGÖR (1979) consists in western Tethys of two different oceanic units adjacent to the southern margin of Laurussia and within the northern part of the Variscan chain respectively: a (Devonian) Carboniferous to Permian ocean adjacent to the southern margin of Laurussia, which we named the Paphlagonian Ocean, and the Middle Triassic to Middle

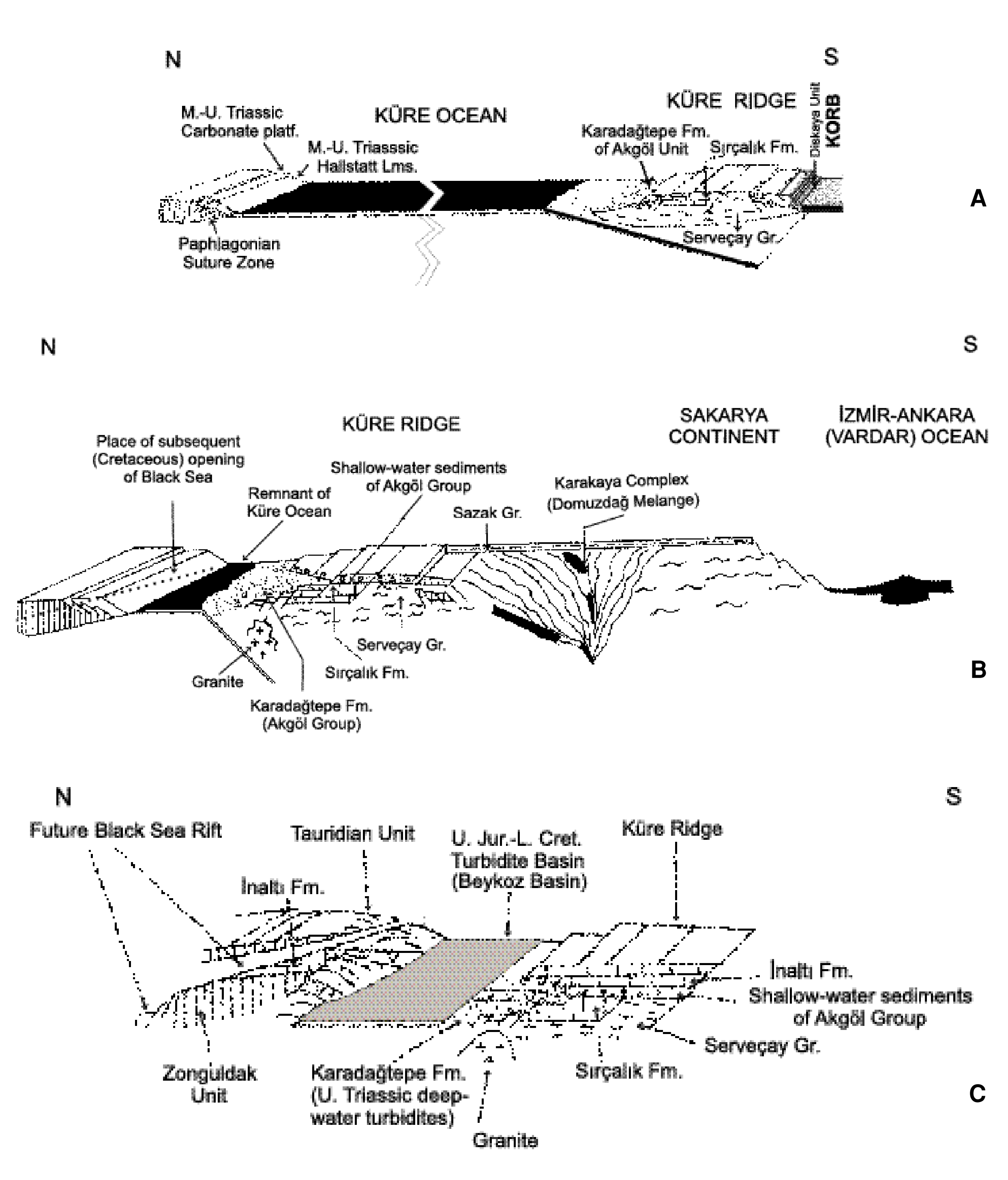

Fig. 3 Schematic N-S cross section through the Middle Pontides. Legend: A) Upper Triassic: southward subduction of the Küre Ocean below the Küre Ridge. This caused the beginning of the rifting in the later Vardar Ocean in the Izmir-Ankara Zone (not shown). Deposition of the turbiditic-olistostromal Karadağtepe Formation of the Akgöl Group over the down-thrust northern margin of the Küre Ridge and the adjacent marginal oceanic part of the Küre Basin. KORB - Karakaya oceanic rift basin. B) Lower Dogger: the southwards subduction of the remnant Küre Ocean continued. Some synsedimentary obducted slices of the basalts and ophiolites in the Karadağtepe Formation are overlain by the upper Karadağtepe Formation. The subduction also caused granitic intrusions. The molasse type Upper Akgöl Group covers not only the Karadağtepe Formation, but also the largest part of the Küre Ridge and lies transgressively over the Sırçalık and Serveçay groups. The Karakaya oceanic rift basin closed during the late Norian, and the turbidite-olistostrome complex is transgressively overlain by the Sazak Group. In the south, oceanic crust is created in the Vardar Ocean of the Izmir-Ankara Belt. C) Upper Jurassic: the Küre Ocean is totally subducted and its accretionary complex as well as adjacent units are covered by the İnaltı shallow-water carbonate platform. The extensional Beykoz Basin opened adjacent to the Zonguldak Terrane north of the Akgöl accretionary complex or on marginal parts of it. The suture zone of the Paphlagonian Ocean is exposed at the northern margin of the Beykoz-Çağlayan turbidite basin and rocks of this zone and subordinately those of the Zonguldak Terrane are transported into the Beykoz-Çağlayan turbidite basin. The somewhat oblique future Black Sea rift (Upper Cretaceous) is indicated that cut in the west the southernmost part of stable Europe, leaving the Zonguldak Unit on the southern side of the Black Sea rift. In the east, the Black Sea rift cut the Beykoz Unit, leaving a part of it in the SE Crimea at the northern margin of the Black Sea rift (Taurida Flysch), the other part on the southern margin of the Black Sea rift (Beykoz Unit of the Middle Pontides).

Jurassic Küre Ocean that opened in the northern marginal part of the Variscan chain (Sakarya) south of the suture zone of the Paphlagonian Ocean. Additionally, Variscan oceanic sequences (Serveçay Group of the Küre Ridge Unit) were put in the "Palaeotethys" sensu ŞENGÖR (1979).

The opening time of the Paphlagonian Ocean is not yet known. Until now, the oldest fossil-proven pelagic rocks are black radiolarites of Carboniferous age and also in the exotic olistoliths in SE Crimea the oldest rocks are Serpukhovian - early Bashkirian. If the Paphlagonian Ocean opened in that time, it would be related to the closure of the Variscan ocean further in the south (both in the Istanbul Terrane and in olistoliths of the Late Triassic Diskaya Unit of the Karakaya oceanic rift basin, the youngest pelagic Variscan rocks are early Bashkirian in age - KOZUR, 1999; KOZUR & GÖNCÜOĞLU, 2000). In this case it would be a marginal trough north of the Variscan Sakarya continent. The other possibility is that the Paphlagonian Ocean opened during the late Early Devonian in prolongation of the northernmost Variscan LIGIHA Ocean of Middle and Western Europe. It may have opened in direct connection to the LIGIHA Ocean or in the same position as this ocean within the formerly accreted margin of Laurussia. Whereas in Middle and Western Europe both the LIGIHA Ocean in the north and the Palaeotethys in the south closed during the Carboniferous, further in the east both oceans remained open and closed only at the end of the Permian (Paphlagonian Ocean) and during the middle Carnian (Palaeotethys).

In the Crimea a Late Palaeozoic fold belt is present containing metamorphosed Devonian - Mississippian deep-water shales and volcanic rocks, including remnants of a volcanic arc (NIKISHIN et al., in press). Lower Carboniferous black shales SW of Sevastopol (NIKISHIN et al., in press) may also belong to this basin. The Bashkirian-Permian deep-water basin with a restricted connection to the world ocean was perhaps a remnant basin of this ocean. The Visean deformation phase was not connected with closure of this ocean.

The term "Palaeotethys" can neither be applied for the combined Paphlagonian and Küre oceans (and the splinter of Variscan basement) which were together assembled into the "Palaeotethys" sensu ŞENGÖR (1979) nor for the northern (and older) of these two oceans alone because it contradicts the priority re-definition of Palaeotethys by STÖCKLIN (1974, 1977) and STAMPFLI (1978) as a Late Palaeozoic - Triassic ocean between Perigondwana in the south and the Variscan chain in the north. For this reason, the northern ocean at the margin of the East European Platform has been named the Paphlagonian Ocean. The suture zone of the priority Palaeotethys sensu Stöcklin and Stampfli lies south of the later Izmir - Ankara Belt. Its remnants were found recently in the Tavas composite nappe of the Lycian Nappes in the western Taurus by KOZUR et al. (1998) who suggested Variscan Lower Carboniferous flysch as the oldest Palaeotethyan flysch, and by KOZUR & ŞENEL (1999) and KOZUR et al. (in press c), who discovered tectonically underlying younger Palaeotethyan successions, such as Pennsylvanian MORB and oceanic sea-mount successions, as well as a Triassic foreland basin in front of the advancing Cimmerian nappes).

5. RESULTS AND DISCUSSIONS

(1) As both the Karakaya oceanic rift basin and the Küre Ocean were early Mesozoic oceans, all three former models of the geological evolution of the Karakaya oceanic rift basin and the Küre Ocean (1 - Küre Ocean - the Late Palaeozoic to Middle Jurassic Palaeotethys, and Karakaya oceanic rift basin its back-arc basin; 2 - Karakaya oceanic rift basin - the Late Palaeozoic to Triassic Palaeotethys and Küre Ocean its back-arc basin; 3 - Karakaya oceanic rift basin and Küre Ocean represent the later separated remnants of the large Late Palaeozoic to Middle Jurassic Palaeotethys) cannot be confirmed.

(2) The Küre Complex is not the remnant of a persistent Late Palaeozoic - Jurassic Palaeotethyan Ocean as assumed by the ŞENGÖR school (e.g., ŞENGÖR & YILMAZ, 1981; ŞENGÖR, 1984, 1985; ŞENGÖR et al., 1984; GENÇ & YILMAZ, 1995), but a Middle Triassic to Middle Jurassic ocean. It opened as a back-arc basin during the latest Scythian. However, its opening is not related to the subduction of a persistent Late Palaeozoic - Triassic Karakaya Ocean as assumed by OKAY et al. (1996), PICKETT et al. (1995), USTAÖMER & ROBERTSON (1995, 1997, 1999), PICKETT & ROBERTSON (1996), but to the northward subduction of Palaeotethys, the suture zone of which is south of the later Izmir - Ankara Belt. Remnants of this Palaeotethys (MORB and OIB, as well as pelagic Carboniferous to Triassic oceanic sediments and Late Pennsylvanian ocean island sediments) were found in the Tavas Composite nappe of the Lycian nappes (KOZUR et al., 1998; KOZUR & ŞENEL, 1999; GÖNCÜOĞLU et al., 2000; KOZUR et al., in press c). The subduction of the rather broad Küre Ocean started during the middle Carnian and continued until the Middle Jurassic closure of this back-arc ocean.

(3) The Karakaya Ocean is a narrow (transtensional) oceanic rift basin in the Eurasian marginal belt (shelf) of Palaeotethys. It existed only from the uppermost Permian to middle Norian. Its opening is not related to the southward subduction of the Küre Ocean because the Karakaya oceanic rift basin opened before the beginning of subduction of the Küre Ocean. However, the closure of the narrow Karakaya oceanic rift basin may be related to the southward subduction of the Küre Ocean because it was filled up by the siliciclastic turbidites and olisto-

stromes of the Diskaya Unit which started exactly at the same time as the southward subduction of the Küre Ocean.

(4) The missing subduction signal in the mafics of the Karakaya Ocean does not indicate that this ocean was the huge Palaeotethyan Ocean, but that its opening was unrelated to the subduction of Palaeotethys and of the Küre Ocean. The opening of the Karakaya oceanic rift basin is related to the collapse of the Variscan cordillera (Sakarya continent). Continuing collapse of the Variscan orogene and northward subduction of Palaeotethys finally creates the opening of back-arc oceans, such as the Küre Ocean. Further to the west, an analogous development caused by the collapse of the Variscan cordillera can be observed in the early rifting (Late Permian) in the area of the later Maliak Ocean, but in contrast to the Karakaya oceanic rift basin it did not develop an oceanic rift stage before the Late Triassic (or late Ladinian). Further collapse of the Variscan orogene and continuous northward subduction of Palaeotethys led to the opening of the Meliata-Hallstatt back-arc ocean during the Anisian. Slab roll-back in the Palaeotethys led to a southward shift of back-arc sea-floor spreading from the Meliata back-arc ocean into the Maliak back-arc ocean during the late Ladinian or early Carnian. Southward subduction of the Meliata ocean and of its eastern continuation, the Küre Ocean, opened the Vardar Ocean from the Vardar Belt to the Izmir-Ankara Belt.

(5) The subduction direction of the Karakaya oceanic rift basin is disputed. This is mainly consequence of the fact that with the onset of flysch sedimentation siliciclastic turbidites were present in the entire basin and therefore no active and passive margin can be lithologically distinguished. The other reason is the very complicated tectonic situation which makes it nearly impossible to recognise the general tectonic dipping. Most authors prefer a southward subduction (e.g., ŞENGÖR & YILMAZ, 1981; ŞENGÖR et al., 1984; GENÇ & YILMAZ, 1995; OKAY et al., 1996; KOZUR & MOCK, 1997). According to PICKETT et al. (1995) and USTAÖMER & ROBERTSON (1995, 1997, 1999) there was a northward subduction of the Karakaya oceanic rift basin. In their opinion this caused the opening of the Küre back-arc basin, which is impossible because the Küre Ocean opened during the late Scythian whereas no evidence for Early and Middle Triassic subduction of the Karakaya oceanic rift basin can be found.

USTAÖMER & ROBERTSON (1997) pointed out that the basement units of the Karakaya Complex exhibit a consistently northward-dipping foliation, and the axial planes of fold and thrust planes also dip northward. If this structural evidence can be confirmed, then subduction in the Karakaya oceanic rift basin was really directed northward. However, in the structurally very complicated Karakaya Complex it is very difficult to establish the subduction direction, if no passive margin sequence can be recognised. Thus, PICKETT & ROBERTSON (1996) accepted the main subduction of the Karakaya oceanic rift basin toward the south, but believed that also a northward-directed subduction was present. This would be in conflict with the previously mentioned structural data. Moreover, such a narrow rift basin as the Karakaya oceanic rift basin would surely not subduct into two opposite directions. OKAY (2000) also changed his former view of a southward-directed subduction into the northward-directed subduction of the Karakaya oceanic rift basin without new structural data, and this contradicted his view of a single Karakaya-Küre Ocean which subducted below the European margin. The northern margin of the Küre Ocean is clearly a passive margin with Anisian to Norian Hallstatt Limestones and Rhaetian-Liassic shales and marls. With exception of OKAY (2000), there is general agreement that the Küre Ocean subducted toward the south. This is proven by the discovery of Anisian to Norian Hallstatt Limestones at the passive northern margin which were, in the Carnian and Norian, contemporaneous with the siliciclastic flysch at the southern active margin of the Küre Ocean.

It is possible that there was southward subduction only in the Küre Ocean and none in the Karakaya oceanic rift basin. If the ridge between the Küre Ocean and the Karakaya oceanic rift basin was elevated with the onset of the southward subduction of the Küre Ocean, then this ridge yielded terrigenous siliciclastic rocks both toward the southern active margin of the Küre Ocean (Akgöl Group) and toward the Karakaya oceanic rift basin (Diskaya Unit). As the Karakaya oceanic rift basin was very narrow, turbidites of this clastic input filled the entire basin. In this case, the Nilüfer Unit may be a northward subducted Palaeotethyan sea-mount which was suddenly brought to the surface perhaps by the onset of the southward subduction of the Küre Ocean. This would be one possible explanation for the fact that middle Carnian to middle Norian turbidites of the Diskaya Unit overlie the HP/LT metamorphic rocks of the Nilüfer Unit. The other possibility would be that the within plate volcanics of the Nilüfer Unit do not indicate a sea-mount but early rifting stage of the Karakaya oceanic rift basin. This would be in better agreement with the succession within the Nilüfer Unit (Table 1), however, it would require a rather unusual development of blueschist facies without very deep, subduction related tectonic burial. Such an explanation seems to be possible because within the Nilüfer Unit the metamorphic overprint changes from very low grade in its upper part to blueschist facies in its lower part in a distance of a few kilometres. A third explanation for the Nilüfer Unit would be that it represents a sequence of the Late Permian - Early Triassic rift stage of the Küre Ocean which cannot be found in the Küre Basin because it was totally southward-subducted under the Küre Ridge Unit and the Karakaya rift basin. As the Karakaya rift basin was during the upper Triassic in its transpressional stage and the Nilüfer Unit is a relatively light slab (not only mafic tuffs and volcanics are present, but also thick shallow-water carbonates in its lower part and thick shales in its upper part), a rapid exhumation during the Upper Triassic is possible.

(6) The Küre Complex consists of three oceanic and continental units with different evolution paths and palaeogeographic positions. These are the Küre Ridge Unit (the Variscan Serveçay Group and the Sırçalık Group, its Lower - Middle Triassic shallow-water cover) in the south, the central Küre Ocean Unit (Middle Triassic basalts, ophiolites, and middle Carnian to Middle Jurassic accretionary complex of the Akgöl Group) and the Çalça Unit (northern passive margin and slope of the Küre Ocean). The Palaeotethys sensu ŞENGÖR (1979, 1984, 1995) comprises all three units, a Variscan complex (Serveçay Group) and its disconformably overlying Lower and Middle Triassic shallow-water cover, as well as the Middle Triassic - Middle Jurassic Küre Ocean (its middle Carnian to middle Jurassic accretionary complex from the active southern margin, obducted ophiolites and mafic volcanics, and its northern passive margin sequence).

(7) The Serveçay Group is a Variscan low-grade metamorphic oceanic unit of pre-Triassic (pre-Permian) age. It is a part of the Variscan Sakarya Continent. It is overlain by a deformed but unmetamorphosed Triassic shallow-water sequence that begins with a Scythian transgressive quartz conglomerate also containing a few pebbles of unmetamorphosed dolomites of post-Variscan / pre-Triassic (probably Permian) age.

(8) The deformed, but unmetamorphosed Sırçalık Group is not an intercalation within the upper Serveçay Group, and it is also not Ladinian in age as assumed by AYDIN et al. (1995). It disconformably overlies the Serveçay Group and begins with the above mentioned transgressive conglomerate. Sandstones and siltstones in the facies of the Alpine Buntsandstein, Werfen Beds, a hypersaline horizon with cellular dolomites at the Olenekian-Anisian boundary, Anisian Gutenstein Limestone and Steinalm Dolomite follow in a shallow-water shelf Triassic sequence of typical North Alpine character. A formerly assumed upper Ladinian part with *Daonella taramelli* MOJSISOVICS cannot be confirmed. This "*Daonella*" has been derived from the Werfen Beds and is a misidentified Scythian *Eumorphotis*. The Late Olenekian (Spathian) age of this part of the Sırçalık Group is proven by *Meandrospira pusilla* (HO), *Spirorbis phlyctaena* BRÖNNIMANN & ZANINETTI (Pl. 5, Figs. 12, 13), and *Eumorphotis* sp. The Anisian age of the platform carbonates is proven by foraminifers (e.g. *Meandrospira dinarica* KOCHANSKY-DÉVIDÉ & PANTIĆ).

(9) The Akgöl "Formation" sensu AYDIN et al. (1995) represents the following different sequences that belong to the Küre Ocean Unit:

- Middle Triassic Ophiolites and mafic volcanics (obducted ophiolites and pillow lavas, tectonic slices and olistoliths),
- Karadağtepe Formation,
- an unnamed formation consisting of a shallow-water sequence of ungraded sandstones, siltstones and shales.

Additionally, the newly established Çalça Unit, a passive margin succession, was also included previously into the Akgöl "Formation". The Karadağtepe Formation and the unnamed formation belong to the Akgöl Group.

(10) The Karadağtepe Formation represents a siliciclastic accretionary complex at the southern, active margin of the Küre Ocean with remnants of the obducted oceanic crust (ophiolites, pillow lava). The matrix of the lower and middle Karadağtepe Formation was dated by the succession of *Torlessia* n.sp. (middle to upper Carnian) and *Torlessia mackayi* (lower and middle Norian) as middle Carnian to middle Norian. Trace fossils indicate deep-water conditions for the turbidite-olistostrome sequence. The upper Karadağtepe Formation has a late Norian to Early or Middle Jurassic age. Olistoliths of the deep-water turbidites of the Karadağtepe Formation contain shallow-water, slope and basinal limestone, radiolarites (all of Anisian age), red radiolarites of probably Ladinian age, Middle Triassic mafic volcanics and ophiolites. The ophiolites and mafic volcanic clasts are part of a pre-Carnian oceanic crust. As there are no basinal and slope sediments older than basal Anisian, a Middle Triassic age for the oceanic crust can be assumed. It was obducted early during the Late Triassic - Middle Jurassic southward subduction because ophiolite and mafic volcanics are already present as olistoliths in the middle to upper Carnian part of the Karadağtepe Formation. A Middle Triassic age is also assumed for tectonic slices of ophiolites and thick pillow lavas in the Küre area, that all have a tectonic lower contact and partly a sedimentary upper contact (USTAÖMER & ROBERTSON, 1995).

As fully pelagic, open sea faunas with *Chiosella timorensis*, the conodont guideform of the pelagic lowermost Anisian, are present in the olistoliths of the Karadağtepe Formation, the opening of the Küre oceanic basin was within the latest Olenekian.

(11) An unnamed shallow-water sandstone-siltstone-shale sequence with coaly layers overlies (? unconformably, contact relations not observed) the Karadağtepe Formation. These beds of molasse character also unconformably overlie the Sırçalık and Serveçay groups. There, they contain only pebbles of local character which were derived from the Sırçalık and Serveçay groups.

(12) The Çalça Unit is an Anisian to Lower or Middle Jurassic deep-water sequence from the passive (northern) margin of the Küre Ocean. It consists of Pelsonian (middle Anisian) to Norian or lower Rhaetian Hallstatt Limestones that have the same lithofacies and fossil content as the North Alpine and Western Carpathian Hallstatt Limestones, and Rhaetian - Liassic marls with brachiopods and trace fossils. Due to the extraordinary palaeogeographic importance of the discovery of Hallstatt Limestones in the investigated area, their fauna and age will be discussed in a separate paper. The dating is based on well preserved conodonts that are very common and have a CAI = 1 (within the oil window). Ammonoids are also common, but were not collected.

For palaeogeographic evaluation it is very important that during the Upper Triassic deposition of siliciclastic turbidites and olistostromes of the accretionary complex at the active southern margin of the Küre Ocean, the deposition of the strongly condensed Hallstatt Limestones without any clastic input continued at the slope of its passive northern margin. Thus, the Küre Basin was rather broad at the end of the Triassic, and its subduction continued during the Lower and Middle Jurassic.

(13) Numerous important micropalaeontological results were obtained from the olistoliths in the Akgöl Group. Conodonts, foraminifers, holothurian sclerites and other echinoderm remains, ostracods, fish remains and sporomorphs have been studied and evaluated both stratigraphically and biofacially.

Stratigraphically important pelagic conodonts were found from the lowermost Anisian *Chiosella timorensis* Zone up to the upper Anisian *Neogondolella constricta* Zone. As the conodonts are well preserved, no taxonomic problems arose. For species present see Pl. 8, Figs. 1-10; Pl. 10, Figs. 4-9; Pl. 11; Pl. 12, Figs. 1-5; Pl. 13, Fig. 10; Pl. 14, Figs. 1-4, 6-10.

The conodont alteration index (CAI) in the Karadağtepe Formation of the Akgöl Group is 3-4 and, consequently, a little above the "oil window" (KOZUR et al., 1997).

Foraminifers yielded important stratigraphic data for olistoliths both of shallow-water and pelagic limestones, but also for the Sırçalık Group. In these rocks algae (only in shallow-water limestones) and sometimes ammonoids, brachiopods, bivalves, fish remains and occasionally *Spirorbis* (only in shallow-water limestones) were also present. For present species see Pls. 5-7; Pl. 8, Fig. 11; Pl. 9, Figs. 1-4; Pl. 10, Fig. 1.

Holothurian sclerites were previously nearly undescribed from Turkey. Only MOSTLER (1968) described 3 *Theelia* species form the upper Anisian of northwestern Turkey. In our material holothurian sclerites are known throughout the entire Anisian. The lower Anisian holothurian sclerites are the first of this age from western Tethys. Except *Theelia*, also *Priscopedatus*, *Eocaudina*, *Tetravirga* and other genera are present in our material and will be described in a separate paper. For some of the species present see Pl. 9, Figs. 5-7 and Pl. 14, Fig. 5.

Aspidocrinites, Echinodermata incertae sedis (Pl. 10, Figs. 2, 3), was found for the first time outside the Alps, where it occurs in the Pelsonian (KOZUR & MOSTLER, 1992). Our form is a new species from the lowermost Anisian *Chiosella timorensis* Zone.

Ostracods yielded very important palaeoecological data. In the lower Anisian *Neogondolella*? *regalis* Zone and in younger faunas palaeopsychrosphaeric ostracods occur that indicate the presence of cold oceanic bottom water currents.

(14) The Küre Complex and adjacent units are covered by an Upper Jurassic shallow-water carbonate platform (İnaltı Formation). Only in the Azdavay - Ağlı - Dikmendağ area (Fig. 1), the İnaltı Formation is missing and replaced by the Upper Jurassic turbidites of the Beykoz Formation. The Beykoz - Çağlayan turbidite basin is probably not a compressional basin as the remnant of the Küre Ocean, but an extensional basin. It widened during the uppermost Jurassic and Lower Cretaceous by the breaking up and subsidence of the İnaltı shallow-water carbonate platform (Lower Cretaceous turbidites of the Çağlayan Formation which overlay both the turbidites of the Beykoz Formation and the shallow-water İnaltı Formation).

(15) The olistostromes and conglomerates of the Beykoz Unit (Beykoz Formation and Çağlayan Formation) contain olistoliths and pebbles of rocks of the Zonguldak Terrane which, since the Devonian, was a marginal part of the East European Platform (GÖNCÜOĞLU & KOZUR, 1998; KOZUR & GÖNCÜOĞLU, 1999, 2000), of Upper Jurassic platform carbonates from the adjacent İnaltı Formation, and of exotic pebbles.

(16) The exotic olistoliths and pebbles of the Beykoz Formation (lower part of the Beykoz Unit) contain Late Pennsylvanian and Early - Middle Permian pelagic deep-water sediments (pelagic limestones, radiolarites), slope sediments and shallow-water limestones. Wordian to Capitanian or post-Capitanian debris flows were also proven. This proves for the first time the existence of a persistent Late

Palaeozoic ocean in the Middle Pontides that was predicted by the ŞENGÖR school (a part of the "Palaeotethys" by ŞENGÖR & YILMAZ, 1981; ŞENGÖR, 1984, 1985; ŞENGÖR et al., 1984; GENÇ & YILMAZ, 1995; YILMAZ et al., 1997). However, its position was farther north than previously assumed, between the Late Palaeozoic stable Europe margin (Zonguldak Terrane) in the north and the northernmost part of the Variscan chain in the south (e.g. Serveçay Group of the Küre Ridge Unit of the Küre Complex and other metamorphic Variscan rocks that occur within the Küre Complex). As the name Palaeotethys cannot be applied to this ocean for priority reasons, this oceanic basin is named the Paphlagonian Ocean. Its remnants are also present in the Eskiorda tectonic complex of SE Crimea at the opposite side of the Black Sea. This indicates that the formerly continuous Eskiorda Unit-Beykoz Unit was separated by the somewhat oblique Late Cretaceous opening of the Black Sea. Likewise, the flysch of the Akgöl Group of the Middle Pontides and the Taurida flysch *s.s.* of SE Crimea are equivalent sequences which were separated by the opening of the Black Sea.

(17) The origin of the Paphlagonian Ocean is not yet known. It may have opened in prolongation of the northernmost Variscan oceanic branch (LIGIGA Ocean; in that case not yet proven pelagic Devonian rocks should be found). Or it may have opened in a zone of crustal weakness in the broad transition zone between stable Europe and the Variscan chain. In this area also later oceanic basins or deep-sea basins on thinned continental crust opened (e.g. Küre Ocean, Beykoz-Çağlayan turbidite basin, Cretaceous Intrapontide Ophiolite Belt = Intrapontide "Neotethys"; the term Neotethys should be only used for the southernmost Tethyan Ocean that opened during the Permian within Gondwana and closed during the Late Cretaceous to Late Tertiary), and finally the Black Sea.

(18) The repeated presence of debris flows at least from the Wordian until the top of the Guadalupian (or Lopingian) may indicate subduction of the Paphlagonian Ocean during this time. The youngest known debris flow block contains Capitanian clasts as the youngest rocks. It may be latest Capitanian to Late Permian (Lopingian: Dzhulfian, Dorashamian) in age. The Eskiorda Unit of SE Crimea also contains dated Dzhulfian and Dorashamian blocks. As neither the Eskiorda Unit of SE Crimea nor the Beykoz Formation of the Middle Pontides contain any pelagic rocks of Early Triassic age, the closure of the Paphlagonian Ocean probably occurred at the end of the Permian or during the earliest Triassic.

(19) Important palaeontological results were obtained from the exotic olistoliths and pebbles in the Beykoz Formation. The stratigraphic evaluation of the olistoliths and pebbles is mainly based on foraminifers, especially on fusulinids, in pelagic beds also on conodonts (e.g., the first evidence of pelagic Upper Carboniferous in northern Turkey by the Gzhelian *Streptognathodus* ex gr. *S. ruzhencevi* - Pl. 14, Fig. 11) and bathypelagic ostracods.

Apart from these biostratigraphic results, these Upper Carboniferous and Permian faunas are also biogeographically important. The fusulinids and small foraminifers, accompanied by algae, are an undoubtedly northern Tethyan fauna and flora, whereas the provenance of the Permian faunas and marine floras of the Karakaya Complex is disputed. We agree with LEVEN (in LEVEN & OKAY, 1996) that the Permian associations of the Karakaya Complex also have a northern Tethyan character, but other authors originate this fauna from Gondwana (e.g., PICKETT & ROBERTSON, 1996; ALTINER et al., 2000).

The often bathypelagic Cypridinidae from the Permian (Guadalupian and older) blocks in the Beykoz Unit are the oldest Permian pelagic fossils of Turkey. Moreover, Cypridinidae are known from the Carboniferous, rarely from the Lower and Middle Triassic and mainly Recent, but not from the Permian. Thus, *Permocypridina mocki* n.gen. n.sp. (Pl. 10, Fig. 10, description in a separate paper by KOZUR & YAKAR, in prep.) is an important link between the Carboniferous and Triassic Cypridinidae.

6. CONCLUSIONS

The Middle Pontides are a geologically very complex area with repeated opening and closure of oceanic or suboceanic basins since the Ordovician. By a post-Silurian-pre-Emsian Caledonian event (folding, very low to low grade metamorphism, thermal alteration, GÖNCÜOĞLU & KOZUR, 1998), the Arenig to Silurian deep-sea basin of the Zonguldak Terrane (with shallowing upwards sequence until the lowermost Lochkovian) was attached to the margin of the East European Platform (stable Europe). The broad transition Zone between stable Europe and the Variscan Sakarya Continent has been a tectonically very unstable area since the Late Palaeozoic. Firstly, during the Carboniferous (or Devonian), the Paphlagonian Ocean opened, immediately south of the margin of stable Europe (south of the Zonguldak Terrane). The southward subduction of this ocean during the Middle and Late Permian (earliest Triassic) and the northward subduction of Palaeotethys south of the later Izmir-Ankara Belt triggered the collapse of the Variscan cordillera. The former Variscan Cordillera (Sakarya continent) subsided, was at first (Late Pennsylvanian to Artinskian interval) periodically, and then from the Kungurian to Dzhulfian permanently covered by shallow seas. Continuing collapse of the Variscan cordillera created the conditions for the latest Permian (Dorashamian) opening of the Karakaya rift, which developed during the Early and Middle Triassic to a narrow oceanic rift basin that filled up from the middle Carnian by siliciclastic turbidites and olistostromes of the Diskaya Unit (junior synonym: Hodul Unit) and closed during the late Norian.

During the Late Olenekian, the Küre Ocean opened north of the Küre Ridge (part of the Sakarya continent) and south of the suture zone of the Paphlagonian Ocean. The Küre Ridge (Variscan metamorphics of the Serveçay Group and unconformably overlying shallow-water Triassic) therefore became a continental "splinter" between two oceanic basins. The ocean floor basalts of the Küre Ocean show a back-arc signature. This is either caused by the northward subduction of Palaeotethys or the subduction signal is inherited from a former southward subduction of the Paphlagonian Ocean and/or from the Variscan subduction.

The Küre Ocean was a rather broad ocean because in the late Norian, more than 20 Ma after the beginning of the subduction during the middle Carnian, it was still so broad that the deposition of a clastic-free, condensed Hallstatt Limestone sequence at its passive northern margin continued contemporaneously with the deposition of siliciclastic turbidites and olistostromes of the Karadağtepe Formation at its active southern margin. This required an ocean width of more than 500 km close to the end of the Triassic, also indicated by the fact that the subduction continued until the Middle Jurassic, when Küre Ocean was closed.

Subsequently, nearly the entire area was covered by the Upper Jurassic shallow-water carbonate platform of the İnaltı Formation which is missing only in the Azdavay-Ağlı-Dikmendağ area. Here, the extensional Jurassic-Lower Cretaceous Beykoz-Çağlayan turbidite basin subsided north of the Küre Complex or on marginal parts of it. Subsequently, during the (?uppermost Jurassic) Early Cretaceous this turbidite basin considerably widened by the break-up and subsidence of the İnaltı carbonate platform and the turbidite deposition of the Çağlayan Formation started.

The occurrence of exotic pelagic Carboniferous and Permian blocks (pelagic limestones and radiolarite) within the Beykoz Formation indicates that the Beykoz-Çağlayan turbidite basin opened on or immediately south of the Paphlagonian suture zone.

The Intrapontide Ocean opened during the Cretaceous and closed at the end of the Cretaceous. Its late Cretaceous closure caused the opening of the Black Sea. As the Black Sea opened somewhat oblique to earlier structures, part of the Akgöl Group of the Middle Pontides can be found on the opposite side of the Black Sea, in SE Crimea (Taurida flysch *s.s.*). The equivalents of the originally northward adjacent Beykoz Unit of the Middle Pontides with the blocks of exotic pelagic Late Palaeozoic are situated even to the larger part in SE Crimea (Eskiorda tectonic complex north of the Taurida flysch *s.s.* and partly thrust on it).

The continuation of the Küre Ocean towards the west is the Kotel Zone in Bulgaria and the Northern Dobrudzha in Rumania, parts of the Transylvanian nappes in Eastern Carpathians (Romania) and the Meliata-Hallstatt Ocean in the Western Carpathians and Eastern Alps (KOZUR, 1991a, b, 1999; KOZUR & MOCK, 1997). Fauna, lithological sequences and event successions in all these areas are very similar or identical. From the Kotel Zone westward, the subduction only began in the Jurassic, but the closure occurred in all these areas in the late Callovian-early Oxfordian interval. The opening of the oceanic basins began earlier toward the east, in the Pelsonian (middle Anisian) in the Eastern Alps, in the uppermost lower Anisian in the easternmost Alps and Western Carpathians, in the uppermost Scythian in the Eastern Carpathians, and in the uppermost Scythian in the Northern Dobrudzha, Kotel Zone and in the Küre Basin (KOZUR, 1999).

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PLATE I

Figs. 1-6 Permian olistoliths in the lower part of the Upper Jurassic Beykoz Formation, within an olistostrome that contains olistoliths of shallow-water and pelagic Permian limestones, partly with reworked upper Carboniferous. Outcrop Dağ Mahellesi at Kircalla village 11.5 km E of Azdavay (locality 4 of text Fig. 1).

Figs. 7-11 Sporomorphs from sample no. 1996/56, a Middle Triassic (? Lower Anisian) black radiolarite, roadcut at the Küre-Inebolu road (locality 1 in text Fig. 1).

Fig. 1 Bioclastic wackestone or grainstone to wackestone. Sample no. 1996/141, x 18.5, Roadian (Kubergandinian to earliest Murgabian fusulinid age).

Fig. 2 Grainstone with sparitic cement and micritic matrix. Rich in bioclasts (fusulinids etc., partly incrusted by *Tubiphytes* and *Archaeolithoporella*). Sample no. 1996/151, x 18.5, Wordian (early Murgabian fusulinid age).

Fig. 3 Bioclastic grainstone with some pelmicritic matrix strongly washed out, mostly sparitic cement, bioclasts partly incrusted. Beside the shallow-water bioclasts, small ammonoids are present (one is visible in the figure) that postmortally drifted into this shallow-water environment. The same facies as for ammonoid-bearing olistoliths in the Taurida flysch of SE Crimea. Sample no. 1996/140, x 18.5, Guadalupian.

Fig. 4 Rudstone, matrix micritic, components wackestone, mudstones, reworked shallow and basinal rocks. Sample no. 1996/148, x 18.5, Wordian (Murgabian to early Midian fusulinid age) with reworked Upper Carboniferous (Gzhelian) conodonts.

Fig. 5 Bioclastic, bioturbated mudstone, few biogenic clasts. Sample no. 1996/146, x 18.5, Upper Carboniferous to Permian.

Fig. 6 Bioclastic bioturbated mudstone. Sample no. 1996/144, x 18.5, Upper Carboniferous to Permian.

Fig. 7 *Striatoabieites balmei* KLAUS, broken specimen, x 850.

Fig. 8 *Platysaccus leschiki* HART, x 425.

Figs. 9, 10 *Triadispora epigona* KLAUS, x 930.

Fig. 11 *Triadispora* sp., x 795.

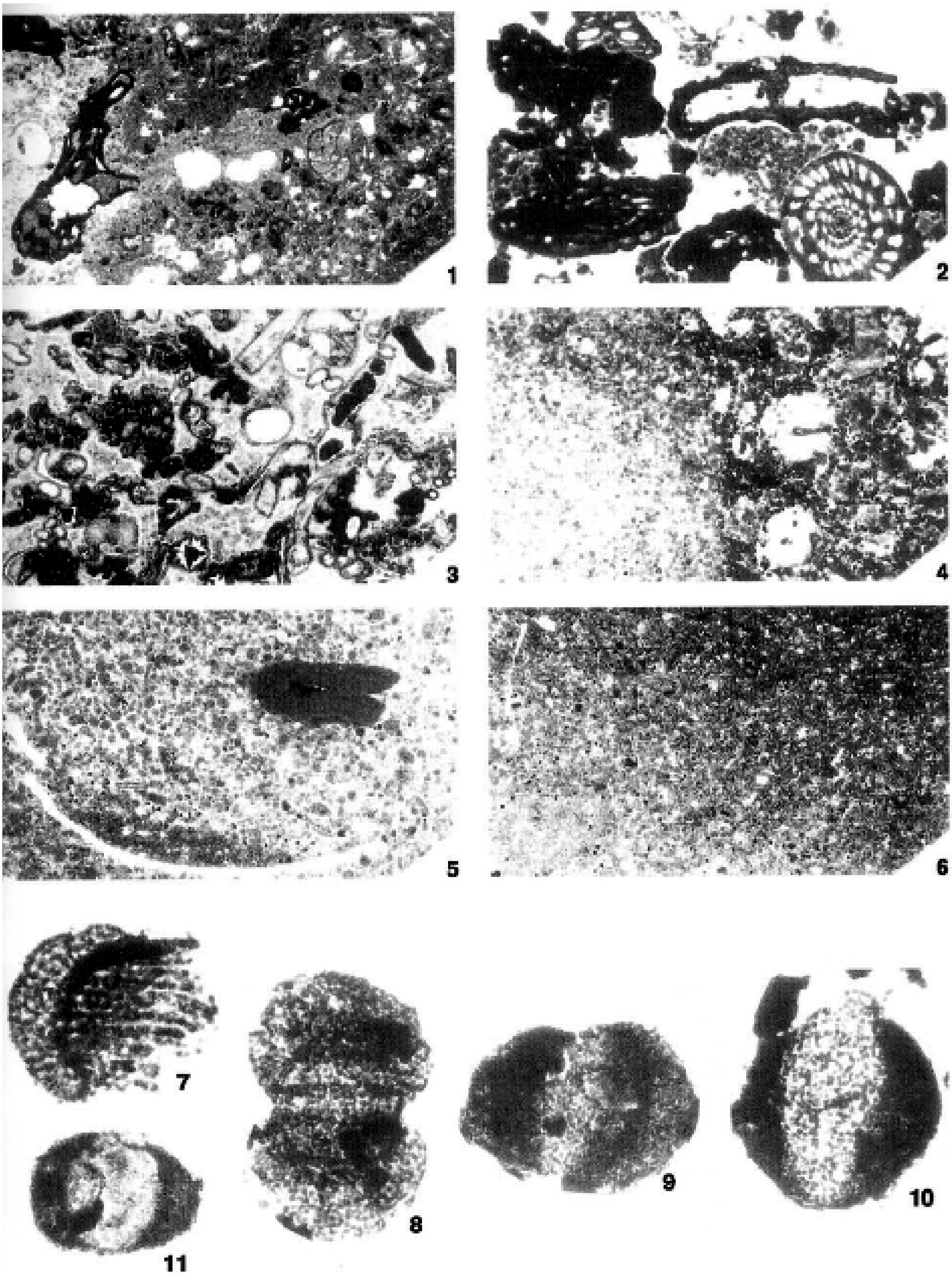
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PLATE II

Microfossils from thin-sections of Permian olistoliths in the lower part of the Upper Jurassic Beykoz Formation, within an olistostrome that contains olistoliths of shallow-water and pelagic Permian limestones, partly with reworked Upper Carboniferous faunas. Outcrop Dağ Mahellesi at Kircalla village 11.5 km E of Azdavay (locality 4 of text Fig. 1).

Fig. 1 *Nankinella* ? sp. Sample no. 1996/143, x 38, Capitanian (Midian fusulinid age).

Fig. 2 *Staffella* sp. Sample no. 1996/141, x 38, Roadian (Kubergandinian to earliest Murgabian fusulinid age).

Fig. 3 Bultoniinae (fusulinid), gen. et spec. indet. Sample no. 1996/143, x 78, Capitanian (Midian fusulinid age).

Fig. 4 *Afghanella* sp. Sample no. 1996/150, x 18.5, Guadalupian.

Fig. 5 *Neoschwagerina simplex* OZAWA. Sample no. 1996/152, x 38, Wordian (early Murgabian fusulinid age).

Fig. 6 *Minojapanella* sp. Sample no. 1996/151, x 19, Wordian (early Murgabian fusulinid age).

Fig. 7 *Parafusulina* sp. Sample no. 1996/150, x 18.5, Guadalupian.

Fig. 8 *Lasiotrochus tatoiensis* REICHEL. Sample no. 1996/143, x 75, Capitanian (Midian fusulinid age).

Fig. 9 *Dagmarita chanakchensis* REICHEL. Sample no. 1996/143, x 38, Capitanian (Midian fusulinid age).

Fig. 10 *Neoendothyra parva* (LANGE). Sample no. 1996/142, x 38, Guadalupian.

Fig. 11 *Globivalvulina* sp. Sample no. 1996/143, x 38, Capitanian (Midian fusulinid age).

Fig. 12 *Palaeotextularia* sp. Sample no. 1996/153, x 38, Guadalupian.

Fig. 13 *Deckerella* sp. Sample no. 1996/143, x 78, Capitanian (Midian fusulinid age).

Fig. 14 Palaeotextulariid indet. Sample no. 1996/151, x 18.5, Wordian (early Murgabian fusulinid age).

Fig. 15 *Pachyphloia ovata* LANGE. Sample no. 1996/149, x 78, Guadalupian.

Fig. 16 *Geinitzina postcarbonica* SPANDEL. Sample no. 1996/152, x 38, Wordian (early Murgabian fusulinid age).

Fig. 17 *Geinitzina reperta* BYKOVA. Sample no. 1996/143, x 53.5, Capitanian (Midian fusulinid age).

Fig. 18 *Nodosaria postgeinitzi* EFIMOVA. Sample no. 1996/146, x 77, Upper Carboniferous to Permian.

Fig. 19 *Tuberitina* collosaREITLINGER. Sample no. 1996/153, x 77, Guadalupian.

Fig. 20 *Tuberitina conili* NGUYEN. Sample no. 1996/141, x 76, Roadian (Kubergandinian to earliest Murgabian fusulinid age).

Fig. 21 *Eotuberitina reitlingerae* MIKLUCHO-MAKLAY. Sample no. 1996/146, x 154, Upper Carboniferous to Permian.

Fig. 22 *Mizzia* sp. Sample no. 1996/151, x 18, Wordian (early Murgabian fusulinid age).

Fig. 23 *Pseudovermiporella nipponica* (ENDO). Sample no. 1996/141, x 78, Roadian (Kubergandinian to earliest Murgabian fusulinid age).

Fig. 24 *Tubiphytes obscurus* MASLOV. Sample no. 1996/151, x 19, Wordian (early Murgabian fusulinid age).

Fig. 25 *Tubiphytes carinthiacus* (FLÜGEL). Sample no. 1996/142, x 19, Guadalupian.

Fig. 26 *Archaeolithoporella* sp. Sample no. 1996/150, x 18.5, Guadalupian.

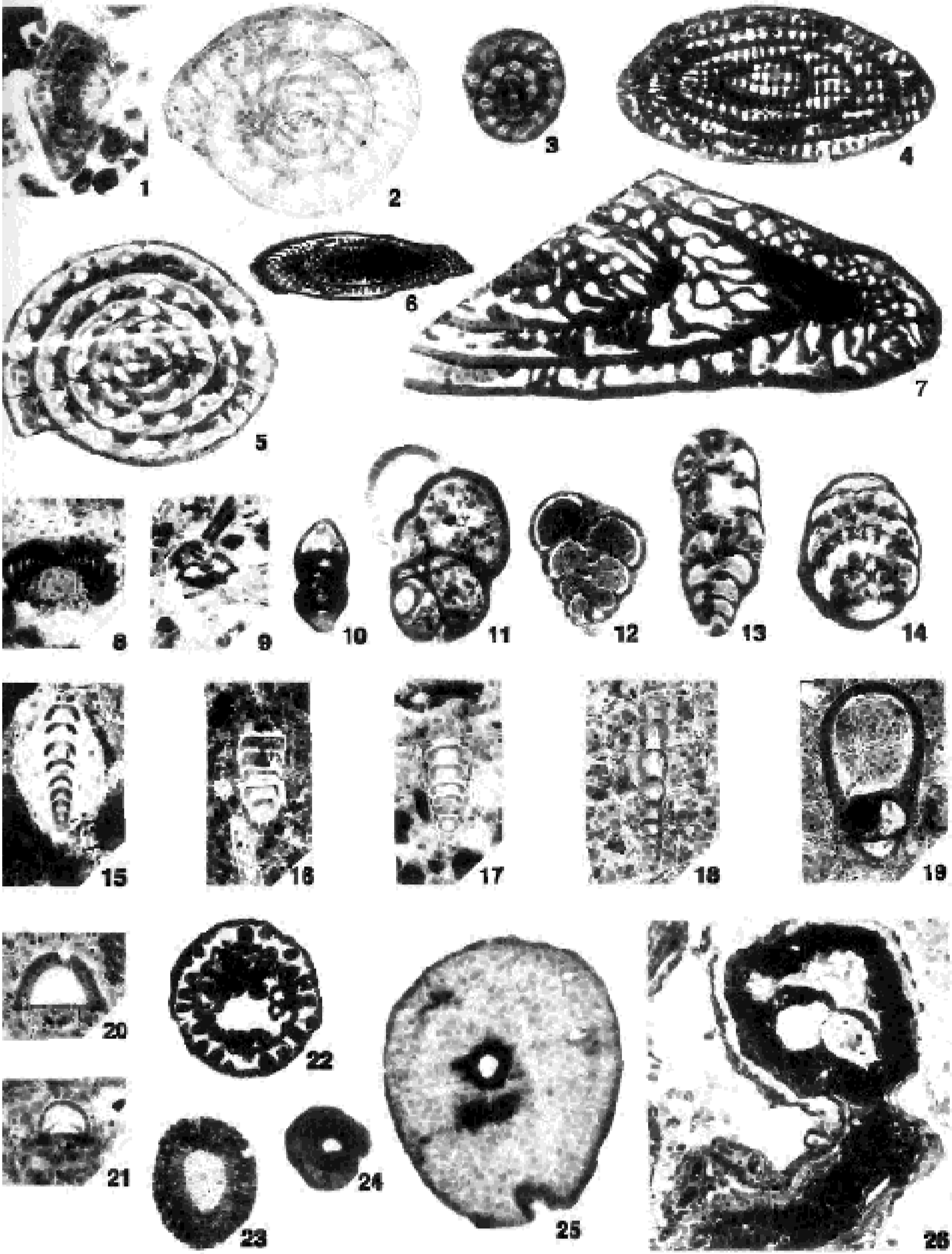

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PLATE III

Figs. 1-3, 5, 6 Different microfacies from Middle Triassic olistoliths in the middle to upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1). All magnifications x 27.

Fig. 4 Permian olistolith in the lower part of the Upper Jurassic Beykoz Formation within an olistostrome that contains olistoliths of shallow-water and pelagic Permian limestones, partly with reworked Upper Carboniferous faunas. Outcrop Dağ Mahellesi at Kircalla village 11.5 km E of Azdavay (locality 4 of text Fig. 1). Magnification x 6.7.

Fig. 1 Bioclastic mudstone (radiolarian biomicrite) with radiolarians, ostracods and filaments. Sample no. 1996/48, (middle or) upper Anisian.

Fig. 2 Filamentous packstone, extremely rich in filaments. Sample no. 1996/49, lower Pelsonian upper *Paragondolella bulgarica* Zone.

Fig. 3 Filamentous biomicrite with abundant filaments and few ostracods. Sample no. 1996/50, Pelsonian to lower Illyrian.

Fig. 4 Bioclastic grainstone with little pelmicritic matrix, mostly sparitic cement, shallow-water bioclasts, but also a small ammonoid shell. Ammonoids probably did not live in this facies, thus the shell is probably postmortally drifted. The same facies as for ammonoid-bearing olistoliths in the Taurida flysch of SE Crimea. Sample no. 1996/140, Roadian (Kubergandinian to earliest Murgabian fusulinid age).

Fig. 5 Clast of filamentous, radiolarian bearing micrites that is rich in filaments and contain ostracods, foraminifers within nearly fossil-free packstone (not in the picture). Sample no. 1996/52, middle-upper Anisian.

Fig. 6 Fine-grained wackestone with small bioclasts (filaments) and graded calciturbidite with reworked shallow-water clasts. Sample no. 1996/54, Illyrian.

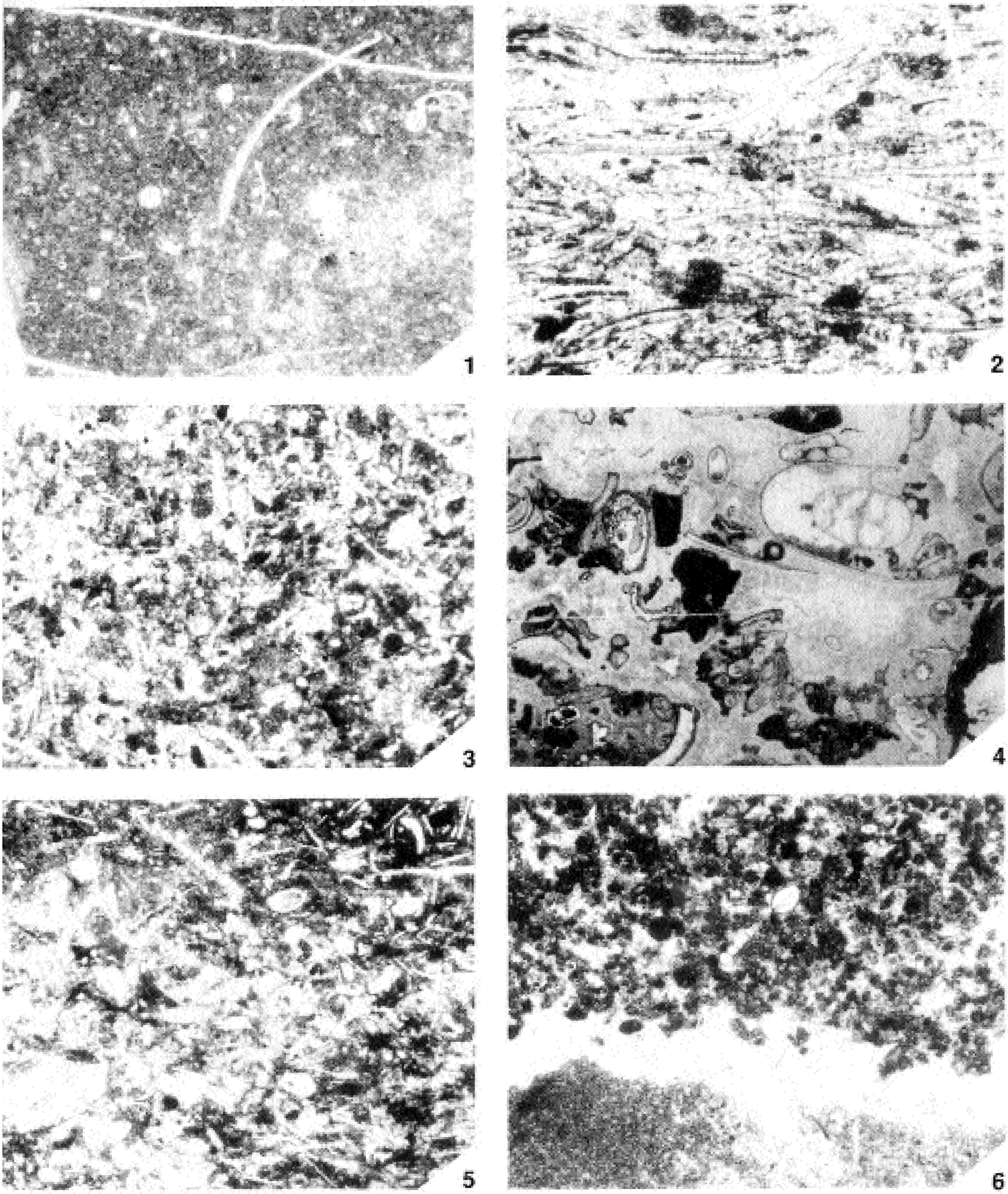
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PLATE IV

Different microfacies from Middle Triassic olistoliths in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1). All magnifications x 26.5.

Fig. 1 Radiolarian wackestone, bioturbated, with filaments and few foraminifers, ostracods and sponge spicules. Sample no. 1996/55, lower Anisian (upper Aegean) *Neogondolella* ? *regalis* Zone.

Fig. 2 Radiolarian-rich lydite, with few sporomorphs (see Pl. 1, Figs. 7-11). Sample no. 1996/56, lower Anisian.

Fig. 3 Bioclastic grainstone. Sample no. 1996/57, Anisian.

Fig 4 Bioclastic wackestone and mudstone with numerous filaments, ostracods, few radiolarians. Sample no. 1996/62, lowermost Anisian *Chiosella timorensis* Zone.

Fig. 5 Bioclastic wackestone, bioturbated, partly packstone, filaments, ostracods and (not in the picture) crinoids, echinid spines and few radiolarians. Sample no. 1996/63, upper Anisian.

Fig. 6 Shallow-water, dasycladacean algae limestone (bioclastic grainstone with mainly sparitic cement) with dasycladacean algae and echinoderm remains. Sample no. 1996/65, Anisian.

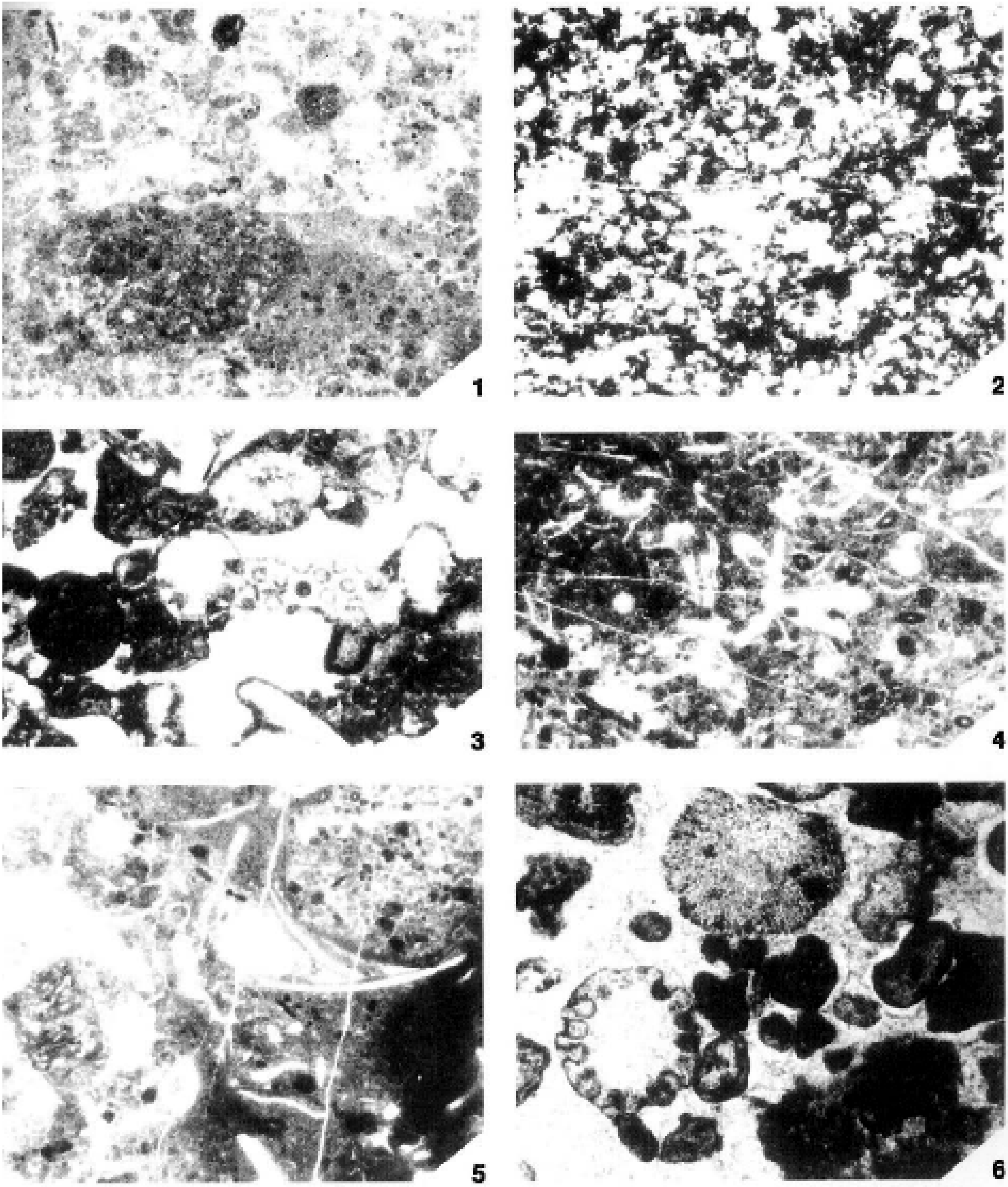
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PLATE V

Figs. 1-11 Thin sections with microfossils from Anisian olistoliths in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Figs. 12, 13 Outcrop of Werfen Beds, "Gutenstein" Limestone and Steinalm Dolomite at the road between the villages of Aha and Sırçalık (locality 3 of text Fig. 1).

Fig. 1 *Ammobaculites* sp. Sample no. 1996/62, x 72, lowermost Anisian *Chiosella timorensis* Zone.

Fig. 2 *Nodosaria ordinata* TRIFONOVA. Sample no. 1996/62, x 103, lowermost Anisian *Chiosella timorensis* Zone.

Fig. 3 *Tolypammina* aff. *T. gregaria* WENDT. Sample no. 1996/62, x 51.5, lowermost Anisian *Chiosella timorensis* Zone.

Fig. 4 Cross section of a leiostrace ammonoid. Sample no. 1996/62, x 25.75, lowermost Anisian *Chiosella timorensis* Zone.

Fig. 5 *Meandrospira pusilla* (HO). Sample no. 1996/64, x 206, upper Olenekian limestone clasts within an Illyrian pelagic limestone olistolith.

Fig. 6 Involutinidae, gen. et spec. indet. Sample no. 1996/65, x 103, Anisian.

Fig. 7 *Trochammina* sp. or Duostominidae. Sample no. 1996/65, x 103, Anisian.

Fig. 8 *Hoyenella gr. sinensis* (HO). Sample no. 1996/65, x 51.5, Anisian.

Fig. 9 *Hoyenella ?* sp. Sample no. 1996/65, x 51.5, Anisian.

Fig. 10 *Hoyenella* sp. Sample no. 1996/65, x 103, Anisian.

Fig. 11 Dasycladacean algae. Sample no. 1996/65, x 18, Anisian.

Fig. 12 *Spirorbis phlyctaena* BRÖNNIMANN & ZANINETTI. Sample no. 1996/95, x 51.5, yellowish weathered, marly, shallow-water Werfen Limestone (formerly regarded as *Daonella*-bearing, pelagic Ladinian limestone), Olenekian (Upper Scythian).

Fig. 13 *Spirorbis phlyctaena* BRÖNNIMANN & ZANINETTI. Sample no. 1996/99, x 51.5, yellowish weathered, marly, shallow-water Werfen Limestone (formerly regarded as *Daonella*-bearing, pelagic Ladinian limestone), Olenekian (Upper Scythian).

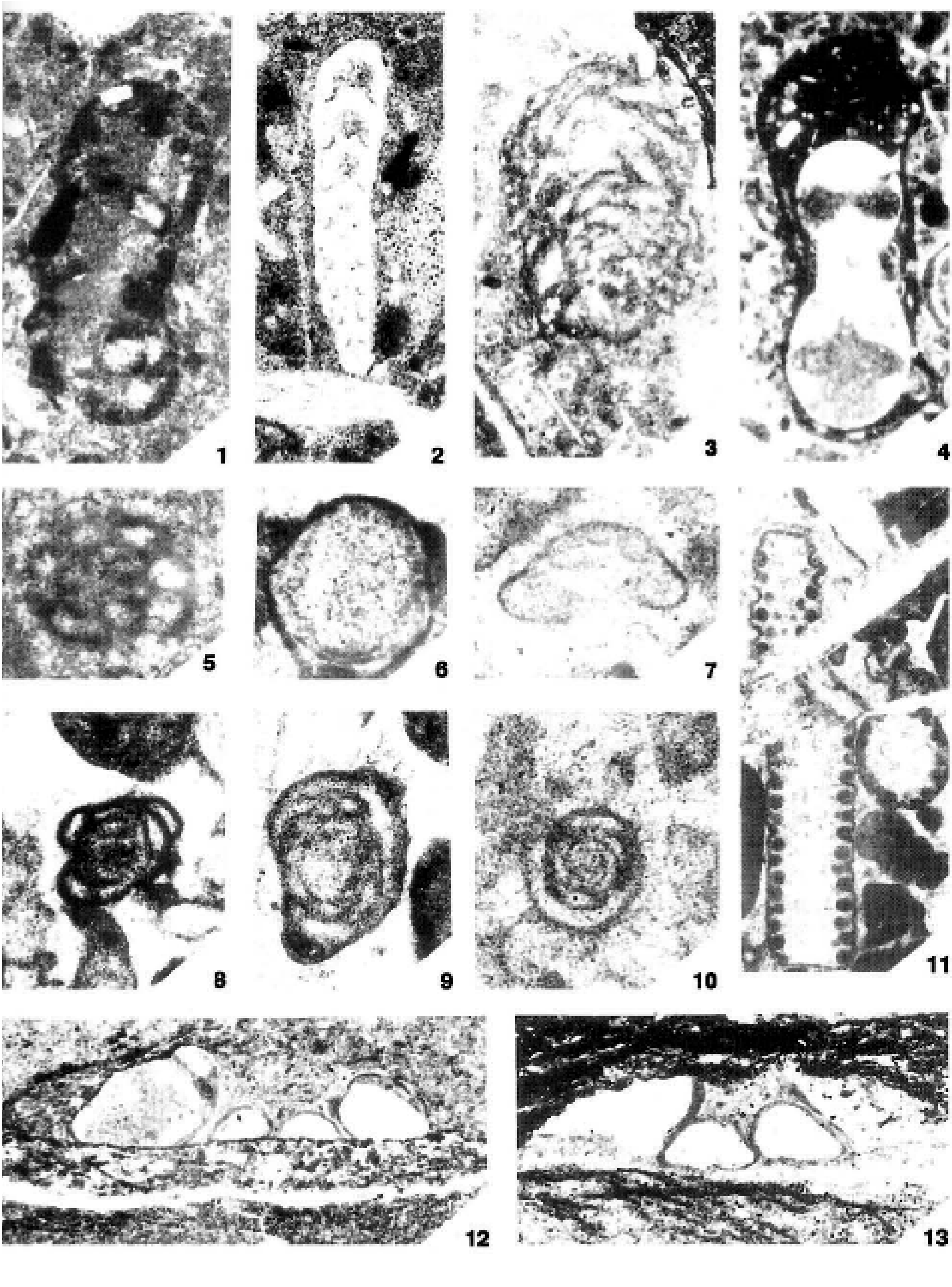
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PLATE VI

Thin-sections with microfossils from Anisian olistoliths in the middle-upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Fig. 1 *Arenovidalina* sp. Sample no. 1996/55, x 105, lower Anisian (upper Aegean) *Neogondolella* ? *regalis* Zone.

Fig. 2 *Spirobis valvata* (GOLDFUSS). Sample no. 1996/57, x 52.5, Anisian.

Fig. 3 Dasycladacean cross section. Sample no. 1996/57, x 26.25, Anisian.

Fig. 4 *Earlandia* cf. *tintinniformis* (MÍŠIK). Sample no. 1996/57, x 105, Anisian.

Fig. 5 *Pilammina* cf. *densa* PANTIĆ. Sample no. 1996/57, x 52.5, Anisian.

Fig. 6 *Hoyenella* sp. Sample no. 1996/57, x 105, Anisian.

Fig. 7 *Hoyenella* gr. *sinensis* (HO). Sample no. 1996/57, x 52.5, Anisian.

Fig. 8 *Hoyenella* sp. Sample no. 1996/57, x 52.5, Anisian.

Fig. 9 *Pilammina* cf. *densa* PANTIĆ. Sample no. 1996/59, x 105, middle-upper Anisian.

Fig. 10 *Hoyenella* gr. *sinensis* (HO). Sample no. 1996/59, x 52.5, middle-upper Anisian.

Fig. 11 *Hoyenella* gr. *sinensis* (HO). Sample no. 1996/59, x 52.5, middle-upper Anisian.

Fig. 12 *Glomospirella* sp. Sample no. 1996/59, x 52.5, middle-upper Anisian.

Fig. 13 *Meandrospira dinarica* (KOCHANSKY-DÉVIDÉ & PANTIĆ). Sample no. 1996/59, x 105, middle-upper Anisian.

Fig. 14 *Glomospira* sp. Sample no. 1996/59, x 105, middle-upper Anisian.

Fig. 15 *Glomospira* sp. Sample no. 1996/59, x 52.5, middle-upper Anisian.

Fig. 16 *Aulotortus* ? *eotriassicus* ZANINETTI, RETTORI & MARTINI. Sample no. 1996/59, x 52.5, middle-upper Anisian.

Fig. 17 ?*Aulotortus* ? *eotriassicus* ZANINETTI, RETTORI & MARTINI. Sample no. 1996/59, x 105, middle-upper Anisian.

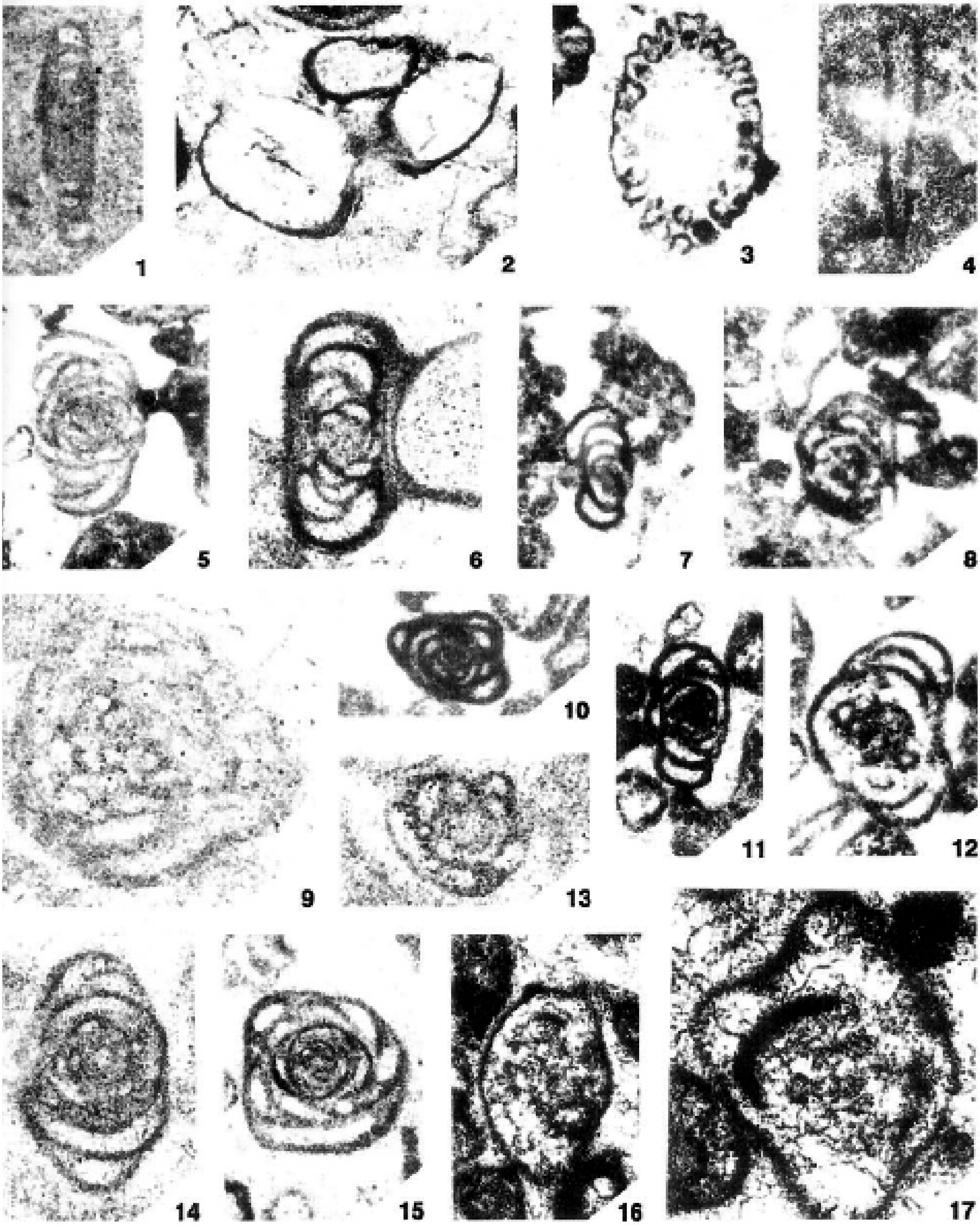

PLATE VII

Thin-sections with microfossils from Anisian olistoliths in the middle-upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Fig. 1-4 *Hoyenella* gr. *sinensis* (HO). Sample no. 1996/60, x 100, Anisian.

Fig. 5 *Hoyenella* sp. Sample no. 1996/60, x 100, Bithynian-Pelsonian.

Fig. 6 *Hoyenella* gr. *sinensis* (HO). Sample no. 1996/60, x 100, Bithynian-Pelsonian.

Figs. 7-8 *Hoyenella* sp. Sample no. 1996/60, x 100, Bithynian-Pelsonian.

Fig. 9 Indet. foraminifer. Sample no. 1996/60, x 100, Bithynian-Pelsonian.

Fig. 10 *Meandrospiranella samueli* SALAJ. Sample no. 1996/60, x 100, Bithynian-Pelsonian.

Fig. 11 *Meandrospira dieneri* (KRISTAN-TOLLMANN). Sample no. 1996/60, x 50, Bithynian-Pelsonian.

Fig. 12 *Meandrospira dieneri* (KRISTAN-TOLLMANN). Sample no. 1996/62, x 200, lowermost Anisian (lower Aegean) *Chiosella timorensis* Zone.

Fig. 13 *Meandrospira dieneri* (KRISTAN-TOLLMANN). Sample no. 1996/62, x 100, lowermost Anisian (lower Aegean) *Chiosella timorensis* Zone.

Fig. 14 *Trochammina* sp. Sample no. 1996/62, x 100, lowermost Anisian (lower Aegean) *Chiosella timorensis* Zone.

Fig. 15 *Earlandia gracilis* ZANINETTI. Sample no. 1996/62, x 50, lowermost Anisian (lower Aegean) *Chiosella timorensis* Zone.

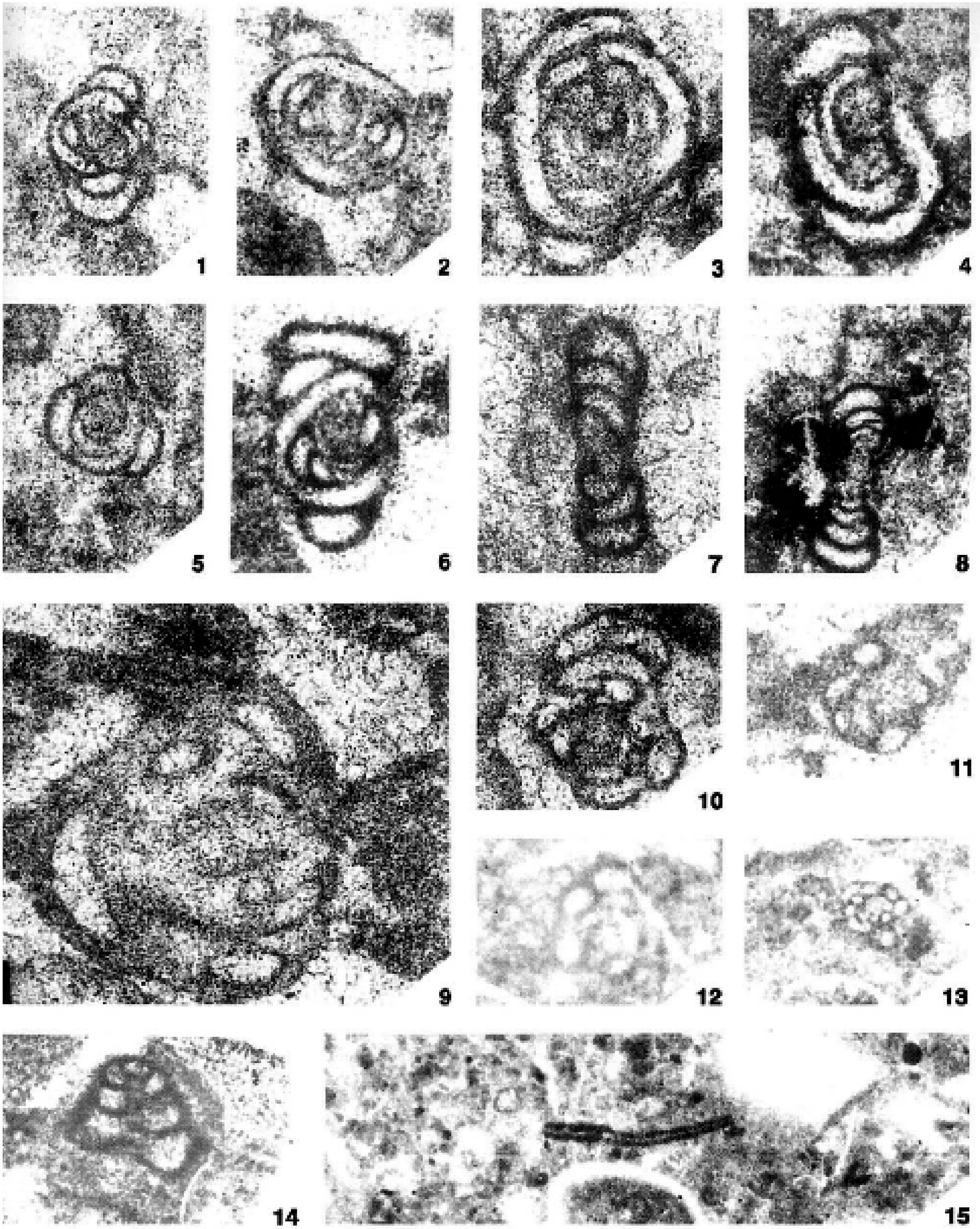
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PLATE VIII

Conodonts and placoid scale from the lowermost Anisian (lower Aegean) *Chiosella timorensis* Zone. Sample no. 1996/62. Olistolith of grey, bioclastic wackestone and mudstone (with numerous filaments, mostly from ostracods) in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Figs. 1, 2 *Chiosella timorensis* (NOGAMI), Pa element, lateral view, x 100; Fig. 1: rep.-no. 1996/22-11-I/5; Fig. 2: rep.-no. 1996/22-11-I/2.

Figs. 3, 4 *Chiosella gondolelloides* (BENDER), Pa element, lateral view; Fig. 3: x 100, rep.-no. 1996/22-11-I/3; Fig. 4: x 147, rep.-no. 1996/22-11-I/22.

Figs. 5, 12 *Gladigondolella* sp., ramiform elements, x 100, Fig. 5: M element, rep.-no. 1996/22-11-I/16; Fig. 12: broken part of Sb element, rep.-no. 1996/22-11-I/29.

Figs. 6-10 *Chiosella* sp., ramiform elements; Fig. 6: Pb element, x 100, rep.-no. 1996/22-11-I/6; Fig. 7: Sa element, x 200, rep.-no. 1996/22-11-I/12; Fig. 8: Sb element, rep.-no. 1996/22-11-I/23; Fig. 9: Sa element, x 200, rep.-no. 1996/22-11-I/18; Fig. 10: broken posterior bar of Sa element, x 79, rep.-no. 1996/22-11-I/13.

Fig. 11 Placoid scale, x 100, rep.-no. 1996/22-11-I/10.

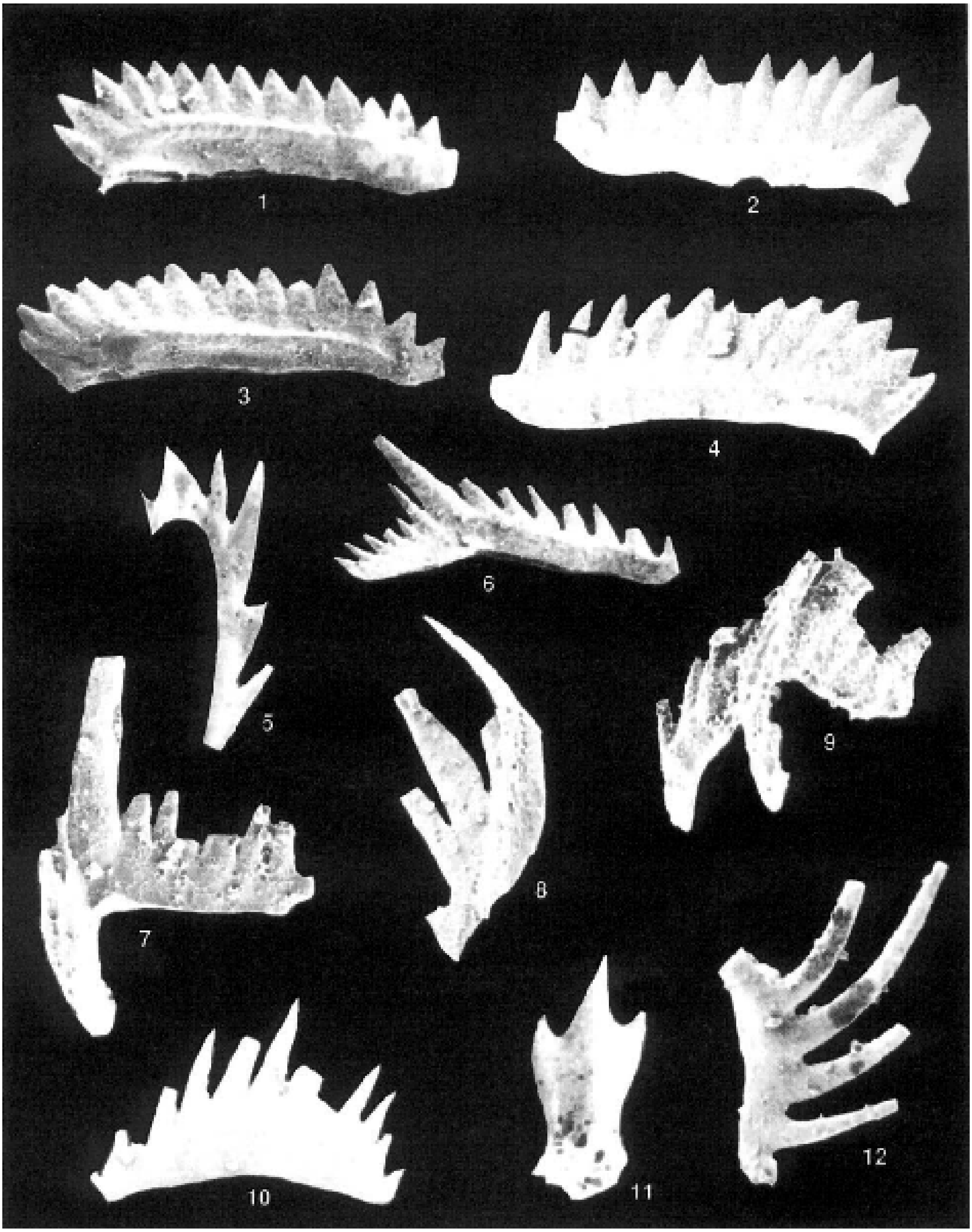
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PLATE IX

Microfossils from the lowermost Anisian (lower Aegean) *Chiosella timorensis* Zone. Sample no. 1996/62. Olistolith of grey, bioclastic wackestone and mudstone (with numerous filaments, mostly from ostracods) in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Figs. 1-4 Fish remains; Fig. 1: ganoid scale, x 100, rep.-no. 1996/22-11-I/31; Fig. 2: *Acrodus* sp., x 142, rep.-no. 1996/22-11-I/27; Fig. 3: placoid scale, x 84, rep.-no. 1996/22-11-I/11; Fig. 4: *Saurichthys* sp., x 100, rep.-no. 1996/22-11-I/14.

Figs. 5-7 Holothurian sclerites; Fig. 5. *Theelia immisorbicula* MOSTLER, x 200, rep.-no. 1996/22-11-II/1; Fig. 6: *Eocaudina* sp., x 294, rep.-no. 1996/22-11-I/24; Fig. 7: *Priscopedatus triassicus* MOSTLER, x 294, rep.-no. 1996/22-11-I/8.

Fig. 8 Gastropod steinkern, x 200, rep.-no. 1996/22-11-I/26.

Fig. 9 *Spinocypris nepalensis* KOZUR, x 200, rep.-no. 1996/22-11-I/20.

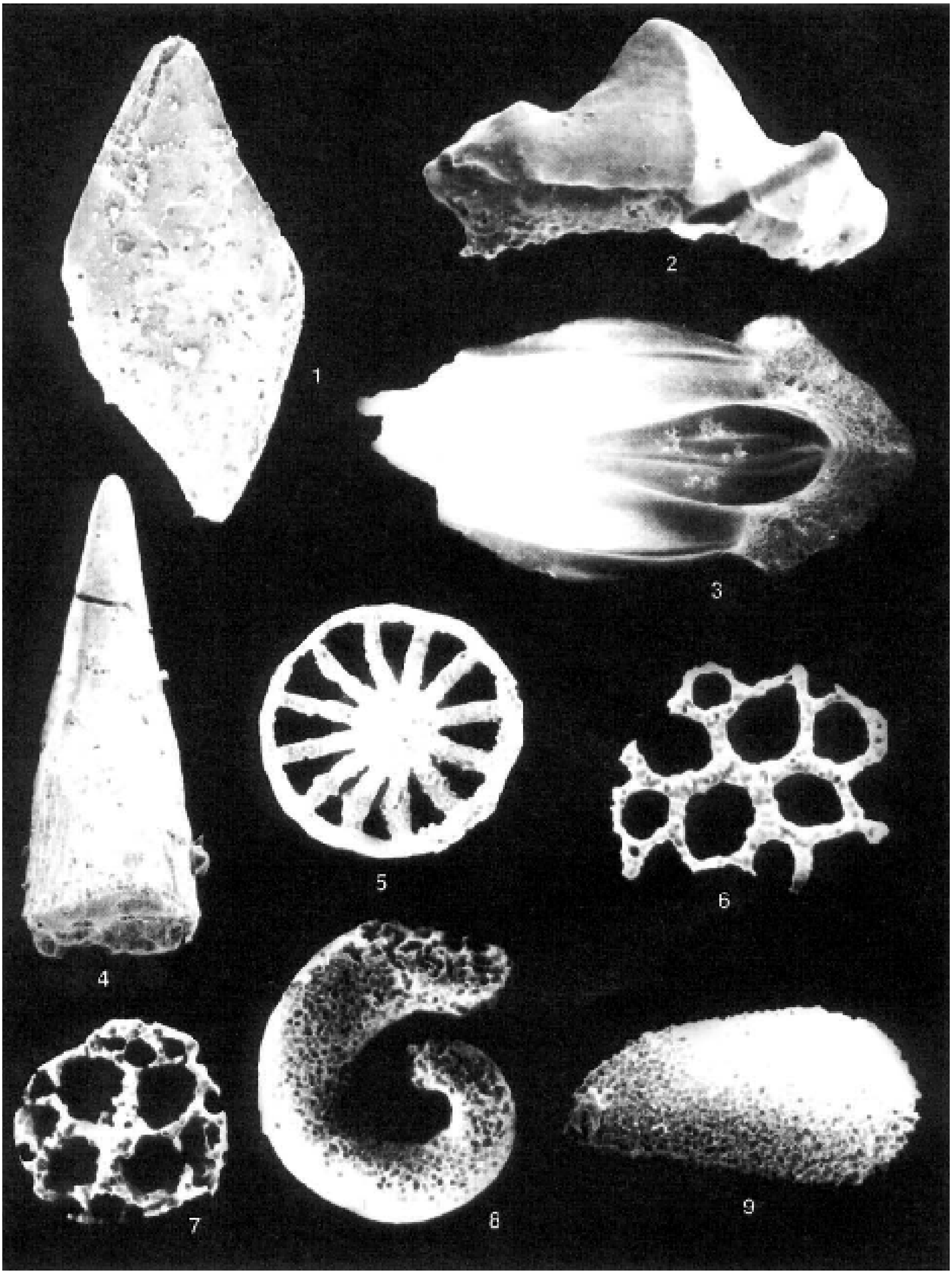
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PLATE X

Figs 1-9 Microfossils (Fig. 1: Foraminifera; Figs. 2-3: Echinodermata; Figs. 4-9: Conodonta) from Anisian limestone olistoliths in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Fig. 10 Bathypelagic ostracod from an olistolith of a dark-grey Upper Carboniferous to Permian bioclastic, bioturbated mudstone with some biogenic clasts, within the lower part of the Upper Jurassic Beykoz Formation (locality 4 of text Fig. 1).

Fig. 1 *Tolypammina* sp. Sample no. 1996/62 (see Plates VII, VIII), x 78, rep.-no. 1996/22-11-I/15.

Figs. 2, 3 *Aspidocrinites* n. sp., lower view, sample no. 1996/62 (see Plates VII, VIII); Fig. 2: x 244, rep.-no. 1996/22-11-I/30; Fig. 3: x 99, rep.-no. 1996/22-11-I/21.

Figs. 4, 5 *Neogondolella* ? *regalis* MOSHER, Pa element, lateral view. Sample no. 1996/55, x 99, lower Anisian (upper Aegean) *N.* ? *regalis* Zone, olistolith of grey radiolarian wackestone (bioturbate, with foraminifers, ostracods, sponge spicules, filaments); Fig. 4: rep.-no. 1996/22-11-II/75; Fig. 5: rep.-no. 1996/22-11-II/81.

Figs. 6, 7, 9 *Gladigondolella budurovi* KOVÁCS & KOZUR. Sample no. 1996/5O, x 99, Bithynian or Pelsonian, olistolith of grey, filamentous biomicrite (with very much filaments, few foraminifers, some ostracods); Fig. 6: Pa element, upper view, rep.-no. 1996/22-11-II/41A, Fig. 7: posterior bar of Sc element, rep.-no. 1996/22-11-II/42; Fig. 9: Pb element, rep.-no. 1996/22-11-II/44.

Fig. 8 *Paragondolella bulgarica* BUDUROV & STEFANOV, Pa element, lateral view, juvenile form, x 197, rep.-no. 1996/22-11-II/39, sample no. 1996/60, Bithynian or Pelsonian, olistolith of a grey grainstone.

Fig. 10 *Permocypridina mocki* n. gen. n. sp., RV, lateral view. Sample no. 1996/146, x 83.

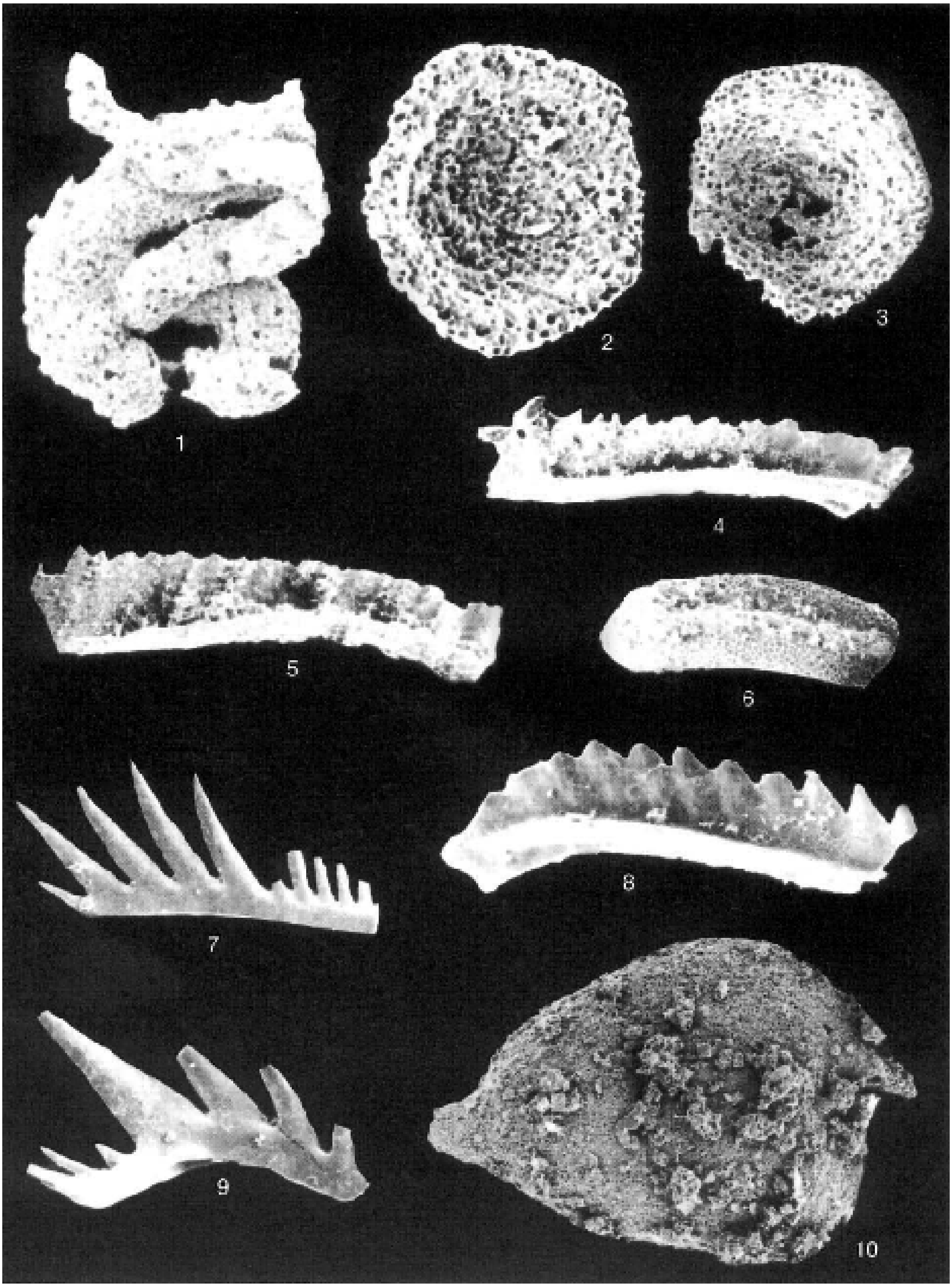
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PLATE XI

Conodonts from the Pelsonian upper *Paragondolella bulgarica* Zone. Sample no. 1996/49. Olistolith of a grey filamentous packstone, extremely rich in filaments, in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Figs. 1-7 *Paragondolella bulgarica* BUDUROV & STEFANOV, Pa element; Fig. 1: lateral view, x 99, rep.-no. 1996/22-11-II/31; Fig. 2: upper view, x 146, rep.-no. 1996/22-11-II/17; Fig. 3: lateral view, x 146, rep.-no. 1996/22-11-I/62; Fig. 4: transitional form to *Paragondolella shoshonensis* NICORA, upper view, x 99, rep.-no. 1996/22-11-II/8; Fig. 5: upper view, x 146, rep.-no. 1996/22-11-II/10; Fig. 6: lateral view, x 99, rep.-no. 1996/22-11-II/7; Fig. 7: lateral view, x 146, rep.-no. 1996/22-11-II/20.

Figs. 8, 11, 12 *Paragondolella bulgarica* BUDUROV & STEFANOV, ramiform elements; Fig. 8: Pb element, x 99, rep.-no. 1996/22-11-I/55; Fig. 11: Sb element, x 99, rep.-no. 1996/22-11-II/34; Fig. 12: Sa element, x 198, rep.-no. 1996/22-11-I/54.

Fig. 9 *Paragondolella bifurcata* BUDUROV & STEFANOV, Pa element, upper view, x 99, rep.-no. 1996/22-11-I/64.

Fig. 10 *Neohindeodella dropla* (SPASOV & GANEV), x 198, rep.-no. 1996/22-11-II/22.

Fig. 13 *Neohindeodella aequiramosa* KOZUR & MOSTLER, x 146, rep.-no. 1996/22-11-I/66.

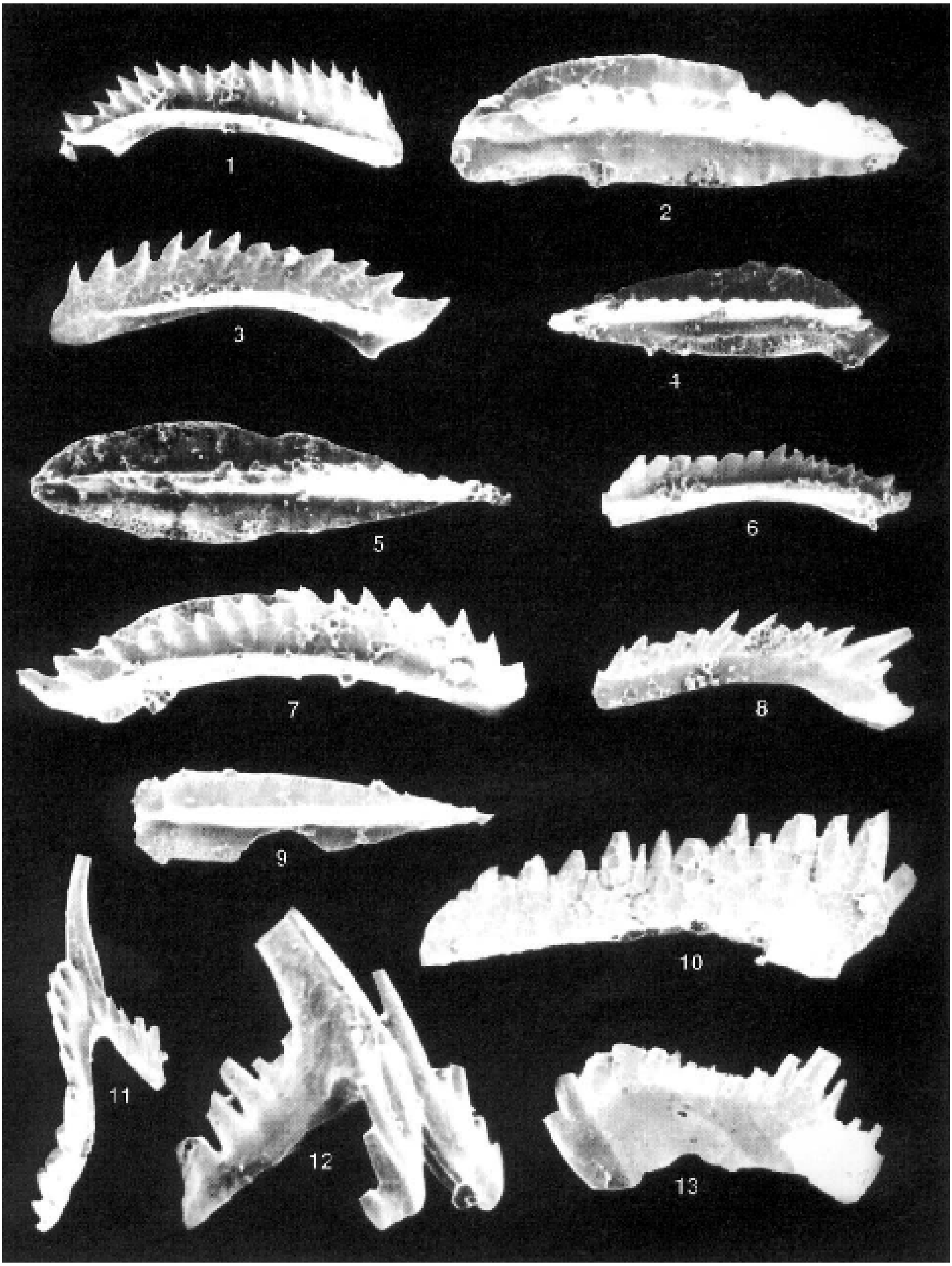
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PLATE XII

Conodonts and palaeopsychrosphaeric ostracods from the Pelsonian upper *Paragondolella bulgarica* Zone. Sample no. 1996/49. Olistolith of a grey filamentous packstone, extremely rich in filaments, in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Figs. 1-5 *Gladigondolella tethydis* (HUCKRIEDE); Fig 1: Pa element, juvenile specimen, lateral view, x 200, rep.-no. 1996/22-11-I/52; Fig. 2: Sb element, x 100, rep.-no. 1996/22-11-I/39; Fig. 3: M element, x 100, rep.-no. 1996/22-11-II/32; Fig. 4. posterior bar of Sc element, x 100, rep.-no. 1996/22-11-II/2; Fig. 5: anterior bar of Sc element, x 100, rep.-no. 1996/22-11-I/48.

Fig. 6 *Spinocypris vulgaris* KOZUR, RV, lateral view, x 147, rep.-no. 1996/22-11-II/4.

Fig. 7 *Acratina goemoeryi* (KOZUR), right lateral view, x 100, rep.-no. 1996/22-11-I/35.

Fig. 8 *Triassocythere* sp., LV, lateral view, x 100, rep.-no. 1996/22-11-II/25.

Fig. 9 *Acratina triassica* KOZUR, LV, lateral view, x 89, rep.-no. 1996/22-11-II/29.

Fig. 10 *Polycope* sp. 1, LV, lateral view, x 147, rep.-no. 1996/22-11-II/14.

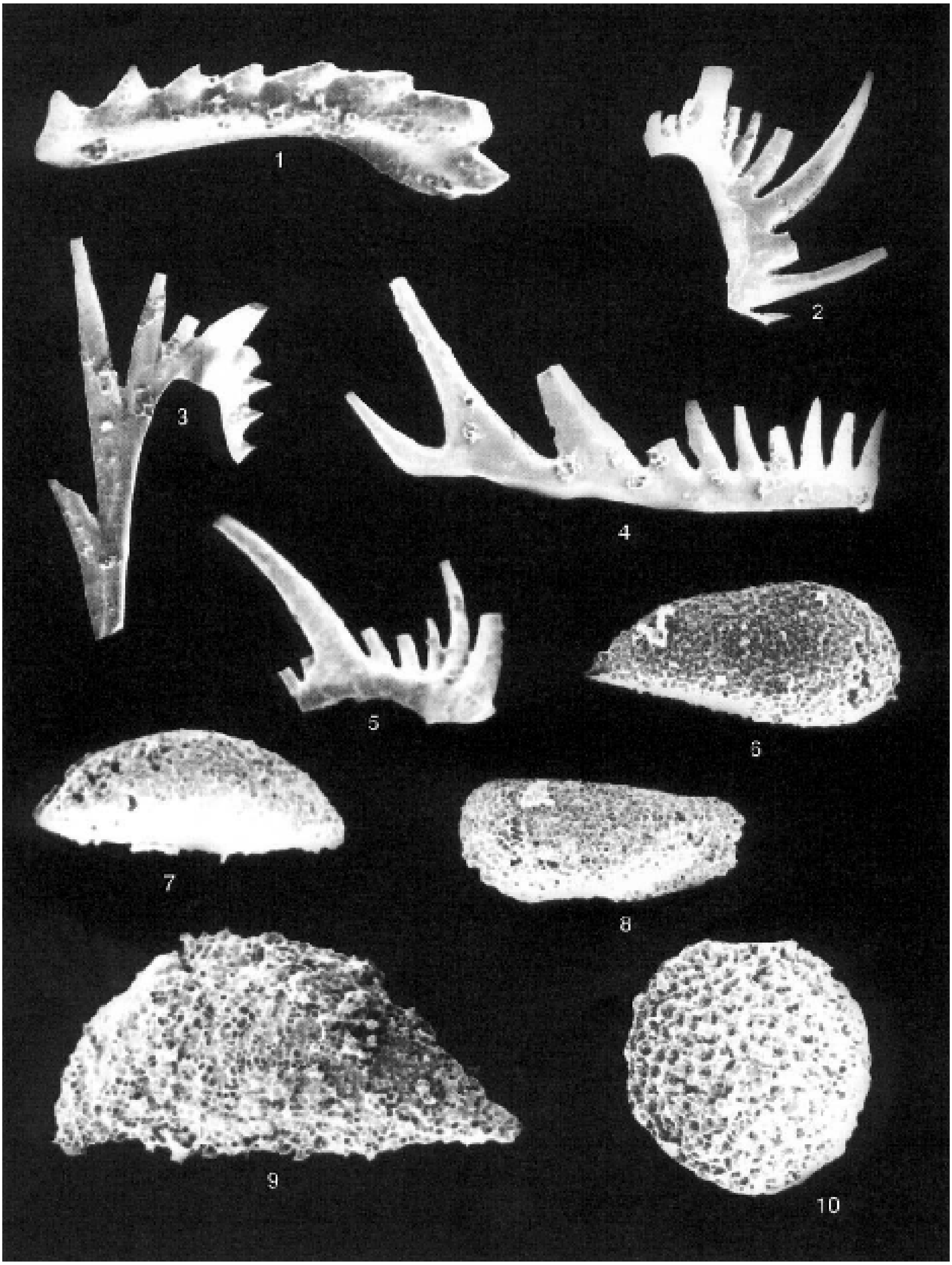
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PLATE XIII

Palaeopsychrosphaeric ostracods and one conodont from olistoliths in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Figs. 1-9 Sample no. 1996/49, Pelsonian upper *Paragondolella bulgarica* Zone. Olistolith of a grey filamentous packstone, extremely rich in filaments.

Fig. 10 Sample no. 1996/63, olistolith of a grey, bioclastic wackestone, bioturbated, partly packstone, with filaments, ostracods, crinoids, echinid spines and a few radiolarians. Illyrian.

Fig. 1 *Cryptobairdia atudoreii* (CRASQUIN-SOLEAU & GRADINARU), LV, inner view, x 99, rep.-no. 1996/22-11-I/38.

Fig. 2 *Polycope* sp. 1, RV, lateral view, x 146, rep.-no. 1996/22-11-II/21.

Fig. 3 *Polycope* sp. 2, LV, lateral view, x 146, rep.-no. 1996/22-11-II/25.

Fig. 4 *Paraberounella* n. sp., identical with the specimen of *Paraberounella ? renardi* CRASQUIN-SOLEAU & GRADINARU figured by these authors on Pl. 9, Fig. 3, RV, lateral view, x 146, rep.-no. 1996/22-11-II/19.

Fig. 5 *Polycopsis cincinnata* (APOSTOLESCU), RV, lateral view, x 146, rep.-no. 1996/22-11-II/3.

Figs. 6-8 *Paraberounella triassica* KOZUR, x 99; Fig. 6: RV, lateral view, rep.-no. 1996/22-11-I/49; Fig. 7: LV, lateral view, rep.-no. 1996/22-11-II/13; Fig. 8: RV, upper view, rep.-no. 1996/22-11-II/16.

Fig. 9 *Nagyella longispinosa* KOZUR, RV, inner view, x 99, rep.-no. 1996/22-11-II/11.

Fig. 10 *Neogondolella cornuta* BUDUROV & STEFANOV, upper view, x 78, rep.-no. 1996/22-11-I/34.

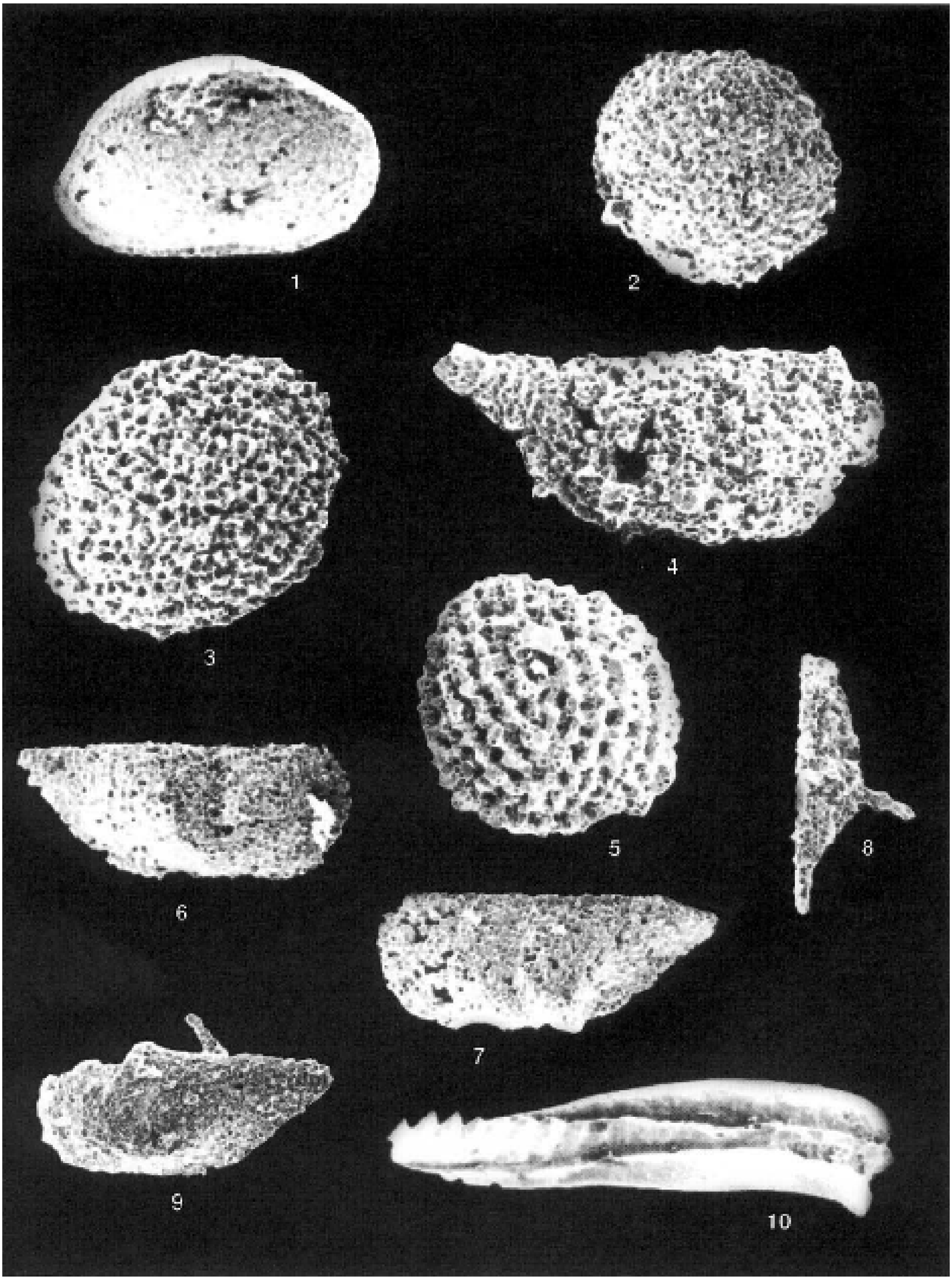
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PLATE XIV

Figs. 1-10 Conodonts and holothurian sclerites from Anisian pelagic limestone olistoliths in the middle - upper Carnian part (turbidites and olistostromes) of the Akgöl Group (Karadağtepe Formation). Outcrop at the Inebolu - Küre road south of Inebolu (locality 1 of text Fig. 1).

Fig. 11 Upper Carboniferous pelagic conodont.

Figs. 1-4 *Gladigondolella* sp., ramiform elements, sample no. 1996/51, Pelsonian grey, filamentous, partly bioclastic wackestone to packstone, with numerous filaments, common radiolarians, few gastropods, and ophiurian remains; Fig. 1: Pa element, lateral view, early, platform-free juvenile specimen, x 140, rep.-no. 1996/22-11-II/70; Fig. 2: Sc element, x 140, rep.-no. 1996/22-11-II/65; Fig. 3: broken part of Sb element, x 85, rep.-no. 1996/22-11-II/66; Fig. 4: M element, x 140, rep.-no. 1996/22-11-II/62.

Fig. 5 *Theelia consona* (CARINI), upper view, x 190, sample no. 1996/51 (see Figs. 1-4), rep.-no. 1996/22-11-II/59.

Figs. 6, 7 *Gladigondolella* sp., ramiform elements, sample no. 1996/54, upper Illyrian grey, fine-grained wackestone with small bioclasts and graded calciturbidites with reworked shallow-water clasts; Fig. 6: Sc element, x 120, rep.-no. 1996/22-11-II/58; Fig. 7: broken part of Sb lement, x 95, rep.-no. 1996/22-11-II/53.

Fig. 8 *Neogondolella constricta* (MOSHER & CLARK), advanced form, lower view, x 190, sample no. 1996/54 (see Figs. 6, 7).

Figs. 9, 10 *Neogondolella* sp., ramiform elements, sample no. 1996/54 (see Figs 6, 7); Fig. 9: Sc element, x 140, rep.-no. 1996/22-11-II/56; Fig. 10: Sa element, x 190, rep.-no. 1996/22-11-II/51.

Fig. 11 Juvenile *Streptognathodus* sp. ex gr. *S. ruzhencevi* KOZUR, oblique upper view, x 200. Sample 148, olistolith of a Wordian rudstone with reworked shallow-water and basinal rocks that also contain Upper Carboniferous pelagic conodonts, olistostrome within the Upper Jurassic Beykoz Formation. Outcrop Dağ Mahellesi at Kircalla village 11.5 km E of Azdavay (locality 4 of text Fig. 1).

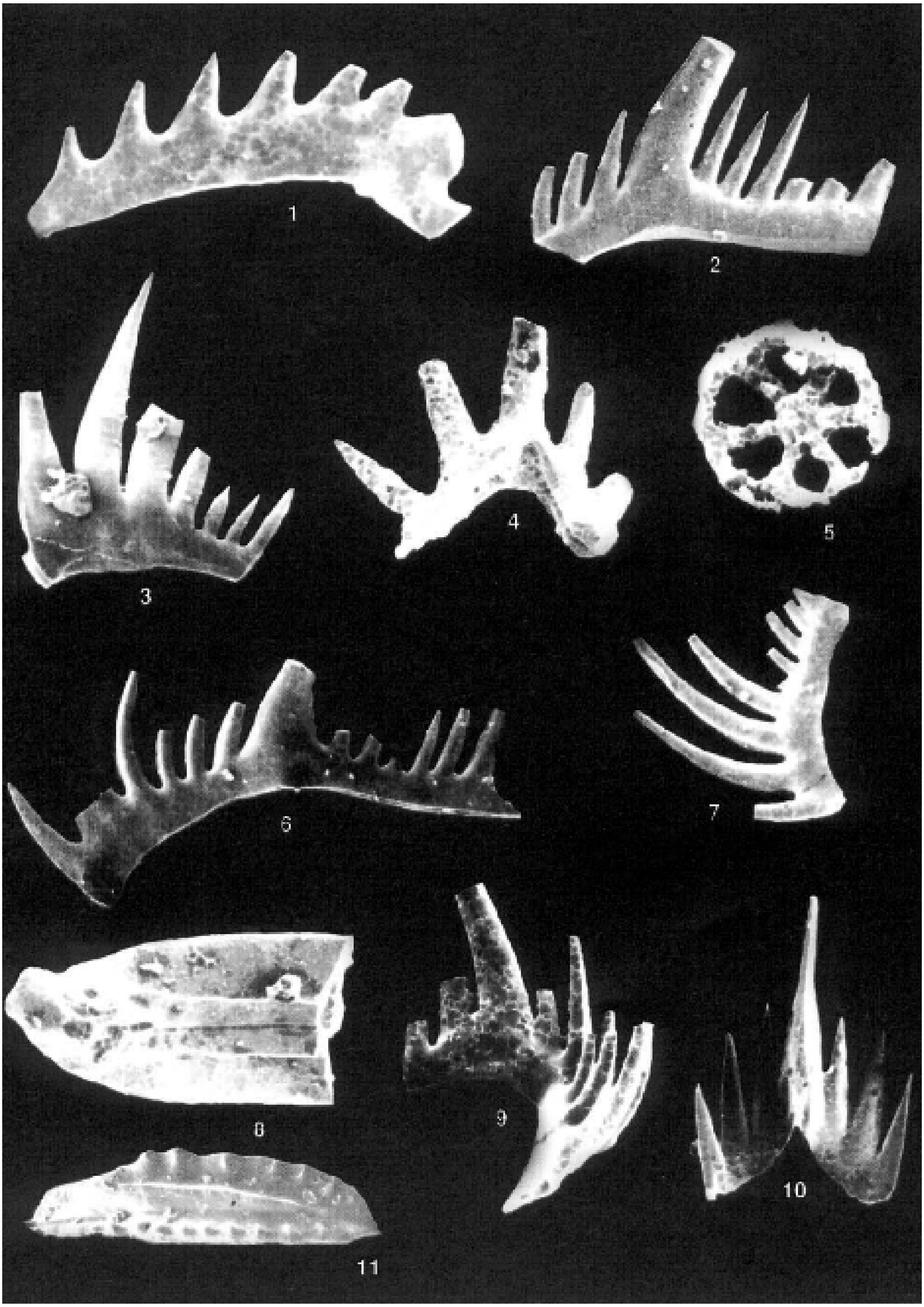
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PLATE XV

Trace fossils and *Torlessia* from Upper Triassic turbidites of the Karadağtepe Formation.

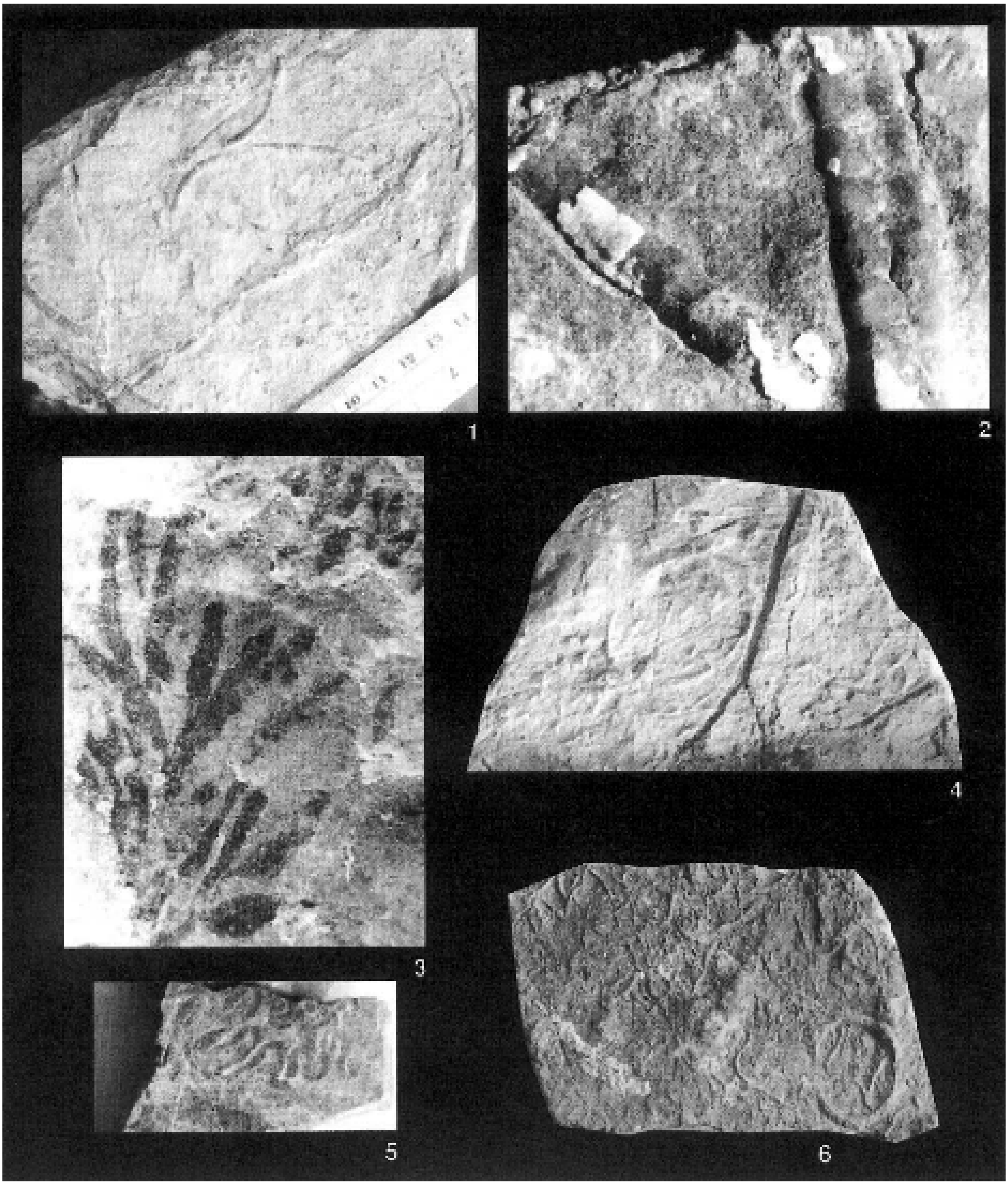
Fig. 1 *Torlessia* n. sp., x 0.85, middle to upper Carnian turbidites of Karadağtepe Formation, roadcut at the Inebolu - Küre road, approximately 9 km south of Inebolu, rep.-no. KY 98-7.

Fig. 2 *Torlessia mackayi* BATHER, detail, x 12, lower to middle Norian turbidites of Karadağtepe Formation, sample 377, roadcut at the Inebolu - Küre road, 10.3 km south of Inebolu, rep.-no. KY 98-10 I.

Fig. 3 *Chondrites* sp. x 12, lower to middle Norian turbidites of Karadağtepe Formation with *Torlessia mackayi*, sample 377 (see Fig. 2), rep.-no. KY 98-21 A.

Figs. 4, 6 Upper Triassic new ichnogenus consisting of an elliptical or round ring; Fig. 4: x 1.2, lower to middle Norian turbidites of Karadağtepe Formation with *Torlessia mackayi* BATHER, sample 377 (see Fig. 2), rep.-no. KY 98-10 D; Fig. 6: *Gordia* sp. and the new ichnogenus, x 0.85, middle to upper Carnian turbidites of Karadağtepe Formation with *Torlessia* n. sp., roadcut at the Inebolu - Küre road, approximately 9 km south of Inebolu, sample 370, rep.-no. KY 98-25 D.

Fig. 5 *Phycosiphon incertum* FISCHER-OOSTER, x 2.15, lower to middle Norian turbidites of Karadağtepe Formation with *Torlessia mackayi* BATHER, sample 440, roadcut at the northern entrance to Esentepe village, rep.-no. KY 98-27 F.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APPENDIX: SAMPLE DATA OF OLISTOLITHS FOR PROTOLITH RECONSTRUCTION

Only samples taken in 1996 that are important (stratigraphically or otherwise) to this study are listed. Material collected in 1998 is not yet fully processed and only part of the SEM study is complete. The most important results from these samples are used in the present paper (e.g. presence of Pelsonian to Norian Hallstatt Limestones in the Çalça Unit) but the fossil data (plates etc.) will be presented later.

Locality 1 (see text Fig. 1)

Karadağtepe Formation, road Inebolu - Küre, roadcut south of Inebolu. If not otherwise indicated, olistoliths within the Karadağtepe Formation with the middle - upper Carnian *Torlessia erenleri* n. sp.

Sample 1996/47

Shallow-water limestone (wackestone). **Fossils**: crinoids, foraminifers (*Hoyenella* sp.). **Environment** : shallow-water shelf. **Age:** probably Anisian.

Sample 1996/48

Bioclastic mudstone (filamentous radiolarian biomicrite). **Fossils:** conodonts (juvenile *Paragondolella hanbulogi* SUDAR & BUDUROV, *Gladigondolella* sp., ramiform elements), radiolarians, and ostracods. **Environment:** pelagic. **Age:** (middle) to late Anisian.

Sample 1996/49

Filamentous packstone, extremely rich in filaments. **Fossils:** conodonts (*Paragondolella bulgarica* BUDUROV & STEFANOV, *P. bifurcata* BUDUROV & STEFANOV, primitive *P. shoshonensis*, only one specimen, *Gladigondolella* sp., ramiform elements, *Neohindeodella aequiramosa* KOZUR & MOSTLER, *N. dropla* (SPASOV & GANEV)), ostracods (*Acratina goemoeryi* KOZUR, *A. triassica* KOZUR, *Cavellina* n. sp., *Cryptobairdia atudoreii* (CRASQUIN-SOLEAU & GRADINARU), *Cryptobairdia* sp., *Hungarella reniformis* (MÉHES), *Nagyella longispinosa* KOZUR, *Paraberounella triassica* KOZUR, *Paraberounella* n. sp. (= *Paraberounella* ? *renardi* CRASQUIN-SOLEAU & GRADINARU, pars), *Polycope* sp. 1, *Polycope* sp. 2, *Polycopsis cincinnata* (APOSTULESCU), *Spinocypris vulgaris* KOZUR, *Triassocypris* sp., *Triassocythere* sp.). **Environment:** pelagic; palaeopsychrosphaeric deep water ostracods indicate full connection to the world ocean and its cold bottom water currents. **Age:** early Pelsonian upper *Paragondolella bulgarica* Zone.

Sample 1996/50

Filamentous biomicrite with abundant filaments. **Fossils:** conodonts (*Gladigondolella budurovi* KOVÁCS & KOZUR), foraminifers, holothurian sclerites (*Theelia immisorbicula* MOSTLER), and ostracods. **Environment:** pelagic. **Age:** middle Anisian to lower part of the late Anisian.

Sample 1996/51

Filamentous, partly bioclastic wackestone to packstone, with numerous filaments. **Fossils:** arthropod spines, conodonts (*Gladigondolella* sp., ramiform elements and juvenile Pa elements), gastropods, holothurian sclerites (*Theelia germanica* KOZUR, *T. immisorbicula* MOSTLER, *T. planata* MOSTLER, *T. consona* (CARINI), *Tetravirga levis* KOZUR & MOSTLER), ophiurian remains, and radiolarians. **Environment:** pelagic. **Age:** middle Anisian (Pelsonian).

Sample 1996/52

Bioclastic packstone, poor in determinable fossils, with clasts of filamentous, radiolarian bearing micrites that are rich in filaments and contain ostracods, foraminifers. **Fossils:** conodonts (*Gladigondolella* sp., ramiform elements and juvenile Pa elements), holothurian sclerites (*Theelia andrusovi* KOZUR & MOSTLER, *Priscopedatus* sp., *Tetravirga* cf. *levis* KOZUR & MOSTLER). **Environment:** pelagic. **Age:** early to middle Anisian.

Sample 1996/53

Shallow-water boundstone. **Fossils:** bryozoa, calcareous sponges (recrystallized). **Environment:** shallow-water shelf.

Sample 1996/54

Fine-grained wackestone with small bioclasts and graded calciturbidites with reworked shallow-water clasts. **Fossils:** conodonts (*Neogondolella constricta* MOSHER & CLARK, advanced forms, *Gladigondolella* sp., ramiform elements), foraminifers (*Nodosaria* sp.), gastropods, holothurian sclerites (*Theelia immisorbicula* MOSTLER, *T. multiradiata* KOZUR, *T. planata* MOSTLER, *T. undata* MOSTLER, *Calclamna germanica* FRIZZELL & EXLINE, *Tetravirga* ? n. sp.), ostracods (*Microcheilinella* sp.), sponge spicules. **Environment:** pelagic calciturbidite. **Age:** late Illyrian (latest Anisian).

Sample 1996/55

Radiolarian wackestone, bioturbated, with filaments. **Fossils:** conodonts (*Gladigondolella* sp., ramiform elements, *Neogondolella* ? *regalis* MOSHER, fish scales, foraminifers (*Arenovidalina* sp., *Nodosaria* sp.), holothurian sclerites (*Priscopedatus* n. sp. 1), ostracods (*Hungarella* sp., *Cryptobairdia* sp., *Praemacrocypris* sp.). **Environment:** pelagic. **Age:** early Anisian *N.* ? *regalis* Zone.

Sample 1996/56

Radiolarite (lydite) with numerous radiolarians (low-diversity fauna, all Entactinaria and Spumellaria) that could not be dissolved from the rock. **Fossils from the palynological separation** : Acritarcha indet., Bacteria, sporomorphs (*Alisporites* sp., *Falcisporites* sp., *Illinites trivisus* VISSCHER, *Lunatisporites* sp., *Platysaccus leschiki* HART, *Striatoabieites balmei* KLAUS, *Triadispora epigona* KLAUS, *Triadispora* cf. *falcata* KLAUS, *Triadispora* sp., few trilete spores). **Environment:** deep water, anoxic to dysaerobic; not too far from the continent; deep, but narrow rift basin, probably restricted connection to the open ocean (abundant, but very low diversity radiolarian fauna). **Age:** Middle Triassic (? early Anisian).

Sample 1996/57

Bioclastic grainstone. **Fossils:** crinoids, dasycladacean algae, echinoderm remains, foraminifers (*Earlandia* cf. *tintinniformis* (MÍŠIK), *Hoyenella* gr. *sinensis* (HO), *Hoyenella* sp., *Pilammina densa* PANTIĆ), gastropods, ostracods (*Bairdiacypris* sp.), Vermes (*Spirorbis valvata* (GOLDFUSS)). **Environment:** shallow-water shelf. **Age:** Anisian.

Sample 1996/59

Bioclastic grainstone-wackestone. **Fossils:** Foraminifers (*Arenovidalina* sp., *Aulotortus* ? *eotriassicus* ZANINETTI et al., *Glomospira* sp., *Glomospirella* sp., *Hoyenella* gr. *sinensis* (HO), *Hoyenella* sp., *Meandrospira dinarica* (KOCHANSKY-DÉVIDÉ & PANTIĆ), *Pilammina densa* PANTIĆ), gastropods, ostracods (*Cryptobairdia* sp.). **Environment:** shallow-water. **Age:** middle to late Anisian.

Sample 1996/60

Grainstone. **Fossils:** Conodonts (*Paragondolella bulgarica* BUDUROV & STEFANOV), foraminifers (*Ammodiscus* sp., *Hoyenella* gr. *sinensis* (HO), *Hoyenella* sp., *Meandrospira dieneri* (KRISTAN-TOLLMANN), *Meandrospira* sp., *Meandrospiranella samueli* SALAJ)), gastropods, Vermes (*Spirorbis* sp.). **Environment:** shallow-water, but very near to the shelf edge (*Paragondolella bulgarica* !). **Age:** Bithyanian-Pelsonian.

Sample 1996/61A

Debris flow with silty matrix, and clasts of mafic volcanics, serpentinite detritus, partly brecciated limestones with filaments, indeterminable foraminifers. **Environment:** upper slope deposit. **Age of matrix:** Late Carnian.

Sample 1996/62

Bioclastic wackestone and mudstone with numerous filaments, mostly from ostracods. **Fossils:** ammonoids, conodonts (*Chiosella timorensis* (NOGAMI), *Chiosella gondolelloides* (BENDER), *Gladigondolella*, ramiform elements), dasycladacean algae, echinoderm remains, among them *Aspidocrinites* n. sp., fish remains (placoid and other scales, *Acrodus* sp., *Saurichthys* sp.), foraminifers (*Ammobaculites* sp., *Earlandia gracilis* ZANINETTI, *Hoyenella* gr. *sinensis* (HO), *Hoyenella* sp., *Glomospira* sp., *Meandrospira dieneri* (KRISTAN-TOLLMANN), *Nodosaria ordinata* Trifonova, *Planiinvoluta* sp., *Tolypammina* aff. *T. gregaria* Wendt, *Tolypammina* sp., *Trochammina* sp.), holothurian sclerites (*Achistrum pulchrum* KOZUR, *Theelia germanica* KOZUR, *T. immisorbicula* MOSTLER, *Theelia* n. sp., *Priscopedatus triassicus* MOSTLER, *Eocaudina* sp.), ostracods (*Cryptobairdia* sp., *Microcheilinella* sp., *Spinocypris nepalensis* KOZUR). **Environment:** upper slope facies. **Age:** earliest Anisian *Chiosella timorensis* Zone. Close to Scythian-Anisian boundary.

Sample 1996/63

Bioclastic wackestone, bioturbated, partly packstone, with filaments. **Fossils:** conodonts (*Neogondolella cornuta* BUDUROV & STEFANOV), crinoids, echinid spines, foraminifers (*Glomospira* sp., *Nodosaria* sp., *Arenovidalina* sp., *Tolypammina* aff. *gregaria* WENDT), ostracods, few radiolarians. **Environment:** pelagic. **Age:** late Anisian.

Sample 1996/64

Bioturbated mudstone with a few filaments, some echinoderm remains and sparse radiolarians; some shallow-water limestone clasts with *Meandrospira pusilla* (HO). **Fossils from the matrix:** conodonts (*Neogondolella constricta* (MOSHER & CLARK)), foraminifers (*Earlandia* sp., *Glomospira* ? sp.). **Fossils from the shallow-water clasts:** foraminifers (*Meandrospira pusilla* (HO)). **Environment:** slope deposit. **Age of the matrix:** late Illyrian (latest). **Age of the clasts:** late Olenekian.

Sample 1996/65

Dasycladacean algal limestone, some oncoids, ostracods. **Fossils:** dasycladacean algae, echinid spines, foraminifers (*Endothyra* ? sp., *Glomospira* sp., *Hoyenella* gr. *sinensis* (HO), *Hoyenella* sp., *Trochammina* sp., Involutinidae, gen. et spec. indet.), gastropods. **Environment:** shallow-water outer shelf. **Age:** Anisian.

Sample 1996/66

Siliciclastic turbiditic siltstone, clayey limestone, disturbed (slumping), organic matter, sand grain-sized mafic volcanic clasts. Matrix of the olistostrome. **Environment:** lower slope at the active margin of an ocean. **Age:** middle to late Carnian.

Sample 1996/67

Turbiditic siltstone with sand grain-sized mafic volcanic clasts, few coaly remnants. Matrix of the olistostrome. **Environment:** lower slope at the active margin of an ocean. **Age:** middle to late Carnian.

Sample 1996/68

Debris flow with clasts of mafic volcanics (spilitic basalts), very sparce ultramafic detritus, hyaloclastics, and shallow-water limestones, dolomites, partly with oncoids, pelagic limestones, few radiolarites. **Environment:** steep slope at the active margin of an ocean. **Age:** as the block lies in a middle - late Carnian matrix, the volcanics must be of pre-middle Carnian age. Some of the radiolarites (lydites) are of (early) Anisian age (see sample 1996/56).

Locality 3 (see text Fig. 1)

Outcrops along the road between the villages of Aha and Sırçalık, Sırçalık Group, flaser-bedded marly limestone with "*Daonella*" (the "*Daonella*" material could not be re-studied, but in the same beds Dr. AYDIN found a badly preserved similar bivalve, probably an *Eumorphotis*), formerly assigned to the Ladinian, but typical Werfen shallow-water facies. **Age:** Scythian.

Sample 1996/91

Fossils: Vermes (*Spirorbis* ? sp.). **Environment:** shallow-water, variable salt content.

Sample 1996/93

Fossils: ostracods, Vermes (*Spirorbis* ? sp.). **Environment:** shallow-water, variable salt content.

Sample 1996/95

Fossils: ostracods (filaments), Vermes (*Spirorbis phlyctaena* BRÖNNIMANN & ZANINETTI). **Environment:** shallow-water, variable salt content.

Sample 1996/99

Fossils: ostracods (filaments), Vermes (*Spirorbis phlyctaena* BRÖNNIMANN & ZANINETTI). **Environment:** shallow-water, variable salt content.

Locality 4 (see text Fig. 1)

SE of the Azdavay village. Beykoz Formation with olistoliths of shallow-water and pelagic, mostly Middle Permian, partly Upper Carboniferous and Lower Permian limestones. All listed samples are olistoliths.

Sample 1996/140

Bioclastic grainstone with some pelmicritic matrix, strongly washed out, mostly sparitic cement, bioclasts partly incrusted. **Fossils:** Algae (*Archaeolithoporella* sp., *Mizzia* sp., *Tubiphytes carinthiacus* (FLÜGEL)), ammonoids (!), brachiopods, bryozoans, foraminifers (*Diplosphaerina* sp., *Globivalvulina vonderschmitti* REICHEL, Geinitzinidae, Palaeotextulariidae indet., *Parafusulina* ? sp.), gastropods, ostracods. **Environment:** shelf edge; shallow-water, but with drifted small ammonoid shells. **Age:** late Cisuralian to lower Guadalupian.

Sample 1996/141

Bioclastic wackestone or grainstone to wackestone. **Fossils:** algae (*Archaeolithoporella* sp., *Pseudovermiporella nipponica* (ENDO), *Tubiphytes* sp.), brachiopods, bryozoans, calcareous sponges, foraminifers (*Climacammina* sp., *Diplosphaerina inaequalis* (DERVILLE), *Globivalvulina* sp., *Langella* sp. or *Pseudolangella* sp., *Pachyphloia* sp., *Tolypammina* sp., *Tuberitina bulbacea* GALLOWAY & HARLTON, *Tuberitina conili* NGUYEN, Geinitzinidae indet., *Staffella* sp.), gastropods. **Environment:** shallow-water open shelf. **Age:** Permian.

Sample 1996/142

Bioclastic wackestone to boundstone, micritic to pelmicritic matrix. **Fossils:** Algae (*Archaeolithoporella* sp., *Tubiphytes carinthiacus* (FLÜGEL), *T. obscurus* MASLOV), brachiopods, bryozoans, echinoderm remains, foraminifers (*Neondothyra parva* (LANGE), *Tetrataxis* sp., Geinitzinidae gen. et spec. indet., Palaeotextulariidae indet., broken walls of fusulinids). **Environment:** open shallow-water shelf. **Age:** Guadalupian.

Sample 1996/143

Fine-grained packstone, slightly washed out, sparitic cement and micritic matrix. **Fossils:** Algae (*Tubiphytes obscurus* MASLOV, dasycladacean algae), brachiopods, byozoans, echinoderm remains, foraminifers (*Dagmarita chanakchensis* REITLINGER, *Deckerella* sp., *Diplosphaerina inaequalis* (DERVILLE), *Endothyra* sp., *Globivalvulina* sp., *Lasiodiscus* sp., *Lasiotrochus tatoensis* REICHEL, *Neoendothyra* sp., *Pachyphloia* sp., *Geinitzina reperta* BYKOVA, *Rectostipulina* sp., *Spiroplectammina* sp., *Tolypammina* sp., *Tuberitina bulbacea* GALLOWAY & HARLTON, Geinitzinidae indet., *Minojapanella* sp., *Nankinella* ? sp., Boultoniidae gen. et spec. indet.), ostracods (*Amphissites* sp.), microproblematica, Porotubida (*Polyporotubus* sp.). **Environment:** open shallow-water shelf. **Age:** Capitanian (*Dagmarita chanakchensis* is not present below the Capitanian, some of the fusulinids do not occur above the Capitanian).

Sample 1996/144

Bioclastic bioturbated mudstone. **Fossils:** foraminifers (*Diplosphaerina inaequalis* (DERVILLE), Geinitzinidae indet.), ostracods (exclusively Myodocopida, e.g., *Permocypridina mocki* n. gen. n. sp., and Cladocopida, e.g. *Polycope* cf. *provecta* ZHANG). **Environment:** pelagic limestone. **Age:** Late Carboniferous to Middle Permian.

Sample 1996/145

Rudstone with shallow-water clasts. **Fossils:** bryozoa, calcareous sponges, corals, foraminifers (*Tetrataxis* sp., broken walls of schwagerinid fusulinids). **Environment:** shelf edge. **Age:** Early-Middle Permian.

Sample 1996/146

Bioclastic, bioturbated mudstone, few biogenic clasts. **Fossils:** algae (*Tubiphytes obscurus* MASLOV), echinoderm remains, foraminifers (*Diplosphaerina inaequalis* (DERVILLE), *Frondinodosaria* sp.), pelagic ostracods (exclusively Myodocopida). **Environment:** pelagic. **Age:** Late Carboniferous to Permian.

Sample 1996/147

Boundstone to wackestone. **Fossils:** algae (*Tubiphytes carinthiacus* (FLÜGEL), *Tubiphytes obscurus* MASLOV, dasycladacean algae), bryozoans, calcareous sponges, corals, echinoderm remains, foraminifers (*Climacammina* sp., *Tolypammina* sp., *Tuberitina bulbacea* GALLOWAY & HARLTON), gastropods, ostracods. **Environment:** open shallow-water shelf. **Age:** Guadalupian (?).

Sample 1996/148

Rudstone, matrix micritic, components wackestone, mudstones, reworked shallow and basinal rocks. **Fossils:** algae (*Tubiphytes obscurus* MASLOV), bryozoans, conodonts (reworked juvenile *Streptognathodus* ex gr. *S. ruzhencevi* KOZUR), echinoderm remains, foraminifers (*Diplosphaerina* sp., *Globivalvulina* sp., *Lunucammina* sp., *Pachyphloia* sp., *Tolypammina* sp., *Neoschwagerina* fragment), gastropods, ostracods (partly pelagic forms). **Environment:** proximal slope (pelagic with transported shallow-water fossils, mostly broken, reworked older material). **Age:** Wordian (Murgabian to early Midian fusulinid age) with reworked Late Carboniferous (Gzhelian) conodonts.

Sample 1996/149

Packstone with bio- and lithoclasts, some siliciclastic material (quartz). **Fossils:** bryozoans, echinoderms, foraminifers (*Diplosphaerina inaequalis* (DERVILLE), *Globivalvulina* sp., *Lunucammina* sp., *Pachyphloia ovata* LANGE, *Tuberitina bulbacea* GALLOWAY & HARLTON, Palaeotextulariidae gen. et spec. indet., Schubertellidae gen. et spec. indet.), ostracods. **Environment:** slope to shelf. **Age:** Guadalupian.

Sample 1996/150

Rudstone, with components of boundstones and wackestones, *Archaeolithoporella-Tubiphytes* boundstone. **Fossils:** algae (*Archaeolithoporella* sp., *Tubiphytes* sp., dasycladacean algae), bryozoans, calcareous sponges, incrusted by *Tubiphytes* and *Archaeolithoporella,* corals, foraminifers (*Diplosphaerina* sp., *Lunucammina* sp., *Pachyphloia* sp., *Palaeotextularia* sp., *Protonodosaria* sp., *Pseudolangella* sp., *Parafusulina* sp., *Afghanella* sp.), ostracods. **Environment:** open shallow-water shelf. **Age:** Guadalupian.

Sample 1996/151

Grainstone with sparitic cement and micritic matrix. **Fossils:** algae (*Mizzia* sp., *Pseudovermiporella nipponica* (ENDO), *Tubiphytes carinthiacus* (FLÜGEL), *T. obscurus* MASLOV), brachiopods, bryozoans, calcareous sponges, corals, foraminifers (*Baisalina* ? sp., *Tetrataxis* sp., *Tolypammina* sp., Geinitzinidae, gen. et spec. indet., Palaeotextulariidae gen. et spec. indet., *Cancellina* ? sp., *Chusenella* sp., *Minojapanella* sp., *Nankinella* sp., primitive *Neoschwagerina* sp.), gastropods. **Environment:** open shallow-water shelf. **Age:** Wordian (early Murgabian fusulinid age).

Sample 1996/152

Rudstone, angular components of wackestones, mudstones, boundstones in micritic matrix. **Fossils:** algae (*Archaeolithoporella* sp., *Tubiphytes obscurus* MASLOV), bivalve fragments, bryozoans, corals, echinoderm remains, foraminifers (*Diplosphaerina* sp., *Geinitzina postcarbonica* SPANDEL, primitive *Neoendothyra, Minojapanella* ? sp., *Neoschwagerina simplex* OZAWA), microproblematica. **Environment:** upper slope deposit. **Age:** Wordian (early Murgabian fusulinid age).

Sample 1996/153

Bioclastic, bioturbated wackestone, fine-grained with few large biogenic remnants. **Fossils:** algae (*Archaeolithoporella* sp., *Tubiphytesobscurus* MASLOV), bryozoans, calcareous sponges, corals, echinoderm remains, foraminifers (*Lasiodiscus* sp., *Pachyphloia* sp., *Palaeotextularia* sp., *Tuberitina collosa* REITLINGER, Geinitzinidae, gen. et spec. indet.), gastropods, ostracods. **Environment:** shelf edge. **Age:** Guadalupian.

Sample 1996/154

Pelagic mudstone with large shallow-water limestone clasts (grainstone, boundstone). **Fossils:** algae (*Archaeolithoporella* sp., *Mizzia* sp., *Tubiphytes obscurus* MASLOV, *Stacheoides* sp. (red algae)), brachiopods, bryozoans, calcareous sponges, incrusted by *Archaeolithoporella* and *Tubiphytes*, corals, echinoderm remains, foraminifers (*Diplosphaerina* sp., *Pachyphloia* sp., *Neoschwagerina* ? sp.), ostracods (shallow-water and pelagic forms). **Environment:** slope deposits (probably reef slope). **Age:** Wordian (Murgabian to early Midian fusulinid age).

Sample 1996/155

Pelagic bioclastic mudstone with shallow-water limestone clasts. **Fossils:** ostracods (shallow-water forms, e.g., *Amphissites* sp., typical moderate high energy shallow-water fauna of carbonate platform, Cladocopida (*Permopolycope* sp., *Polycope* sp.) and some pelagic ostracods (Myodocopida, *Permocypridina* ? n. sp.)). **Environment:** slope debris flow. **Age:** Permian.