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# PALEOZOIC STRATIGRAPHY OF THE GEYİK DAĞI UNIT IN THE EASTERN TAURIDES (TURKEY): NEW AGE DATA AND IMPLICATIONS FOR GONDWANAN EVOLUTION

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**Abstract:** The stratigraphy of the Geyik Dağı Unit of the Eastern Taurides has been revised on the basis of new field observations from this critical tectono-stratigraphic unit. The Emirgazi Formation, of Precambrian age, is shown to occur throughout the whole Tauride Belt. The Çal Tepe Formation probably reaches the Upper Cambrian. The Cambrian-Ordovician boundary is close to the base of the Seydişehir Formation; the latter includes mixed carbonate-siliciclastic tempestites. Its upper part may be of late Middle Ordovician age. The stratigraphic gap between the Seydişehir and Sort Tepe Formations is the result of a thermal event, as recorded in many other places in the peri-Gondwanan terranes of Europe. The graptolite-bearing black shales of the Puscu Tepe Shale Formation of early Silurian age, overlying the glacier-related sediments of the Halit Yaylası Formation is a typical unit in most of the peri-Gondwanan terranes in S Europe and N Africa. The "*Orthoceras* Limestones" of the overlying Yukarı Yayla Formation are of latest Llandovery to earliest Wenlock and post-middle Ludlow age. The Lower Devonian basal quartzites of the Ayı Tepesi Formation are interpreted as overlying an unconformity, which may coincide with the stepwise detachment of some small microcontinents from Gondwana accompanying the opening of Paleotethys. The conformably overlying Safak Tepe Formation yielded Eifelian–Givetian conodonts and is overlain by the Gümüşali Formation of Frasnian–Famennian age. The Devonian-Carboniferous boundary is located within the black shales of the Ziyarettepe Formation. The deposition of these black shales seems to be related to an anoxic event. Although the available geological data in the Taurides are still too fragmentary to provide a comprehensive picture, the new findings may facilitate the correlation of the Eastern Tauride stratigraphic units with corresponding strata in the Central and Western Taurides and improve the understanding of Early to middle Paleozoic events in NE peri-Gondwana.

**Key words:** Paleozoic, Eastern Taurides, Turkey, Gondwana, paleogeography, stratigraphy, conodonts.

## Introduction

The Tauride Belt in southern Turkey is an Alpine unit comprising a pile of nappes, or tectono-stratigraphic units formed during the closure of Neotethyan oceanic branches in the Eastern Mediterranean region (Şengör & Yılmaz 1981; Göncüoğlu 1997, Fig. 1). The nappes include more or less continuous Paleozoic-Mesozoic sequences of varying tectonic settings such as platforms, slopes and basins, related to the Proto-, Paleo- and Neo-Tethyan oceans (see Stampfli 2000 for discussion on the definition of the Tethyan oceans).

A comprehensive tectonic classification of these nappes was proposed by Özgül (1976) regarding their paleogeographical origins. Özgül (1984) suggested the presence of a central "autochthonous" belt (Geyik Dağı Unit), overthrust by northerly (Bozkır, Bolkar, and Aladağ Units) and southerly (Alanya and Antalya Units) derived tectono-stratigraphic units (Fig. 2a). From these, the most prominent and uninterrupted Paleozoic successions are mainly observed in the Geyik Dağı Unit (GDU) in the Eastern Taurides.

The overall stratigraphy of the Paleozoic successions within the GDU in the Eastern Taurides has been the topic of numerous studies (e.g. Özgül et al. 1972; Özgül & Gedik 1973; Metin et al. 1986; Dean & Monod 1990; Özgül & Kozlu 2002). A recent review was given by Göncüoğlu & Kozlu (2000). These studies, however, mostly lack sufficient biostratigraphic data. This shortcoming prevented reliable correlation of Paleozoic events in this critical area for the geodynamic evolution of northwestern Gondwana.

In this work, we report field and conodont data on poorly known Paleozoic sequences of the GDU in the Eastern Taurides in the Saimbeyli-Tufanbeyli area (Fig. 2) utilizing previously unpublished conodont data of the second author. We will focus on the Cambrian to Early Carboniferous rock-units we sampled in detail for conodont fauna, but also describe briefly other formations, which were dated by other fossil groups (e.g. trilobites, graptolites, corals and brachiopods) in previous studies. The description of the stratigraphy of these units is based on numerous published and unpublished studies and our own field observations. The responsibility of the second and third authors is limited mainly to the paleontological determinations. Correlations with the northern Central Taurides, mainly with the Kütahya-Bolkardağ Belt (KBB, Fig. 1) of Göncüoğlu et al. (1997) are used for regional paleogeographic interpretations. Our aim is to establish a more reliable stratigraphic correlation of the Paleozoic successions along

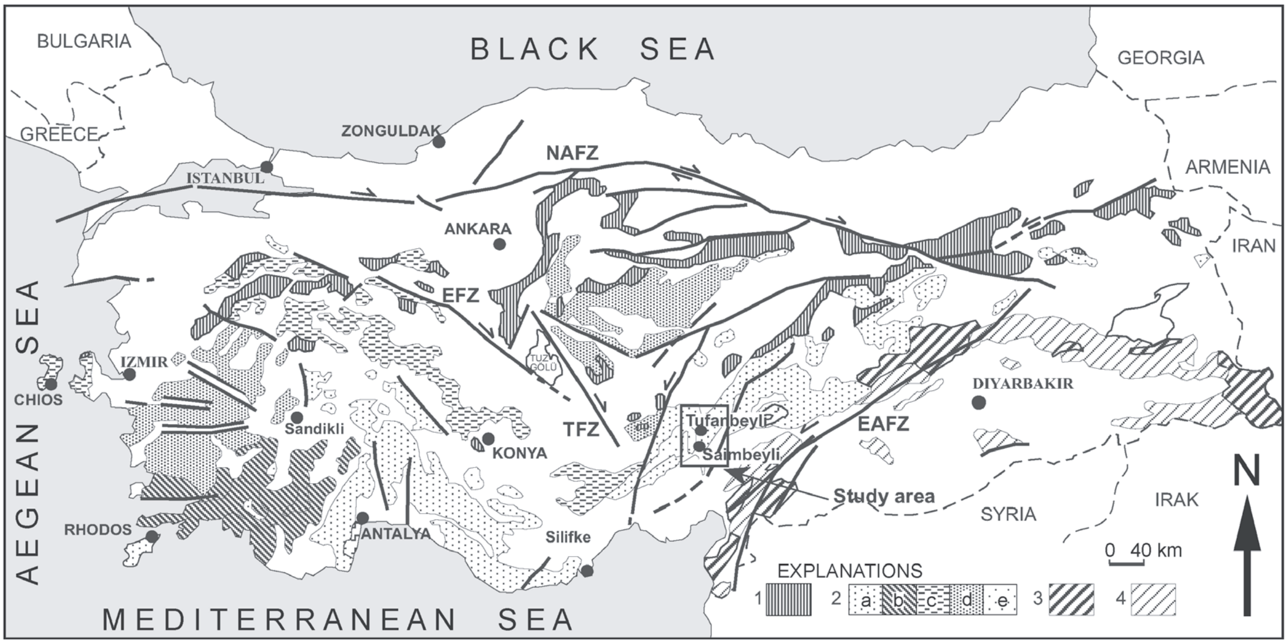


**Fig. 1.** Tectonic map of Turkey (modified after Göncüoğlu 1997) and the location of the study area. **1** —İzmir–Ankara–Erzincan Suture Belt; **2** — Tauride-Anatolide Terrane: a — undifferentiated, b — Lycian Nappes, c — Kütahya-Bolkardağ Belt, d — Metamorphic massifs, e — Bozkır Nappes; **3** — Southeast Anatolian Ophiolite Belt and the Kemer Ophiolites (Antalya nappes); **4** — Southeast Anatolian Autochthon. **NAFZ:** North Anatolian Fault Zone, **EAFZ:** East Anatolian Fault Zone, **EFZ:** Eskişehir Fault Zone, **TFZ:** Tuz Gölü Fault Zone.

the Tauride Belt and hence contribute to a better understanding of the Early Paleozoic paleogeography of the NW peri-Gondwana.

## Paleozoic stratigraphy of the Geyik Dağı Unit

### *The pre-Early Paleozoic rock units*

In previous studies the very thick succession underlying the Feke Quartzite Formation was considered to be a single formation and named, following Özgül et al. (1972), the Emirgazi Formation (see Kozlu & Göncüoğlu 1997). Dean & Monod (1990) considered this unit to be a synonym of the Zabuk Formation in SE Anatolia. The Zabuk Formation in its type locality (Kellog 1960) rests unconformably on ?Precambrian andesites and comprises continental to shallow marine clastics. This succession is completely different in their stratigraphy from that in the Eastern Taurides, so we therefore retain the Emirgazi Formation.

The type locality of the Emirgazi Formation was mapped by Özgül et al. (1972). Our recent fieldwork has shown that the succession around the Emirgazi village is probably overturned and the variegated shales with interbedded nodular limestones, previously attributed to the Emirgazi Formation, represent the lower part of the Seydişehir Formation. However, along numerous sections in the Kozan, Feke, Tufanbeyli and Saimbeyli areas there is a very thick package of low-grade metamorphic siliciclastic rocks with bands and lenses of black shales, lydites (Oruclu Member) and stromatolitic, ankeritic and cherty limestones and dolomites (İcmetepe Member). Except for a few badly preserved and undetermined trace fossils within the İcmetepe Member no organic remains have yet been reported.

The illite crystallinity (IC) value of the white micas of the Emirgazi Formation is <0.25 indicating epimetamorphic conditions prior to the deposition of the overlying Cambrian rocks (Bozkaya et al. 2002).

In the Western Taurides, a very similar unit has been recognized recently and described as the "Sandıklı Basement Complex" (Gürsu & Göncüoğlu 2001). This is composed of siliciclastic rocks with rare black chert and dolomite lenses and includes conglomerates, dark coloured brecciated limestones, cherty and laminated limestones interbedded with sandstones. This low-grade metamorphic unit is intruded by porphyroids, which in turn are unconformably overlain by variegated conglomeratic sandstones and shales with basic to intermediate lava flows. Upwards, they grade into green, violet and yellow quartz siltstones, which have yielded Early Cambrian trace fossils (Uchmann et al. 2000). Although some discontinuous conglomerate pockets with diabase, quartzite and quartz-porphyry pebbles occur between the uppermost İcmetepe lithologies and the overlying Feke siliciclastics, the distinct angular unconformity we identified (Gürsu & Göncüoğlu 2001) in the Sandıklı area has not yet been proven in the Eastern Taurides. However, based on regional correlation, we ascribe the low-grade metamorphic rocks of the Emirgazi Formation in the Eastern Taurides to the Precambrian basement of the Taurides.

### *Feke Quartzite*

This unit was named the Kocyazı Member of the Emirgazi Formation by Özgül & Kozlu (2002). The Feke Quartzite ?unconformably overlies the Emirgazi Formation. The type locali-

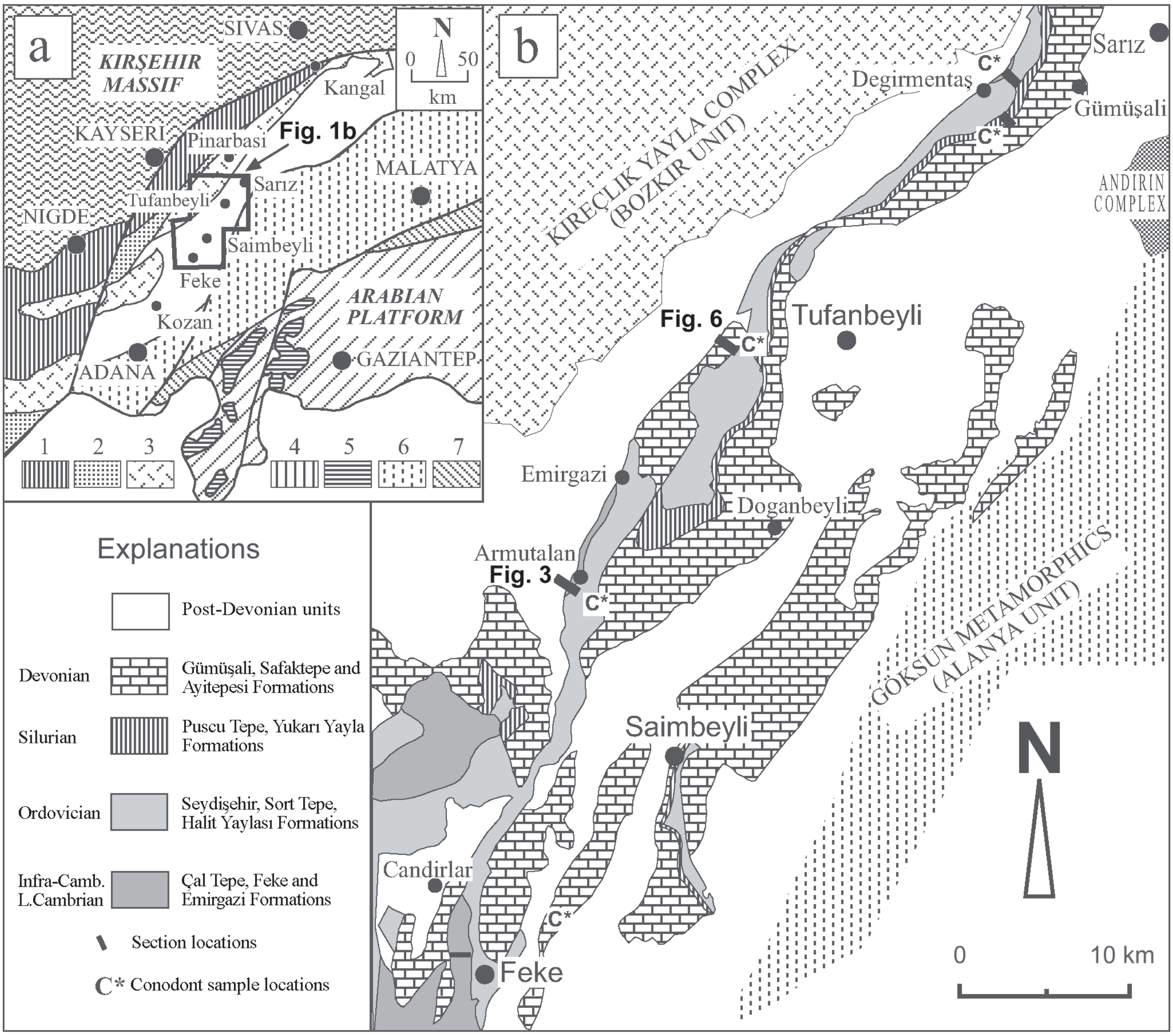


**Fig. 2. a** — Distribution of the tectono-stratigraphic units in the Eastern Taurides (after Özgül 1976): 1 — Bolkardağı Unit, 2 — Aladağ Unit, 3 — Bozkır Unit, 4 — Geyik Dağı Unit, 5 — Antalya Unit, 6 — Alanya Unit, 7 — Misis Unit. **b** — Simplified geological map of the study area (modified from Metin et al. 1986).

ty is to the north of the town of Feke, where the measured thickness of the unit reaches up to 600 meters. Despite lateral thickness variations, the Feke Quartzite Formation can be traced all along the Eastern Tauride Belt.

The formation correlates with the Hüdai Quartzite, and Zabuk Formation, both synonyms of the Feke Quartzite in the Western Taurides (Dean & Özgül 1994) and SE Anatolia (Kellog 1960), respectively.

### *Çal Tepe Formation*

In the Eastern Taurides an almost 110 m-thick carbonate sequence conformably overlying the Feke Quartzite Formation was described by Demirtaşlı (1978) as the Değirmentaş Formation, the equivalent of the Çal Tepe Formation. The latter was described by Dean & Monod (1970) at its type locality at Çal Tepe near Seydişehir and from the Sandıklı areas (Dean & Özgül 1994) in the Central Taurides. Following Dean & Monod (1990), we use the term Çal Tepe Formation to describe this unit in the entire Tauride Belt. In the Saimbeyli area, on the road from Armutalan village to Naltaş in the Babadere Valley (Fig. 3), sample CON-4 from the red nodular limestones of the uppermost part of Çal Tepe Formation yielded poorly preserved conodonts (Fig. 4) with a CAI (Conodont Alteration Index) of 7–8. These may belong to *Proconodontus*. We tentatively ascribe the uppermost part of the Çal Tepe Formation to the Upper Cambrian (Miller 1988).

The grey limestones in the lowermost part of the formation at its type locality in Seydişehir area have yielded small shelly fossils which mark the Lower-Middle Cambrian transition (Sarmiento et al. 1997). The nodular limestones have been dated by trilobites and conodonts from different localities in the Western and Central Taurides (Dean & Monod 1970; Özgül & Gedik 1973; Gedik 1977, 1989; Dean & Özgül 1994; Göncüoğlu & Kozur 1999a). The fossil data indicate an early

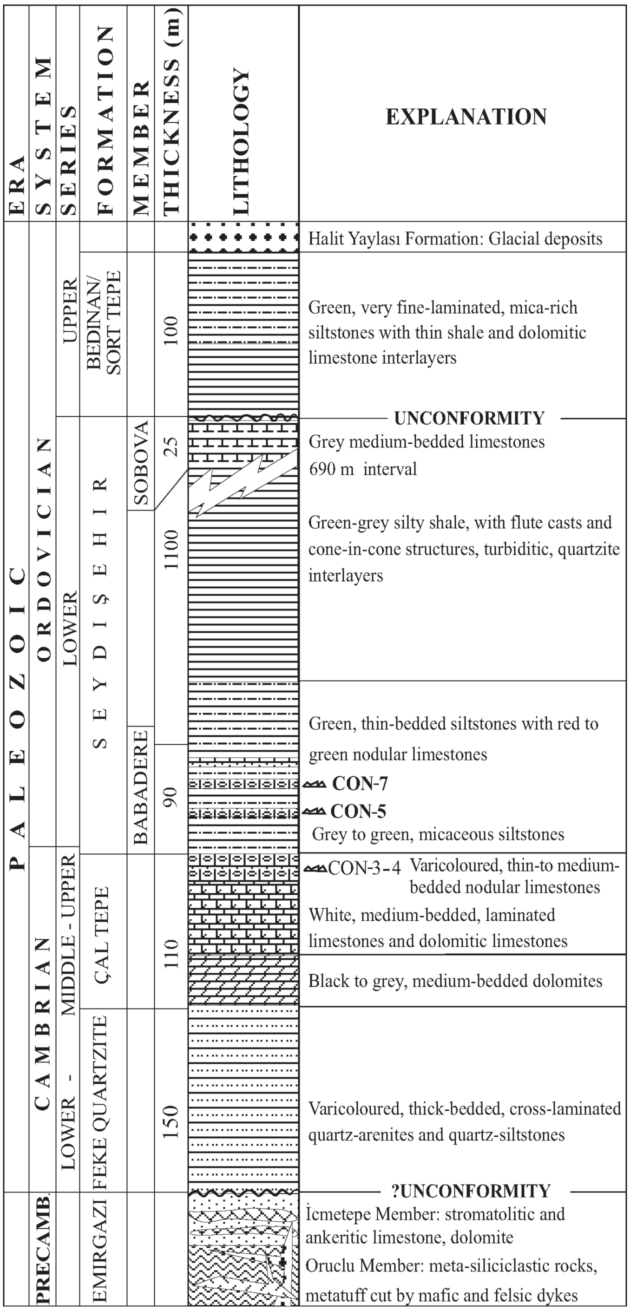


**Fig. 3.** Generalized columnar section of the Cambrian and Ordovician units in Eastern Taurides (modified from Metin et al. 1986). CON-7— Conodont sample horizons.

Middle–early Late Cambrian depositional age. It is important to note that the trilobites in this formation display strong affinities with those of southern France and Spain (Dean & Monod 1990).

### *Seydişehir Formation*

An almost 1300 m-thick sequence, consisting mainly of siliciclastic rocks was named the Armutludere Formation by Demirtaşlı (1978). This name was superseded by Dean & Monod (1990), as it is identical with the Seydişehir Formation, first described by Blumenthal (1947) in the Central Taurides. Its lower contact with the Çal Tepe Formation in the Eastern Taurides is conformable.

From bottom to the top (Fig. 3) the unit consists of Babadere Limestone Member (Metin et al. 1986), a middle and unnamed member, represented by an about 1100 m-thick sequence of slates and quartzarenites, and Sobova Limestone Member, which was initially described by Monod (1977) in the Beyşehir area in the western Central Taurides. The thickness of this member in the Kozan area is about 25 m. The dark grey bioclastic limestone lenses within grey siltstones/shales in the lower part of the member are very rich in brachiopods, trilobite fragments and corals. The middle part consists of a grey, almost 4 m-thick, medium to thick-bedded, sandy limestone band with abundant *Cystoides* sp. The bedding-planes of the limestones are characterized by hardgrounds. The upper part of the member includes thin bands and lenses of dark grey sandy limestones interlayered with siltstones and terminates with grey silty shales.

The lithofacies of the Seydişehir Formation as a whole represents open-shelf depositional environments. The Babadere lithofacies may correspond to an upper offshore depositional environment with carbonate-tempestites (Einsele 1992). The main body of the formation includes a large number of coarsening-upwards sequences. Distinctive depositional features of the carbonates and associated siliciclastics in the Sobova Limestone Member are suggestive of a mixed carbonate-siliciclastic tempestite-type deposition in a shelf environment.

Sample CON-5 comes from a road-cut on the Armutalan-Naltaş road in Babadere Valley about 15 m above the top of the Çal Tepe Formation, from the first nodular limestone band in the Seydişehir Formation (Fig. 3). This sample yielded poorly preserved (CAI = 7–8) *Protopanderodus*? sp. and *Scolopodus* sp. (Fig. 4), suggesting a Tremadocian age. The next sample from this section (CON-7) is from a carbonate band, about 45 m above the previous sample (Fig. 3). It represents the last limestone band of the lower member of the Seydişehir Formation in this location, from where mostly turbiditic shales were observed. This sample contains poorly preserved (CAI = 7–8) oistodiform elements, indicating an Early (to Middle) Ordovician age.

Dean (1972, in Özgül et al. 1972) reported trilobites from the same layers in Toybuk Yayla to the north of Tufanbeyli and suggested a Tremadocian age for the lower part of the Seydişehir Formation. In the upper parts of the formation to the south of Saimbeyli, Dean & Monod (1990) found *Taihungshania* cf. *migueli,* which closely resembles an early Arenig species from southern France.

In previous studies the Sobova Member of the Seydişehir Formation was neglected and the Middle Ordovician was presumed to be a period of non-deposition (e.g. Özgül et al. 1972; Dean & Monod 1990). The bands and lenses of limestones in the Sobova Member in the Kozan area have yielded a diverse conodont fauna: *Ansella jemtlandica* (Löfgren), *Baltoniodus navis* (Lindström), *Baltoniodus* cf. *navis*, *Baltoniodus norrlandicus* (Löfgren), and was attributed to the *Baltoniodus norrlandicus* Biozone (Volkhov–Kunda stage boundary) based on the occurrence of the index species in the investigated levels (Sarmiento et al. 2003).

Our findings, together with the trilobite data, indicate that the Cambrian-Ordovician boundary is within the lowermost Seydişehir Formation, between samples CON-4 and CON-5. Convincing evidence of a disconformity has not been found during our field observations in this part of the sequence. This contrasts with Dean & Özgül's (1994) suggestion that Ordovician strata were deposited after a depositional break. However, only a very few and poorly preserved (CAI = 7–8) conodonts were found in the uppermost Çal Tepe and lower Seydişehir Formations. In the Western Taurides (Şenel et al. 2000) and western Central Taurides (Alanya region, Göncüoğlu & Kozur 1999a) Late Cambrian conodonts were reported in equivalents of the lower Seydişehir Formation.

In the Hadim area of the Central Taurides, a red nodular limestone band, 100 m above the Çal Tepe Formation has yielded Late Cambrian-Early Ordovician conodonts. Gedik (1977) determined *Oneotodus* cf. *gallatini* Müller and *Furnishina furnishi* Müller at the same location from a similar nodular limestone band from the lowermost 50 m of the Seydişehir Formation, indicating a Late Cambrian age. The same author also mentions the presence of *Hertzina bisulcata* Müller and "*O.*" *tenuis* Müller in the lower part of the sequence, but does not indicate the exact stratigraphic positions.

Gedik (1977, 1988) has described from bands of red nodular limestones in the lower part of the Seydişehir Formation early Arenig conodonts from a sliver of the Antalya Nappe, a few kilometers north of the Alanya Tectonic Window to the north of Kaş Yaylası. The presence of *Oepicodus evae* (Lindström) and *Trapezognathus triangularis* (Lindström) in this locality indicates the upper part of the lower and the middle Arenig. From 5 km north of the former locality, Gedik (1977) further reported *Cordylodus angulatus* of early to middle Tremadocian age. On the basis of these data, Dean & Monod (1990) concluded that the depositional age of the Seydişehir Formation was Tremadocian to Arenig and may reach up to late middle Arenig. The new finding of Darriwilian limestones in the Ovacık area, Southern Taurides (Kozlu et al. 2002) and in the Kozan area (Sarmiento et al. 2003) now indicate that its deposition may reach up to the upper Middle Ordovician.

### *Sort Tepe Formation*

Dean & Monod (1990) recently described a previously unrecognized unit that overlies the Seydişehir Formation in the Değirmentaş area with an inferred unconformity in the vicinity of Tufanbeyli. On the basis of lithological correlation with the Sort Tepe Formation in the Zap Valley of Southeast Anatolia, the authors also used this name in the Eastern Taurides. A very well developed succession of the unit was also observed by the first author in the Halevik Dere area, where it rests with an angular unconformity on the brown to green cleaved siltstones of the Seydişehir Formation. Trilobite findings from this unit (Dean & Monod 1990) in the Değirmentaş area (Fig. 2) indicate an early Ashgill age.

### *Halit Yaylası Formation*

The conglomerates, conglomeratic sandstones and sandstones unconformably overlying the Sort Tepe Formation were assigned by Demirtaşlı (1978) to the Halit Yaylası Formation and assumed to represent the basal conglomerates of transgressive Silurian deposition (e.g. Metin et al. 1986; Dean & Monod 1990). Özgül et al. (1972) noted that this unit has also been observed in the northwestern and southwestern parts of the Eastern Taurides. The total thickness of the formation in the type locality is about 140 meters (Metin et al. 1986). In the Halevik Dere area the thickness of the formation does not exceed 80 m. In a recent study, Monod et al. (2003) have shown that the unit represents glacier-related deposition. The acritarchs and brachiopods in the upper part of this unit are of Ashgill and more precisely Hirnantian (*Tanuchitina elongata* Zone) age in the Ovacık area (Monod et al. 2003). In the Eastern Taurides, the age of the unit can only be bracketed between early Ashgill (underlying Sort Tepe Formation) and early Llandovery (overlying Puscu Tepe Shale Formation).

### *Puscu Tepe Shale Formation*

This formation conformably overlies the Halit Yaylası Formation (Fig. 5). It is about 80 m thick. The black shales of this formation yielded graptolites including *M. convolutes,* which is one of the zonal index species of the middle Aeronian (middle Llandovery, Özgül et al. 1972). The recent sampling of the black shales in the lower part of the unit by Monod et al. (2003) provided graptolites indicating the Rhuddanian (*acuminatus* Zone) to Telychian Stages.

Time-equivalents of the Puscu Tepe Shale Formation have so far been described only from a few localities (Tahtalı Unit in the Western Taurides and the Ovacık area in the Central Taurides, Demirtaşlı 1984). Demirtaşlı (1984) distinguished the Hirmanlı Formation within his Southern and Intermediate zones in the Ovacık area, which are parts of the GDU. The Hirmanlı Formation is composed mainly of very thin-bedded, pyrite-bearing siliceous black shales alternating with very finely-laminated black shales yielding early Silurian graptolites. These very finely-laminated shales are assumed to have been deposited in a deep restricted basin (Demirtaşlı 1984). In the Antalya Unit in Kemer area in the Western Taurides, Dean et al. (1999) found conodonts of *Pterospathodus celloni* Biozone within the nautiloid-limestones in the lower part of the Sapandere Formation (Marcoux 1979). A rich conodont fauna of the *Pterospathodus eopennatus* Biozone of the middle Telychian (Loydell et al. 2003) was found by Göncüoğlu & Kozur (2000a) in the overlying greenish-grey limestones.

### *Yukarı Yayla Formation*

The Yukarı Yayla Formation (Demirtaşlı 1978) has a transitional boundary with the underlying Puscu Tepe Shale Formation (Fig. 5). The limestones in the lower part are rich in nautiloids and were named as the "*Orthoceras* Limestone" in previous studies (e.g. Özgül 1976). The lowermost layer of the lowermost "*Orthoceras* Limestone" band on the road between Armutalan and Naltaş in Deliahmet Dere (sample CON-9) yielded a deep-water fauna (paleopsychrospheric ostracod fauna) with the following conodonts (Fig. 4): *Panderodus* cf. *langkawiensis* Igo et Koike, numerous *Pterospathodus amorphognathoides* Walliser, *P. pennatus procerus* Walliser.

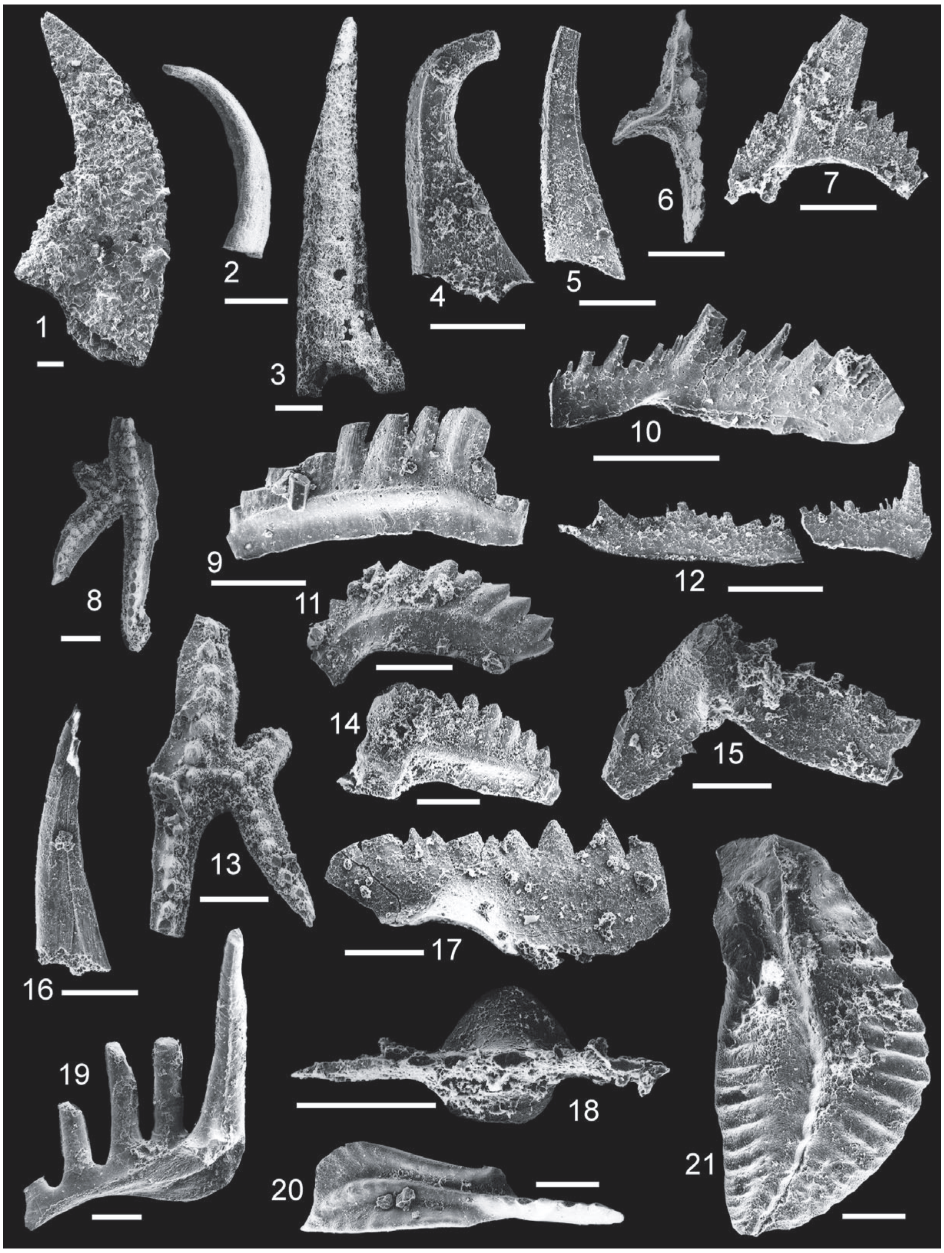


**Fig. 4.** Representative conodonts from the Saimbeyli-Tufanbeyli area, Eastern Taurides. The position of the samples is indicated in Figs. 3–6. The samples are reposited in the Geology Department of the General Directory of Mineral Research and Exploration (MTA), Ankara. **1** — ?*Proconodontus muelleri* Miller, sample CON-4, uppermost Çal Tepe Formation, Upper Cambrian, rep.-no. 27-11/II-65. **2** — *Protopanderodus*? sp., sample CON-5, lowermost Seydişehir Formation, Tremadocian, rep.-no. 27-11/III-8. **3** — *Scolopodus* sp., sample CON-5, (see Fig. 2), Tremadocian, rep.-no. 27-11/III-9. **4–5** — *Panderodus* cf. *langkawiensis* Igo et Koike, sample CON-9, basal part of the "*Orthoceras*" limestone of lowermost Yukarı Yayla Formation, *P. amorphognathoides* Biozone (uppermost Llandovery or lowermost Wenlock); 4 — rep.-no. 27-11/III-23; 5 — rep.-no. 27-11/III-24. **6** — Juvenile *Pterospathodus amorphognathoides* Walliser, Pa element, or *P. pennatus procerus* Walliser, Pa element, sample CON-9 (see Figs. 3 and 5), *P. amorphognathoides* Zone (uppermost Llandovery or lowermost Wenlock), rep.-no. 27-11/III-19. **7–9, 11, 13–14** — *Pterospathodus amorphognathoides* Walliser, sample CON-9, basal part of the "*Orthoceras*" limestone of lowermost Yukarı Yayla Formation, (see Figs. 3 and 5), *P. amorphognathoides* Biozone (uppermost Llandovery or lowermost Wenlock); 7 — M element, rep.-no. 27-11/III-10; 8 — Pa element, rep.-no. 27-11/III-19; 9 — $Pb_1$ element, rep.-no. 27-11/III-13; 11 — $Pb_2$ element, rep.-no. 27-11/III-16; 13 — Pa element, rep.-no. 27-11/III-18; 14 — $Pb_1$ element, rep.-no. 27-11/III-12. **10, 12** and **15** — *Ozarkodina* sp., sample CON-11, uppermost part of the "*Orthoceras*" limestone of lower Yukarı Yayla Formation; 10 — Sb element, Ludlow, rep.-no. 27-11/III-33; 12 — Sc element, Ludlow, rep.-no. 27-11/III-35 (broken into two parts); 15 — Sa element, Ludlow, rep.-no. 27-11/III-34. **16** — *Panderodus* sp., sample CON-11 (see Fig. 6), Ludlow, rep.-no. 27-11/III-39. **17–18** — *Ozarkodina eladioi* Valenzuela-Rios, Pa element, sample CON-11 (see Fig. 5), Ludlow; 17 — lateral view, rep.-no. 27-11/III-37; 18 — upper view, rep.-no. 27-11/III-38. **19** — Undetermined conodont, sample CON-37 (see Fig. 5), upper Givetian, rep.-no. 27-11/III-47. **20** — *Polygnathus* cf. *parawebbi* Chatterton, Pa element, upper view, sample CON-37, uppermost part of the Safak Tepe Formation, upper Givetian, rep.-no. 27-11/III-45. **21** — *Polygnathus* cf. *webbi* Stauffer, sample CON-37, (see Fig. 6), upper Givetian, rep.-no. 27-11/III-48. All scale bars = 100 μm.

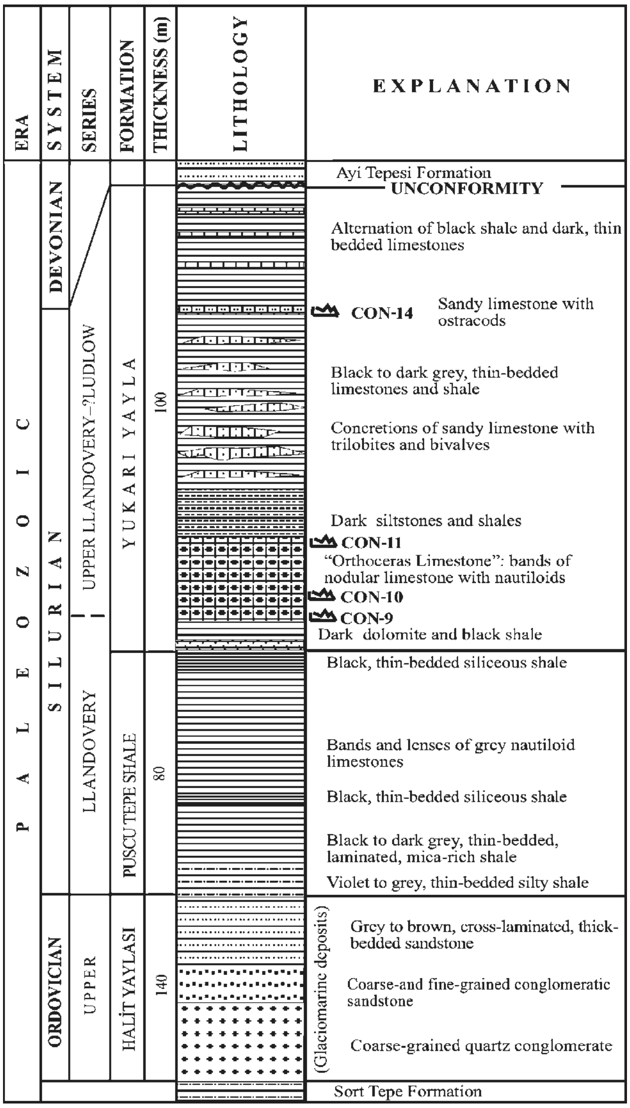


**Fig. 5.** Generalized columnar section of the Silurian units in the Eastern Taurides (modified from Metin et al. 1986). CON-11— Conodont sample horizons.

These conodonts indicate the *P. amorphognathoides* Biozone of latest Llandovery to earliest Wenlock age (Subcomission on Silurian Stratigraphy 1995).

Sample CON-10 from the thinner bedded middle part of the nodular limestone contains some poorly preserved ostracods, whereas the uppermost layers (sample CON-11) are very rich in deep-water ostracods with Tricorninidae and conodonts (Fig. 4) such as *Ozarkodina eladioi* Valenzuela-Rios, *Ozarkodina* sp., *Panderodus unicostatus*, suggesting, together with the ostracods, a late Silurian age (Subcomission on Silurian Stratigraphy 1995). The limestone bands of the upper member yielded only poorly preserved ostracods and indeterminable fragments of conodonts (sample CON-14). All Silurian conodonts have CAI = 5.

In the Konya area of the Central Taurides, dark coloured siltstones and shales alternating with tuffaceous layers and distal turbiditic black cherts (ribbon cherts) within the low-grade metamorphic Turbidite Unit (Göncüoğlu et al. 2000a) yielded Muellerispherida of Wenlock age (Kozur 1999).

### *Ayı Tepesi Formation*

The medium- to thick-bedded, laminated and cross-bedded, white to pink, well-sorted shallow-marine quartz-arenites transgressively overlying the Yukarı Yayla Formation were described first by Özgül et al. (1972). The sandy limestones in the upper part of the formation are unconformably overlain by the Safak Tepe Formation (Fig. 6). Except for a few poorly preserved brachiopods (*Strephodonta*? sp., *Acrosprifer* sp.), which could indicate an Early Devonian age, no fossils has been found in this unit.

The Lower Devonian rocks in the Silifke-Anamur area, Demirtaşlı (1984) described a succession of quartzite and limestone with shaly alternations conformably overlying the upper Silurian–Lower Devonian. An Early Devonian age was suggested for this formation by Demirtaşlı (1984). In the northern Central Taurides of the Konya area, siliciclastic rocks of late Ludlow–early Lochkovian age underlie and grade into massive limestones. The lowermost layers are represented by nodular limestones with late Lochkovian conodonts, followed by "*Orthoceras* Limestones" that include upper Lochkovian–Pragian conodonts (Göncüoğlu et al. 2000a). In the western Central Taurides, Göncüoğlu & Kozur (2000b) have shown that conglomeratic sandstones and late lower to mid middle Lochkovian (Lower Devonian) limestones disconformably overlie the upper Silurian (Gedik 1977). A rich conodont fauna in the lowermost limestones in this locality indicates mid to late early Lochkovian age. As a result, an early to middle Lochkovian age was assigned to the Ayı Tepesi Formation, on the basis of the correlation with the similar units in the Central Taurides.

### *Safak Tepe Formation*

The Safak Tepe Formation unconformably overlies the Ayı Tepesi Formation. The main body of this formation is composed of dark grey to black, thick bedded, partly dolomitic biogenic limestones with abundant corals including *Amphipora ramosa* Phillips, *Thamnophyllum trigemme*, *Calcaeola sandalina* and *Coenites* sp. (Özgül et al. 1972; Metin et al. 1986). The thickness of the formation varies from 1500 m to about 750 m in the type locality (Fig. 6). There is no agreement on the age of the formation (Özgül et al. 1972: Givetian; Demirtaşlı 1978: Emsian–Givetian; Metin et al. 1986: Eifelian).

The uppermost layers of the formation on the eastern flank of Domuz Dağ (NW of Tufanbeyli, sample CON-37) are rich in shallow marine conodonts (Fig. 7), such as *Icriodus* cf. *brevis* Stauffer, *Polygnathus* cf. *webbi* Stauffer and *P.* cf. *parawebbi* Chatterton. *I. brevis* occurs from the middle Givetian to Frasnian. The occurrence of *Calceola sandalina* Lamarck in the Safak Tepe Formation indicates upper? Eifelian. Sample CON-37 from the top of the formation indicates a middle to late Givetian age. Thus, the Safak Tepe Formation comprises the Eifelian and Givetian.

The *Amphipora*-limestones of the Safak Tepe Formation are considered to be one of the key-horizons throughout the Tau-

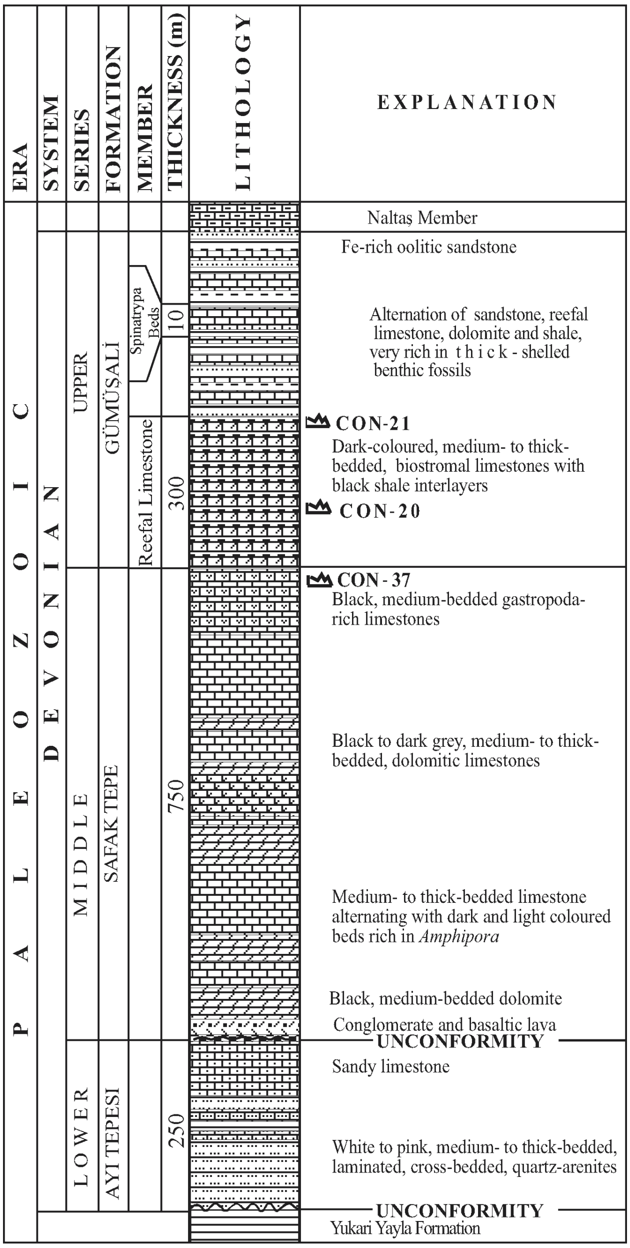


**Fig. 6.** Generalized columnar section of the Devonian units in Eastern Taurides (modified from Metin et al. 1986). CON-20 — Conodont sample horizons.

rides. They are found in the Silifke-Anamur area (Demirtaşlı 1984), the Konya area (Göncüoğlu & Kozur 1998; Göncüoğlu et al. 2000a) and in the Central Taurides (Özgül 1984). However, there is no control on the exact age of this unit and any long-distance correlation in the Taurides, based only on the occurrence of *Amphipora* may be misleading.

### *Gümüşali Formation*

This formation, about 500 m-thick, consists of alternations of dolomites, limestones, shales, sandstones, siltstones, calcareous sandstones and quartzites (Fig. 6). It conformably overlies the Safak Tepe Limestone. Özgül et al. (1972) reported brachiopods from the uppermost limestone levels just beneath the "*Spinatrypa* Beds", suggesting a Frasnian age.

Çapkınoğlu (1991) described conodonts from a 6 cm-thick ostracod-bearing (*Cryptophyllus*-Beds) grainstone bed about 449 m above the base of the Gümüşali Formation in Cürükler village NE of Feke in the Saimbeyli-Tufanbeyli Autochthon, indicating the middle *Palmatolepis triangularis* Biozone of the lower Fammenian.

Sample CON-20, from the lower to middle part of the formation (Fig. 6) from black limestone layers contains only a broken specimen (Fig. 7) of *Icriodus brevis*, indicating a shallow-water environment and a middle Givetian to Frasnian age. Sample CON-21 from the medium-bedded limestone in the upper part of the medium to thick-bedded biostromal limestones yielded scolecodonts (indicators of shallow water) and shallow-water conodonts (Fig. 7), such as *Ancyrodella pristina* Khalimbadzha et Chernysheva, numerous *Icriodus brevis* Stauffer, and *Polygnathus stylus* Stauffer. The fauna indicates an early Frasnian age (Ziegler & Sandberg 1990). All Devonian conodonts have a CAI of 2–3.

The uppermost layers of the iron-rich oolitic sandstones contain (Özgül et al. 1972) *Leptagonia analoga* (Phillips) indicating a latest Devonian age.

### *Ziyarettepe Formation*

The Ziyarettepe Formation conformably overlies the Gümüşali Formation except at a single locality to the north of Sarız. In the type section in Naltaş Gedigi (Plodowski & Salancı 1990) the formation is about 400 m thick (Fig. 8). The lower part of the sequence is considered to be one of the reference sections for the Devonian-Carboniferous boundary and hence was studied in detail by Demirtaşlı (1978) and Plodowski & Salancı (1990). The former author suggested that the lower part of the formation with *Whidbornella* sp. is of Etroeungtian (= Strunian) age. The latter authors defined the 100 m-thick lower part of the sequence between the basal limestone layers and the black shales as the Naltaş Member and studied the brachiopods, trilobites and sporomorphs in detail. They suggest a typical "Strunian-fauna" and, therefore, came to the same stratigraphic conclusion as Demirtaşlı (1978).

Sample CON-23 is from the lowermost layers of the sandy limestones (Fig. 8) following the *Leptagonia*-Beds and represents the lowermost part of the Naltaş Member. The sample yielded the following conodonts (Fig. 7): *Bispathodus aculeatus* (Branson et Mehl) and *Pseudopolygnathus vogesi* Rhodes, Austin et Druce, suggesting a latest Devonian to earliest Carboniferous (*Siphonodella crenulata* Biozone, Sandberg et al. 1978) age. Sample CON-23 belongs to the uppermost Devonian taking into consideration that *Bispathodus aculeatus* (common in sample CON-23) is more common in the uppermost Devonian than in the lowermost Carboniferous and that both Demirtaşlı (1978) and Plodowski & Salancı (1990) found latest Devonian brachiopods, trilobites and sporomorphs in these beds. In addition to conodonts this sample is rich in fish remains (mainly hybodontid teeth). Sample CON-18, from the Naltaş type section, was taken from the upper marly limestone layers between the basal sandy limestone level, represented

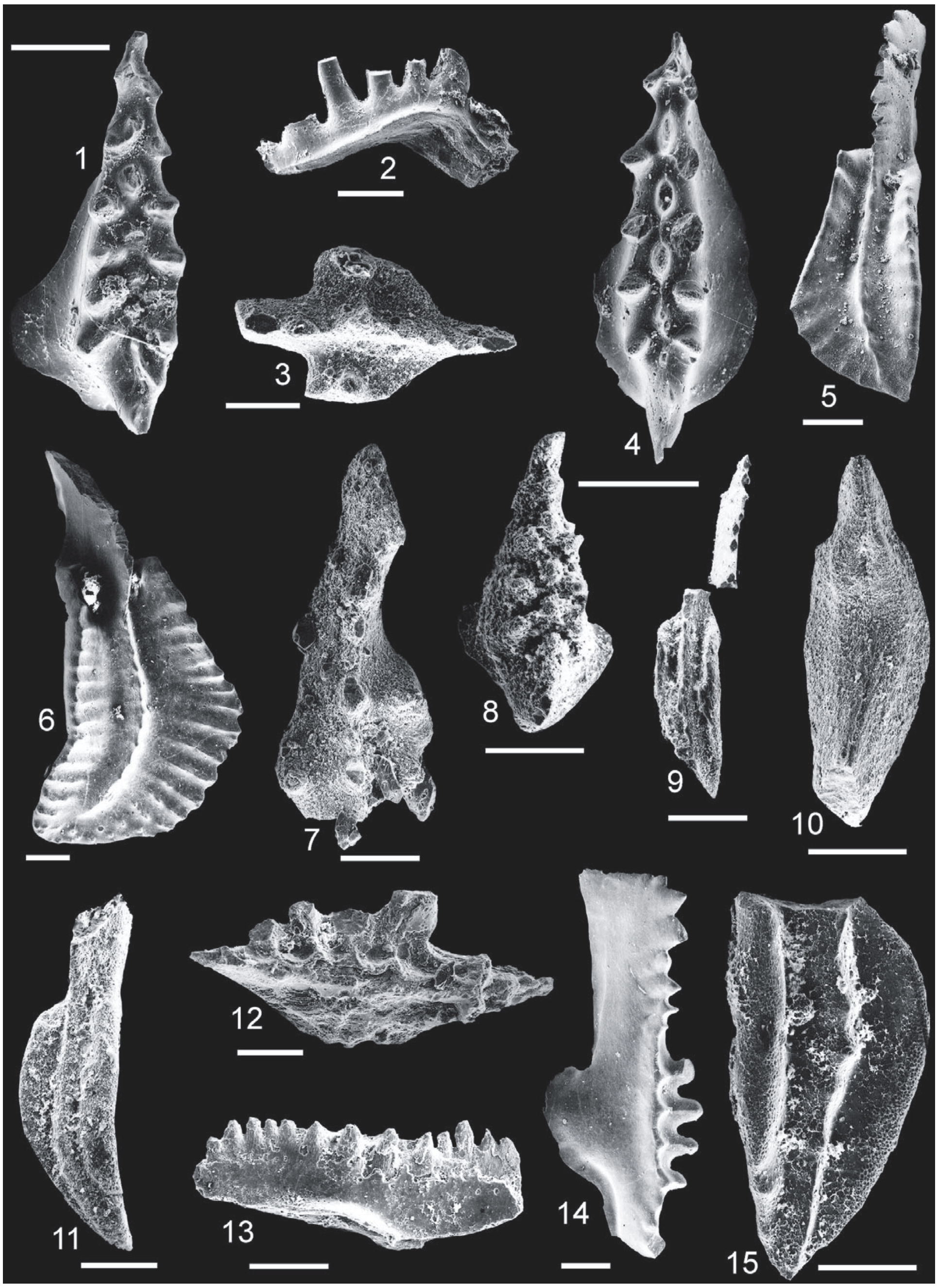


**Fig. 7.** Representative conodonts from the Saimbeyli-Tufanbeyli area, Eastern Taurides. The position of the samples is indicated in Figs. 5–8. The samples are reposited in the Geology Department of the General Directory of Mineral Research and Exploration (MTA), Ankara. **1, 4** — *Icriodus* cf. *brevis* Stauffer, Pa element, upper view, sample CON-37, uppermost part of the Safak Tepe Formation, upper Givetian; 1 — rep.-no. 27–11/III-46; 4 — rep.-no. 27–11/III-44. **2** — *Oulodus*? sp., Pb element, sample CON-37 (see Fig. 6), upper Givetian, rep.-no. 27–11/III-50. **3** — *Ancyrodella pristina* Khalimbadza et Chernyseva, Pa element, upper view, sample CON-21, upper reefal limestone member of lower Gümüşali Formation, lower Frasnian, rep.-no. 27–11/III-56. **5–6** — *Polygnathus* cf. *parawebbi* Chatterton; Pa element, upper view, sample CON-37 (see Fig. 6), upper Givetian; 5 — rep.-no. 27–11/III-43; 6 — rep.-no. 27–11/III-42. **7–8** — *Icriodus brevis* Stauffer, sample CON-20, lower reefal limestone member of lower Gümüşali Formation (see Fig. 8), lower Frasnian; 7 — broken Pa element, upper view, rep.-no. 27–11/III-41; 8 — Pa element, upper view, rep.-no. 27–11/III-54. **9–11** — *Polygnathus xylus* Stauffer, sample CON-21, upper reefal limestone of lower Gümüşali Formation, lower Frasnian; 9 — Pa element, free blade broken during preparation for SEM, upper view, rep.-no. 27–11/III-57; 10 — Pa element, lower view, rep.-no. 27–11/III-55; 11 — upper view, rep.-no. 27–11/III-59. **12** — *Pseudopolygnathus vogesi* Rhodes, Austin et Druce, Pa element, upper view, sample CON-23, lowermost Naltaş Member of basal Ziyarettepe Formation, uppermost Famennian, rep.-no. 27–11/III-2. **13–14** — *Bispathodus aculeatus aculeatus* (Branson et Mehl), Pa element, sample CON-23 (see Fig. 8), uppermost Famennian; 13 — lateral view, rep.-no. 27–11/III-1; 14 — oblique upper view, rep.-no. 27–11/III-4. **15** — *Polygnathus* cf. *communis* Branson et Mehl, sample CON-18, uppermost part of Naltaş Member, lower Ziyarettepe Formation, uppermost Famennian, rep.-no. 27–11/III-40. All scale bars = 100 μm.

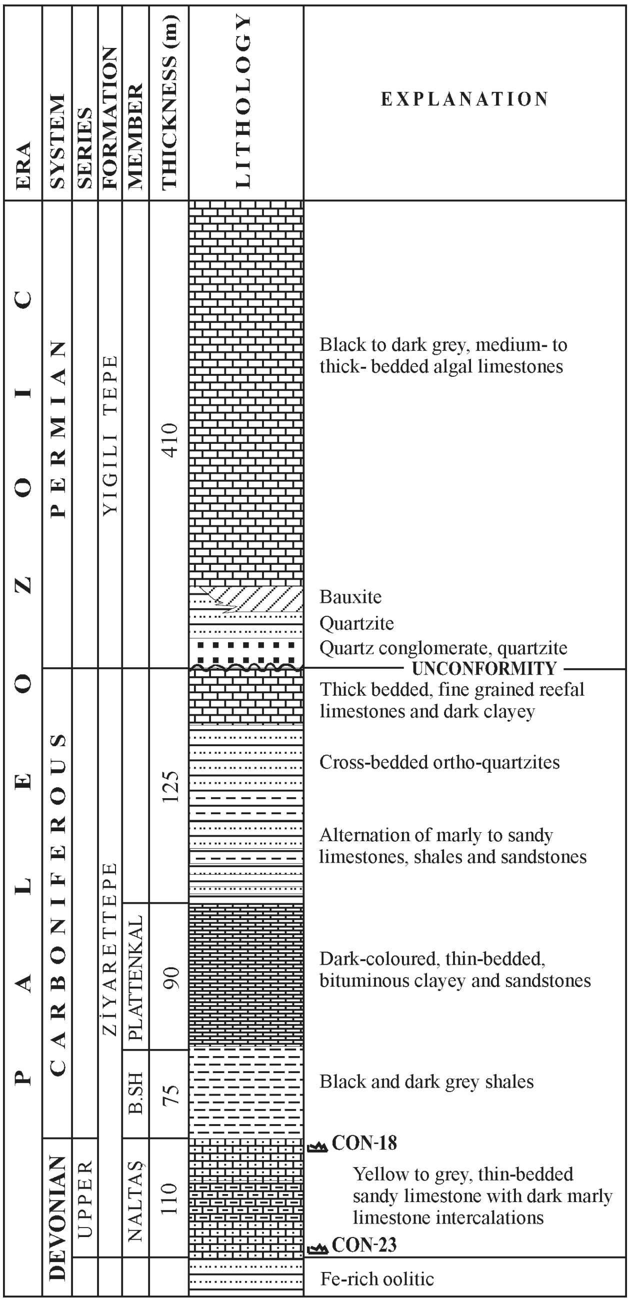


**Fig. 8.** Generalized columnar section of the Carboniferous and Permian units in Eastern Taurides (modified from Metin et al. 1986). B.SH — Black Shale member, CON-18 — Conodont sample locations.

by sample CON-23, and the overlying black shales (Fig. 8), just above sample KF-4 of Özgül et al. (1972), which contained *Sinuatella sinuata* Dekoninck, *Whidbornella caperata* Sowerby, *Rhipodomella michelini* Leveille and *Athyris (composita)* cf. *ambiqua* Sowerby. Sample CON-18 contains *Polygnathus communis* Branson et Mehl (Fig. 7) indicating a latest Devonian to Early Carboniferous age (Sandberg et al. 1978). This age is in good agreement with Plodowski & Salancı (1990), who suggested that the Devonian-Carboniferous boundary is within the black shales.

The equivalent of the Ziyarettepe Formation was described by Demirtaşlı (1978) from the Silifke area in the Central Taurides (Korucak Formation). The lower part of this unit contains a very similar fauna and is also ascribed a Strunian age by Plodowski & Salancı (1990). The youngest age obtained yet from the upper part of the Ziyarettepe Formation in the Geyik Dağı Unit in Saimbeyli-Tufanbeyli area is Visean (Özgül et al. 1972; Özgül & Kozlu 2002). However, deposition of shallow-marine carbonates and clastics in the Aladağ Unit of the Taurides continued into the early Moscovian (Özgül 1997) and very probably until the Late Carboniferous (Gzelian) and Early Permian (Sakmarian) as indicated by the recent findings of Okuyucu (2002) in the Yahyalı area.

***Permian units***

The Ziyarettepe Formation is unconformably overlain by the Upper Permian Yıgılı Tepe Formation, which is more than 410 m thick (Fig. 8). Metin et al. (1986) reported that the Upper Permian limestones locally overlie Lower Carboniferous units, which could suggest an important erosional period prior to its deposition. The limestones are rich in foraminifers indicating an Late Permian (Murghabian) age (Özgül & Kozlu 2002).

## Remarks on the geological evolution along the Tauride Belt

It is commonly agreed that the Taurides represent the northern margin of Gondwana (e.g. Dean et al. 2000; Cocks 2001). However, there is a wide range of suggestions (e.g. Stampfli 2001) about the detailed paleogeographical position of it in regard to the peri-Gondwanan terranes (e.g. Avalonia, E European terranes or NE Africa/Arabia). To decipher the succession of events along the Tauride Belt in the western, central and eastern parts a correlation chart of the Precambrian to Lower Carboniferous lithologies is given in Fig. 9.

In the GDU in the Eastern Taurides, the pre-Middle Cambrian (?Late Precambrian) basement is represented mainly by fault-controlled shallow marine sediments with acid and basic volcanic rocks. Farther west, in the western Central Taurides (Afyon area), within-plate-type rhyolites and granitoides intruded by basic volcanic rocks dominate over sedimentary rocks (Gürsu & Göncüoğlu 2001). This basement complex is interpreted as representing the formation of post-Pan-African extensional basins along the northern margin of peri-Gondwana. The Lower Cambrian rocks in the Afyon area disconformably cover the basement rocks and start with red continental clastics associated with back-arc-type basaltic-andesitic volcanism and grade into siliciclastic rocks with Lower Cambrian trace fossils (Gürsu & Göncüoğlu 2001). This succession is interpreted as representing rift-related deposition in the western Central Taurides. In the Eastern Taurides, this basal succession is not observed, but marine siliciclastic rocks of the Feke Quartzite directly overlie the Emirgazi Formation. This would imply that the rifting and the marine transgression on the Precambrian basement commenced in the Afyon area and then transgressed the Eastern Taurides. Considering the paleogeographical position of Gondwana during the Early Cambrian (e.g. Unrug 1997) this regional transgression is from the northwest, suggesting a rapid subsidence in the area to the northwest of the Taurides and hence the opening of a relatively deep basin. This event is clearly indicated in the subsidence curve in Fig. 10, where maximum subsidence rates are attained during the Cambrian–Early Ordovician periods. Göncüoğlu (1997) suggested that this "Early Paleozoic" basin was opened by back-arc spreading, generated by southward subduction of the Iapetus oceanic crust, along the north Gondwanan margin and separated some Gondwana-derived terranes (e.g. İstanbul Terrane of Göncüoğlu & Kozur 1998) from the main continent. In a recent work, Raumer et al. (2002) proposed a similar scenario and put forward that the Rheic Ocean, separating Avalonia from Gondwana had a lateral continuation in the eastern peri-Gondwanan terranes, to which the Taurides belong.

The Lower Ordovician in the Western, Central and Eastern Tauride units comprising the Tremadocian and Arenig Series (Seydişehir Formation) is characterized by monotonous siliciclastic deposition represented by tempestites. Towards the end of the early Llanvirn, shallowing-upward sequences developed. The Middle Ordovician (Darriwilian) carbonate rocks are known in the Geyik Dağı Unit in the Southern Taurides and in the study area. This unit may indicate that the basin to the north of the Taurides was filled and probably raised above the sea level (Fig. 10). It is important to note that the Darriwilian conodont fauna in the southern Central Taurides includes taxa known from the Baltoscandian region (Sarmiento et al. 2003). As a result, it is suggested that the Baltic Terrane was in close proximity to the Gondwana-related terranes to exchange benthic shelly faunas during the Middle Ordovician. ?Late Caradoc and Ashgill sandstones, siltstones and shales (turbidites) with peri-Gondwana cold-water fossil associations occur in the Geyik Dağı and Antalya Units. They rest transgressively on Lower Ordovician strata, indicating an erosional period during the early Late Ordovician (Fig. 9). This regional unconformity was accompanied by a thermal event

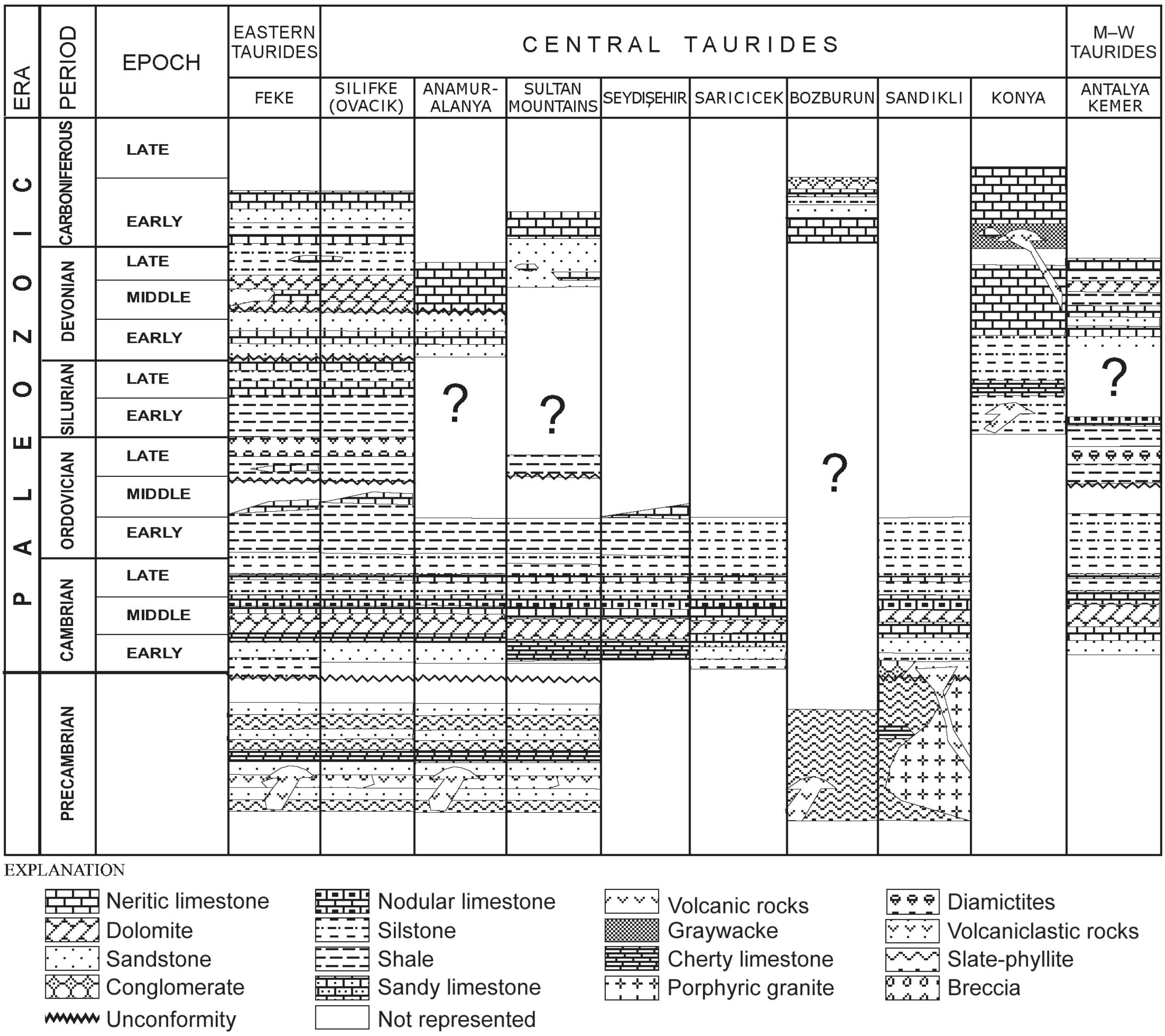


**Fig. 9.** Correlation chart of the lithological units in the Western, Central and Eastern Taurides (revised after Göncüoğlu & Kozlu 2000).

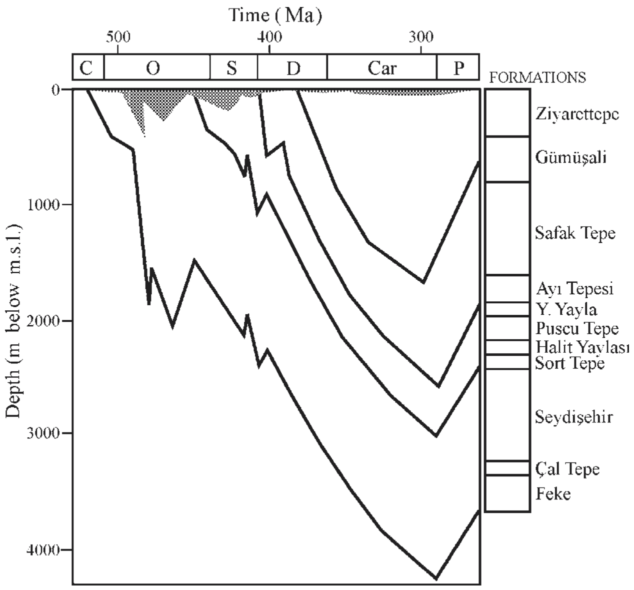


**Fig. 10.** Subsidence history (with inferred water depths) for the Paleozoic units of the Eastern Taurides. The shaded area indicates the water depth. **MSL** — Mean Sea Level, **C** — Cambrian, **O** — Ordovician, **S** — Silurian, **D** — Devonian, **Car** — Carboniferous, **P** — Permian.

(Göncüoğlu & Kozur 1999b), which is accentuated by the sudden change of the conodont CAI-values in the Cambrian (CAI = 7–8) to Silurian (CAI = 5) rock-units and the differences in the illite crystallinity index values, $b_0$ parameters, organic matter maturation and polytypes of K-micas of the Seydişehir and the unconformably overlying Sort Tepe Formations (Bozkaya et al. 2002). This feature may indicate an important tectonic event along the peri-Gondwana margin as recorded in many other places in Europe (see Raumer et al. 2002) and ascribed to the opening of Paleotethys *sensu* Stampfli (2000).

In the GDU, the uppermost part of the Ordovician is represented by a glacio-fluvial/glacio-marine succession with sandstones and dropstones (diamictites) and is conformably overlain by lower Silurian (Rhuddonian) shales and (Aeronian-Telychian) to upper Silurian "*Orthoceras* Limestones" alternating with black shales, containing a warm-water conodont fauna. This has important paleogeographical implications, as it shows that during the Late Ordovician, the Taurides were at a similar paleo-latitude to the other peri-Gondwanan terranes such as NW Spain, N Africa and Arabia, which were also covered by the South Polar ice-sheet. The following early Silurian transgression and deposition of organic-rich shales and nautiloid limestones in the Taurides is also typical for the whole North African region (e.g. Lüning et al. 2000). During the mid to late Silurian, the GDU in the Eastern Taurides was probably in an upper-slope tectonic setting, where terrigenous and volcanogenic sediments alternate with calcareous ones. In contrast to the GDU, the Wenlock and Ludlow in the KBB are represented by turbiditic shales, ribbon-cherts, radiolarites, felsic tuffs and include MORB (Mid-Oceanic Ridge Basalt)-type (Kurt 1994) basic volcanic rocks. Thus, we can assume that the KBB was in a more internal position (with regard to the Paleotethys *sensu* Stampfli 2001) than the GDU.

Devonian deposition occurred during the development of a large carbonate platform on the northern Gondwanan and peri-Gondwanan terranes (e.g. Gedik 1988). The local unconformities and differences in the stratigraphy of the Devonian rock-units in the Taurides (Fig. 9), however, can hardly be explained by lateral facies changes and suggest that this platform may have been the site of smaller carbonate platforms, separated by intervening extensional basins. The Lower Devonian in the Geyik Dağı, Kütahya-Bolkardağ, Antalya and probably Alanya Units are almost identical and represent shelf-type carbonate deposition (Fig. 9). The Lower Devonian basal quartzites in the Eastern Taurides are interpreted to mark an unconformity. In the Anamur area, the basal quartzites are underlain by conglomerates. As the uppermost levels of the Yukarı Yayla Formation could not be precisely dated, it is as yet uncertain whether this Early Devonian event is accompanied by a non-depositional/erosional period, which may include the uppermost Silurian (Fig. 8). If this is confirmed by detailed biostratigraphic work, the Early Devonian unconformity in the Taurides may indicate a tectonic event, which coincided with the stepwise detachment of some small microcontinents from Gondwana, that triggered the opening of Paleotethys (e.g. Raumer et al. 2002). The occurrence of Middle Devonian basaltic volcanism in the Sarız area, Eastern Taurides, and the fact that the Middle Devonian carbonates commence with an unconformity on the Lower Devonian units may also be considered as indications of this event. On the other hand, it is important to note that the middle to lower Upper Devonian rocks in the KBB are very similar to the Middle-Upper Devonian shallow-water carbonates in the rest of the Tauride units. Thus, it cannot be clearly resolved whether the KBB was already detached from the Taurides during the Early to Middle Devonian interval.

During the Early Carboniferous the depositional features and succession of events in the GDU of Taurides and the KBB are completely different. In the former, the Devonian-Carboniferous transition is marked by continuous deposition (Fig. 9) of shallow-marine carbonates, sandstones and shales, followed by neritic limestones of Visean age. In the Catalotuıran Nappe of the Aladağ Unit, which is considered to be located paleogeographically between the Geyik Dağı and KBB Units (Özgül 1976), the Tournaisian and lower Visean are characterized by turbiditic limestones, alternating with radiolarian cherts and tuffs, which reflect the basin-slope toe environment (Tekeli et al. 1984). In the KBB, on the other hand, the Visean is represented by an olistostrome with bimodal volcanic rocks (Kurt 1994). It includes olistoliths of the older formations and paraconformably overlain by Sepukhovian-Bashkirian neritic limestones. The formation of this Visean turbidite-olistostrome unit is ascribed to the opening of a back-arc basin on top of the Devonian carbonate platform in the KBB (Göncüoğlu et al. 2000b). This would imply that the KBB had already approached the SW European Variscan front and had been in the upper plate setting in front of a southward-subducting Paleotethyan oceanic plate. The closure of the Paleotethys basin between the KBB and the GDU of the Taurides was very probably realized by oblique collision some-where between the Late Carboniferous and Late Permian. The recent finding of Visean flyschoid deep-water sediments (Kozur et al. 1998) and upper Moscovian-Kasimovian ocean island basalts (Göncüoğlu et al. 2000a) in the Tavas Nappe of the Lycian Nappes may be the remnants of this ocean.

## Conclusions

Our new data is based on recent fieldwork and study of conodonts. Important new stratigraphical results have been obtained, which enable fine-tuning of the stratigraphy in the Eastern Tauride Autochthon:

**1.** The Emirgazi Formation has been re-evaluated. We emphasize the presence of basic and felsic igneous lithologies, which intrude or are interbedded with the siliciclastic rocks, black shales, lydites and stromatolitic limestones of the formation. The Emirgazi Formation correlates very well with corresponding units of the Precambrian Basement Complex of the Western Taurides (e.g. Sandıklı area).

**2.** The Early Cambrian rifting and the marine transgression in the Taurides was very probably from northwest to southeast, indicating the opening of a basin to the northwest.

**3.** In the Eastern Taurides, conodonts in the uppermost Çal Tepe Formation indicate that the deposition probably continued into the Late Cambrian, and that the Cambrian-Ordovician boundary is close to the base of the Seydişehir Formation. In the Central Taurides the same formation is of Middle Cambrian age, whereas the Upper Cambrian is represented by the lower part of the Seydişehir Formation (Dean & Özgül 1994; Sarmiento et al. 1997). Therefore, it is confirmed that the boundary between the Çal Tepe and Seydişehir Formation is a diachronous facies boundary as indicated by Dean & Özgül (1994).

**4.** The pink and green nodular limestone bands alternating with shales/siltstones (Babadere Limestone) in the lower interval of the Seydişehir Formation comprise a consistent unit. These are interpreted as proximal carbonate tempestites and the alternation of the limestones and siliciclastics is typical for mixed carbonate-siliciclastic tempestites (Einsele 1992). This unit can be traced all along the Taurides for more than 400 km and deserves to be defined as a distinct lithostratigraphic unit.

**5.** The upper age limit of the Seydişehir Formation was given in the previous studies as late middle Arenig (Dean & Monod 1990). Conodonts from the sandy limestone/dolomite beds with algae (*Cystoides*) in the Sobova Member of this formation in the Kozan area (Sarmiento et al. 2003) indicate that the deposition continued up to the Darriwilian (Volkhov–Kunda stage boundary).

**6.** The angular unconformity associated with a thermal discontinuity between the Seydişehir and Sort Tepe Formations may indicate an important event during the Middle Ordovician.

**7.** One of the main findings of the last few years was the discovery of glaciation-related deposits in the Halit Yaylası Formation of the Eastern Taurides by Monod et al. (2003) as suggested by earlier studies (e.g. Göncüoğlu 1997). The paleogeographical implications of these new data are that the Taurides were at a similar paleo-latitude to Sardinia and Iberia at about the end-Ordovician. Regarding the stratigraphy, it is important to note that the Halit Yaylası Formation is not of early Silurian age and does not represent the basal conglomerates of the early Silurian transgression, as formerly suggested.

**8.** The Puscu Tepe Shale Formation with its well-developed black shales correlates with the Sapandere Formation of the upper Antalya Nappe at Kemer (Western Taurides). In the latter area, this event was ascribed to an apparently very rapid warming and sea-level rise after the end-Ordovician glaciation. Deposition of black shales during the early Silurian, was followed by a sea-level drop in the late Telychian in southern Turkey (Göncüoğlu & Kozur 2000a). The sea-level fluctuations may have lasted from the deposition of the thick pelagic "*Orthoceras*" limestones of the lower Yukarı Yayla Formation. According to our conodont data, this occurred close to the base of Wenlock in the *P. amorphognathoides* Zone. The same succession of events can be observed in the Central/Western Taurides.

**9.** Previous views that the Yukarı Yayla Formation is either of late Silurian to Early Devonian age without an unconformity at the base of the Devonian (Özgül et al. 1972; Demirtaşlı 1978; Metin et al. 1986) or entirely Llandovery in age with a long gap before the Early Devonian transgression (Dean & Monod 1990) could not be confirmed. Sample CON-11 from the lower Yukarı Yayla Formation is not older than middle Ludlow. In the 200 m-thick shales, siltstones with few limestones of the middle and upper Yukarı Yayla Formation, large parts of the lower upper Silurian may be present.

**10.** Our conodont data confirm the view of Plodowski & Salancı (1990) that the Devonian-Carboniferous boundary lies within the black shales (Ziyarettepe Formation), as in many other places of the world.

**11.** A possible geodynamic scenario based on the available data is as follows. During the Infracambrian-earliest Cambrian periods, the consolidated Pan-African NW Gondwanan pericratonic margin was rifted by back-arc extension or transtension. The marine transgression in the late Early-early Middle Cambrian was followed by deposition of slope-type siliciclactic rocks and hence the presence of a deep (oceanic?) basin to the north of the Taurides is assumed. Paleobiogeographical data indicate that the Taurides were at a similar paleo-latitude to Baltica. The Middle Ordovician hiatus and the corresponding sudden jump in the conodont CAI values have been ascribed to a tectonic event, which had been recorded along the peri-Gondwana margin in many other places in Europe (Raumer et al. 2002) and ascribed to the opening of Paleotethys *sensu* Stampfli (2000). The latest Ordovician saw the arrival of glaciers from Gondwana and indicate that Baltica had already drifted away from the Taurides and that the latter was in a similar paleogeographic position to Iberian and Armorican Terranes. The early Silurian included rapid climatic changes in the Central and Southern units. There is no record of these events in the Konya area, Northern Taurides, where oceanic deposition continued until the end of the Silurian. The open shelf to slope deposition of this ocean persisted in the central and southern parts of the Taurides, until the end of the Silurian. The Early Devonian unconformity in the Geyik Dağı and Antalya Units is another important difference. The pre-Middle Devonian unconformity/volcanism and shallow-marine limestone deposition in the GDU is not observed in the

KBB and is indicative of block-faulting within the platform. The Early Carboniferous bimodal volcanism and proximal flysch formation in the KBB is ascribed to the opening of a back-arc basin, related to the closure of a Carboniferous oceanic basin to the north of the Taurides.

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