PALAEOTETHYAN, NEOTETHYAN AND HUĞLU-PINDOS SERIES IN THE LYCIAN NAPPE (SW TURKEY): GEODYNAMICAL IMPLICATIONS

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Abstract—The idea of a continuum between the Hellenides and the Taurides is based on correlations between the platform series of the external parts of the Hellenides-Taurides system, as well as similarities between sedimentary sequences in southwestern Turkey and in the Dodecanese islands (Greece). In this system, the Lycian Nappes, and particularly the Tavas Nappe occupy a key area. The Tavas Nappe forms the lowermost unit in the Lycian pile and is classically divided into the Karadağ, Teke Dere, Köyceğiz and Hatilece units. The lowermost Karadağ unit consists of a Gondwana-type platform succession ranging from the Late Devonian to the Late Triassic. A large hiatus exists between the Sakmarian and the Middle Triassic (deposition of sandstones, quartzites and limestones). The Carnian is marked by a general deepening of the platform prior to the deposition of a shallow-marine-like formation. The discovery of the Cordevolian (early Carnian) Pseudofurnishius murcianus murcianus conodont fauna on top of the platform is of crucial importance. This fauna characterizes the Westmediterran-Arabian Province and is a typical indicator for the Neotethyan domain. The Karadağ unit is always found structurally below the Teke Dere unit, this superposition being a possible result of the Late Triassic Eocimmerian orogenic event. The Teke Dere unit is formed by several slices including Kasimovian OIB-type basalts representing a Palaeotethyan seamount, Carboniferous MORB-type basalts, an Early Carboniferous shallow-marine siliciclastic deep-water series and a Middle Permian arc sequence. Both the platform limestones associated to the seamount and the dolostones above the Early Carboniferous siliciclastic series yield shallow-marine microfauna and microflora sharing strong biogeographical affinities with the northern Palaeotethyan borders. The thick Mesozoic sequence formed by the Köyceğiz and Hatilece units occupies a high structural position above the Karadağ and Teke Dere units. The base of the series comprises a Late Triassic continental formation followed by Liassic shallow-marine limestones and a late Liassic Ammonitico Rosso. It continues with late Liassic to Maastrichtian pelagic limestones and calciturbidites. A Late Paleozoic to Lutetian flysch unconformably overlies it. Locally, volcanic rocks associated with Late Triassic pelagic limestones, turbiditic sandstones, and calcareous sandstones alternating with volcaniclastic sediments form the lowermost exposure of the Köyceğiz series. Detailed fieldwork supported by numerous micropalaeontological evaluations suggest that the Tavas Nappes is in reality highly composite and includes dismembered units belonging to the Palaeotethyan, Neotethyan and Huglu-Pindos realms. The Karadağ unit belongs to the Cimmerian Taurus terrane and was part of the northern passive margin of the Neotethys (= East-Mediterranean); the Teke Dere succession is composed of several thrust sheets of Palaeotethyan origin. Palaeotethyan remnants found as subduction-accretionary complexes or reworked during the Eocimmerian orogenic event provide a strong means to identify and locate the Palaeotethyan suture zone; the sedimentological evolution of the Köyceğiz and Hatilece series is in many points similar to classical Pindos sequences. These series originated in the Huglu-Pindos Ocean along the northern passive margin of the Anatolian (Turkey) and Síthia-Pindos (Greece) terranes.

INTRODUCTION

Geodynamical field-oriented geology requires the use of terms that need to be accurately defined. This is particularly the case with the names, definitions and positions of the different oceanic basins involved in the geodynamical history of the Tethysides. Recent developments in Tethyan geology gave birth to a complicated nomenclature where several concepts and definitions are used in different manners, often in strong disagreement with their original significance. Stampfli and Kozur (2006) discussed the priority definition of the terms Tethys, Palaeotethys and Neotethys. The Palaeotethys-(Neo) Tethys sensu stricto concept of Kahler (1939) and Hertitsch (1940) was not only a time-related concept of different Palaeozoic-Mesozoic opening and closure, but also a notion of two spatially separated oceans, of which the (Neo)-Tethys was the southernmost. In a modern sense, the original Palaeotethys-(Neo) Tethys concept of Kahler (1939) is basically the same as the one of Stöcklin (1974) and Stampfli (1978): the Palaeotethys is located between the Variscan active margin to the north and the Cimmerian blocks, and the Neotethys between the latter and the Gondwana passive margin to the south. As Stöcklin (1974) and Stampfli (1978) were the first to use the term Neotethys in agreement with the priority Palaeotethys-(Neo) Tethys concept of Kahler (1939) and Hertitsch (1940), the term Neotethys has to be used only in this priority-supported modern sense. Thus, the use and abuse of the terms Palaeotethys, Neotethys and Tethys (including the so-called northern, southern branches) for some geodynamically different oceans opening at different Palaeozoic-Mesozoic times basically violate the original priority concepts and lead to confusion.
The Turkish segment of the Tethysides is composed of several “Geodynamic Units” (hereafter GDU) gradually assembled during several orogenic phases, as a consequence of the closure of Tethyan oceanic basins. The term GDU (Moix, 2010) is introduced here, emending the term “terrane” used so far. It describes the present-day smallest continental/occeanic fragment, possessing its own geodynamical scenario. The scenarios are based on the evolution of continental margins (active, passive) and/or on the processes generating the GDUs material (e.g., oceanic crusts, basaltic plates, insular arcs, accretionary complexes). A geodynamical scenario combined with biostratigraphic and palaeogeographic data (e.g., palaeoclimatology, biostratigraphy, palaeobiogeography, palaeomagnetism) define the GDU’s position in space and time. In the plate tectonic reconstructions, a GDU is used as a geological marker within a terrane, a continent or an ocean and always keeps its present day shape. A terrane is potentially composed of several GDUs, thus it has both geologic and tectonic significance (e.g., Şengör et al., 1990; Hochard, 2008).

The internal geometry of the Tethyan domain is characterized by a complex array of plate boundary systems composed of a continuously evolving network of ridges, transforms and subduction zones. Their record of activity is now found, in various states of preservation, mainly along the sutures of the Tethysides, the sites of former Tethyan oceans ( Şengör and Yılmaz, 1981). On a Turkish transect, the present-day juxtaposition results from large lateral displacements and north/south shortening from at least the Cadomian to the Alpine cycles (e.g., Stampfli and Borel, 2002, 2004; Moix et al., 2008a; von Raumer and Stampfli, 2008; Moix, 2010). The Tethyan evolution of Turkey may be divided into two main phases, namely a Paleo- and a Neotethyan, although they partly overlap in time ( Şengör and Yılmaz, 1981). In addition, several independent back-arc basins inferred both for the Paleo- and Neotethys oceans opened and developed from Early Mesozoic times (e.g., Stampfli and Kozur, 2006). As their remnants are now found as nappes, these basins undoubtedly played an important role in the tectonic evolution of the Tethysides.

In this framework, the Lycian Nappes in southwestern Turkey (Brunn et al., 1971) occupy a large area between the Beydağları platform to the SE and the Menderes Massif to the NW (Fig. 1). The Lycian Nappes are derived from the Izmır-Ankara Belt and represent allochthonous parts of the Anatolian GDU (Moix et al., 2008a). The underlying paraautochthonous units of these nappes generally belong to the Taurus terrane (e.g., Beydağları, Menderes, Geyik Dağ) flexured in Carnian and in Eocene times. A flysch development preceded the emplacement of the Anatolian nappes with their ophiolites, the latter corresponding to the Late Cretaceous obduction event, generally sealed by a Maastrichtian carbonate platform (Moix et al., 2008a). The Lycian Nappes and their paraautochthons are a key area in western Turkey as they are situated between the Hellenic and the Tauric systems to the west and to the east, respectively. For a long time, the idea of a Dinarides-Hellenides-Taurides-Zagros continuum has been postulated and discussed (Philippson, 1914; Kober, 1915; Kossmat, 1924; Renz, 1940; Brunn, 1960; Nebert, 1961; Ricou 1973; Ożgıl and Arpat, 1973; Ricou, 1974; Bernoulli et al., 1974; Lebouleguer, 1975; Ricou et al., 1975; Argyriadis et al., 1976; Aubouin et al., 1976; Brunn et al., 1976; Bonneau et al., 1977; Dürr et al., 1978; Thorbecke, 1987; Robertson et al., 1996; Oberhansli et al., 1998; Ring et al., 1999; Kozur, 2000; Okay, 2001; Gessner et al., 2001a; Stampfli et al., 2003; Jolivet et al., 2004). This idea of continuum was mainly based on correlations between the plate boundary systems of the external parts of the Hellenides-Taurides system, as well as similarities found between sedimentary sequences in southwestern Turkish and in the Dodecanese islands (Greece) (Bernoulli et al., 1974; Brunn et al., 1976; Poisson, 1984).

In this paper, we aim to focus on the Karadağ and Teke Dere units in the Tavas Nappe of the Lycian Nappes. Geodynamical-oriented geology based on a multidisciplinary approach focused on some key sections sheds light on the evolution of the Palaeotethyan, Neotethyan and Huglu-Pindos margins as well as oceanic realms in space and time. Although comparisons between the external platforms of Turkey and Greece are important for any correlations, the recognition of Palaeotethyan remnants, and particularly subduction-accretion complexes situated in different parts of southern Turkey (and adjacent areas), is of importance to constrain the Palaeotethyan evolution and the position of its suture zone. In addition, the identification of Pindos-type series in Crete, in the Dodecanese, in the Lycian nappes and farther east in the Antalya and Beyşehir-Hoyran nappes, in Mersin and in Elbistan, is crucial to constrain the origin of these nappes along the northern margin of the Anatolian (Turkey) and Sitia-Pindos (Greece) GDUs.

**Tectono-Stratigraphy of the Lycian Pile**

**Parautochthons**

Both the Beydağları and the Menderes form the autochthonous sequences of the Lycian and the Antalya nappes (Fig. 1). The “core series” of the Pan-African Menderes Massif are related to the Cimmerian Taurus GDU ( Şengör, 1984; Hetzel and Reischman, 1996), which is, together with the Beydağları-Susuz Dağ-Göcek domains part of the Greater Apulia terrane (Moix et al., 2008a). The eastern prolongation of the Taurus GDU is well documented in Sandıkçay (e.g., Gürsu and Göncüoğlu, 2006), in the Karacahisar dome (e.g., Dumont, 1976), and in the Geyik Dağ autochthonous (central Taurus) where it is overlain by the Bokşar Nappes (e.g., Ożgıl, 1976; Monod, 1977; Gutmé et al., 1979; Ożgıl, 1997).

The Geyik Dağ forms the most autochthonous unit in southern Turkey (Taurus GDU), and its sedimentation generally starts in the Cambrian/Ordovician and ends in Late Cretaceous times or later (Palaeocene, Eocene), depending on the proximity of the Anatolian ophiolitic front. The Hirnantian glaciation event was recognized in several Tauric sequences (Monod et al., 2003) and the Late Triassic to Liassic interval is marked by the Eocimmeric unconformity. This event is characterized by a large detrital input of polygenic, partly pelagic material (Gutmé et al., 1979; Akay, 1981; Altmüller, 1981; Demirtaş, 1984; Monod and Akay, 1984; Koç et al., 1997; Moix et al., 2008a, 2008b; Moix and Stampfli, 2009). These Tauric sequences are comparable to the Alborz development in northern Iran (Stampfli et al., 2001; Baghri, 2007; Baghri and Stampfli, 2008), and record the opening and closure of both Palaeo- and Neotethys.

In the Geyik Dağ autochthons on the road between Taşkent and Alanya near the village of Muzvad (Dumlugöze), we collected samples from the uppermost part of the series just below the ophiolitic olistostrome. One sample yielded a middle to Late Eocene assemblage including Discocyclinidae, Nummulitidae sp., Asterocyclina sp., and Sphaerogypsina sp. [P (percentage of planktonics) = 0], red algae Lithothamnium sp., and brachiopods. Another sample of slope deposits is Middle Eocene in age and yielded Discocyclinidae, Nummulites sp., Asterocyclina sp., Rotalia sp., Morozovella sp. (Pl. 1, Figs. 5, 9), Acaninina sp. (Pl. 1, Figs. 6, 9), A. bulbrooki (Bolli) (Pl. 1, Figs. 7, 8) and Globigerinatheka sp. (P = 5-10%). This demonstrates that the ophiolitic front has only reached that part of the autochthons during the Middle-Late Eocene interval, much later than other more internal autochthonous units, whereas some external plate platform units were not reached by the ophiolitic nappes at all (Koç et al., 1997).

**Beydağları**

Ricou et al. (1979) subdivided the Beydağları into a western and an eastern part. On its western flank, the stratigraphic sequence ends during the Burdigalian/Langhian interval, and is tectonically overlain by the Lycian Nappes. On its eastern flank, the stratigraphic sequence ends in Palaeocene/Eocene times, and is tectonically overlain by the Antalya Nappes. Locally, the eastern Beydağları is thrust over the western Beydağları after the Burdigalian/Langhian and before the Serravalian/Tortonian molasse of the Antalya Basin.
In its northern part (Bucak area), the Beydağları unit is made of Late Triassic/Early Jurassic to Cenomanian neritic limestone displaying evidences of drowning on its top. The sedimentation continues with Senonian to Danian hemipelagic and pelagic limestones, proving the flexuration of the platform. The Beydağları unit is overlain by an ophiolitic olistostrome formed during the Late Palaeocene to early Ypresian period. The olistostrome is transgressed by pelagic Early Eocene (late Ypresian) and Lutetian limestones, followed by a terrigenous and pelagic calcareous sedimentation lasting until the end of the Oligocene. The latest Oligocene shows local karstic surfaces related to emersions of the platform (Poisson, 1977; Gutnic et al., 1979). The Göcek domain is the most external (southernmost) part of the autochthons. Near the harbor of Göcek (Göcek window), the uppermost part of the Beydağları series is characterized by a continuous sedimentary succession ranging from the Cenomanian to the early Burdigalian, and followed by an alternation of sandy limestones and marls of late Burdigalian to Langhian age (de Graciansky, 1968, 1972).

South of Imeç and Ovacık, near Pozan Göl, we logged the Pozan Göl section that includes, at its top, an olistostromal formation associated with serpentinites. The succession starts with 30 m of mudstones, grainstones and chalk followed by 2 m of debris-flow including ophiolitic elements. It continues with 2 m of green and red silstones and argillites with nodules of micritic limestones. These nodules yielded Cuneolina sp. and Pseudorphapydionina sp. (?) that likely indicate a Barremian-Santonian age. The siltstones are transitional to a few meters of grainstones, laminated at the base and massive at the top. These levels supplied a Middle Eocene assemblage of foraminifers including Nummulites sp., Asterocyclina sp., Discocyclina sp., Turborotalia cerroazulensis cerroazulensis (Cole) (Pl. 1, Figs. 1-4), Morozovella sp., Globigerinatha sp., Subbotina sp., plus Rotaliidae, Cibicididae, Anomalalinidae, red algae Lithothamnium sp., and microproblematica Microcodium sp. (reworking of paleosols?). The sequence ends with 3 m of red argillites followed by a few meters of debris-flow and turbidites. One sample from the uppermost level below the large olistostromal formation (including blocks of serpentinites, gabbros, and shallow-water limestones) yielded Nummulites sp., Discocyclina sp., Asterocyclina sp., Assilina sp., plus Rotaliidae, Cibicididae, Anomalalinidae, red algae Lithothamnium sp., and microproblematica Microcodium sp. (reworking of paleosols?). A second sample yielded Nummulites sp., Discocyclina sp., Assilina sp., plus Campanian-Maastrichtian lithoclasts with Heterohelix sp., Globotruncanita sp., Globigerinelloides sp., and Gansserina sp. (?). These assemblages are Middle to Late Eocene in age.

The Susuz Dağ shows some differences in the sedimentary record: the pelagic interval during the Late Cretaceous is less developed or even absent. The Paleocene and the Eocene periods are characterized by neritic sedimentation (Nummulites sp.) including emersions, followed by karstification during the latest Eocene. The Oligocene is not preserved.
From the Miocene onward, both the Beydağları and the Susuz Dağ present the same history. Shallow-water carbonates compose the Early Miocene. It is then overlain by flysch-like sedimentation, followed by molassic-type deposits. Hayward (1984) studied the Miocene clastic sediments between Kağızman and Fınike and deduced both an eastern and western provenance for this material. Sediments lying on the Beydağları were derived from the east and record the original emplacement of the Antalya Nappes, whereas those lying on the Susuz Dağ were derived from the northwest and record the original emplacement of the Lycian Nappes. The structural relationships between the Beydağları, the overlying Antalya Nappes and the Lycian Nappes can be clarified in the “Isparta angle.” The Isparta Çay unit of the Middle Antalya Nappes is thrust over the Late Cretaceous Beydağları platform, and transgressive Aquitanian sediments seal both of them. This neo-autochthon of Miocene age is in turn tectonically overlain by the Lycian Nappes (Akköy), posterior to Burdugalian (or Langhian) flysch deposits, which marked the emplacement of the nappes. This new assemblage is finally sealed by Tortonian conglomerates (Gütnic et al., 1979).

Menderes

The Menderes Massif is subdivided into three sub-massifs (Şengör, 1987; Seyitoğlu et al., 1992) and was exhumed as a core complex in the Late Tertiary (e.g., Bozkurt, 2001; İşık and Tekeli, 2001). The Menderes Massif underwent a complex polyphase metatectonic history and four distinct episodes of magmatic activity were identified during, the Proterozoic, Cambrian, Middle Triassic and Tertiary (Bozkurt and Oberhänsli, 2001; Koralay et al., 2001; İşık et al., 2004; Koray et al., 2004). Recent U-Pb dating of granitoid rocks belonging to the southernmost sub-massif yielded core ages ranging from Palaeoproterozoic to Neoproterozoic whereas the rims gave ages of 541 ± 14 and 566 ± 9 Ma (Gessner et al., 2004). These ages prove that the rocks were deformed, metamorphosed and intruded during the Pan-African orogeny. The stratigraphy of the Menderes Massif is still controversial. Okay (2001) proposed that the name Menderes Massif should be used only for the southernmost sub-massif whereas the other sub-massifs show different stratigraphy and metamorphic facies, which present more similarities with the Cycladic Massif. For some authors, the Menderes consists of a pile of nappes (Partzsch et al., 1998; Ring et al., 1999; Gessner et al., 2001; Régnier et al., 2007). For others and in a more classical view, the Menderes stratigraphy consists of the superposition of two tectono-stratigraphic units: the core and the cover units (de Graciansky, 1965; Özgül, 1976; Şengör, 1984; Sattar and Friedrichsen, 1986; Oberhänsli et al., 1997; Oberhänsli et al., 1998; Bozkurt and Oberhänsli, 2001; Candan et al., 2001; Dora et al., 2001; Özer et al., 2001; Rimmelé et al., 2003b). Because of complex structural and metamorphic histories, the relationship between the core and the cover series is still debated. Some authors interpret the transition from one to the other as a major unconformity marked by a metaglomerate (e.g., de Graciansky, 1965; Şengör, 1984; Sattar and Friedrichsen, 1986; Konak et al., 1987), whereas others consider this contact as intrusive (e.g., Bozkurt et al., 1993, 1995; Erdoğan and Göngör, 2004).

(A) The “core series” comprise Precambrian to Cambrian orthogneiss, paragneiss, schists, metagranites, migmatites and metagabbros with eclogites [prior to 550 Ma according to Candan et al., 2001] and granulite relics. Hetzel and Reischman (1996) considered that the schists are Precambrian and that Pan-African granites intruded the latter. Based on structural considerations, Bozkurt (2007) argued that the gneiss-schist contact is tectonic. Most authors agree with a Late Precambrian- Early Cambrian age for the protoliths of the gneiss and relate them to the Pan-African basement (Şengör, 1984; Sattar and Friedrichsen, 1986; Hetzel and Reischman, 1996; Hetzel et al., 1998; Loos and Reischmann, 1999; Candan et al., 2001; Gessner et al., 2004; Koralay et al., 2004). Based on cross-cutting relationships and on the age of the youngest overlying lithology, other authors argued, on the contrary, that the protoliths of the gneiss are Tertiary granitoid rocks (Bozkurt et al., 1993; Bozkurt and Park, 1994; Bozkurt et al., 1995, 2001).

(B) The “cover series” comprise a succession of two sub-units predominantly composed of schists for the lower unit and marbles for the upper one. The schists consist of gneiss, micaschists, quartzites, phyllites, amphibolites and some marble intercalations, attributed to the Ordovician to Devonian period (Konak et al., 1987; Loos and Reischmann, 1999). The lower unit is transitional upward to schists including graphite veins, phyllites and black marbles (i.e., Göktepe Limestone) assigned to the Permo-Carboniferous (Önay, 1949; Okay, 2001). This age is questionable since Late Cretaceous radiiids were found within the series (Özer and Sözbilir, 2003). The Palaeozoic and Mesozoic sequences are separated by a metaglomerate consisting of elongated granite pebbles, tourmaline-rich quartzite pebbles, marbles, metadolomites and micaschists, containing also several occurrences of well-preserved HP- HT paragenesis (Rimmelé et al., 2003b). Above the conglomerates, Bozkurt and Oberhänsli (2001) described Late Triassic to Liassic marbles intercalated with schists and metavolcanics, Jurassic to Early Cretaceous marbles with metabauxite pockets (Konak et al., 1987), Cenomanian to Campanian radiiis-bearing marbles with thin micaschist intercalations (Özer, 1998), late Campanian/Maaschrichtian thin-beded red pelagic marbles (Özer, 1998), and late Maastrichtian/Early Palaeocene to Late Eocene (Özer et al., 2001) ophiolitic meta-olistostrome and flysch, containing serpentinites, metagabbros, eclogites and varied blocks of marbles embedded in a chlorite/albite schist matrix.

Lycian Nappes

Definition

The tectono-stratigraphy of the Lycian Nappes has been greatly improved during the last four decades, although no real consensus has been reached concerning the nomenclature and the origin of the different units (Table 1). The Lycian pile was historically subdivided into three main tectonic units, the autochthonous series, the intermediate complex and the peridotite nappe (de Graciansky et al., 1967; de Graciansky, 1968; 1972; Bernoulli et al., 1974; Şenel et al., 1994). The intermediate complex is made of imbricated thrust sheets comprising several independent and coherent series, the Karadag, the Teke Dere, the Köyceğiz, the Hateceana Dağ and the Innice series, plus an ophiolitic “diabase nappe” and a “mélange” associated with the uppermost Peridotite Nappe (Fig. 2). Poisson (1977) separated the Lycian Nappes into eight units: the Gümüşli, the Gülbahar and the Domuz Dağ units occupy a high position in the tectonic pile and are essentially composed of carbonates and radiolites. The Yavuz and the Yeleme units are characterized by a strong detrital input and are situated just above the Beydağları. Additionally, there are some Tertiary detrital units (flysch-like), an ophiolitic mélange and an ophiolitic nappe sensu stricto. Özkaya (1990) subdivided the Lycian allochthonous slices into four major units, which are from bottom to top the Emlali, the Köyceğiz and the Tavas thrust slice, and the Tefenni Nappe. More recently, the Lycian Nappes were subdivided into eight structural units, the Beydağları Autochthon, the Marmaris Ophiolitic Nappe, the Yeşilbarak, Tavas, Bodrum, Dumanlıdağ, Domuz Dağ and Gülbahar nappes (Şenel, 1997; Şenel et al., 1994). According to Şenel et al. (1994), the Tavas Nappe forms the uppermost thrust slice of the Lycian pile (except for the peridotite nappe). It is underlain by the Yeşilbarak Nappe separated into the Gömbü and the Yavuz units (Şenel, 2004), both of them resting tectonically on the Beydağları platform and representing a flyschoid basin developing in front of the southward progressing Lycian Nappes (Fig. 1). Merging the nomenclature of de Graciansky (1972) and Poisson (1977), Collins and Robertson (1997, 1998, 1999) classified the Lycian thrust sheets into five tectono-stratigraphic units, (1) the Menderes and Beydağları platforms acting as autochthonous, (2) the Lycian thrust sheets, (3) the Lycian mélange, (4) the Lycian ophiolitic thrust sheet and (5) the Palaeogene neo-autochthonous series. The Lycian thrust sheets were themselves subdivided into four regionally coherent units, the Karadag, the Teke Dere, the Köyceğiz and the Yavuz thrust sheets (Table 1).
TABLE 1. Summary table of the Lycian Nappes.

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<tr>
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<th>Autochthon &amp; Tavas/Boz Da Unit</th>
<th>Karada Thrust sheet</th>
<th>Yavuz Thrust sheet</th>
<th>Tekedere Thrust sheet</th>
<th>Köyce iz Thrust sheet</th>
<th>Lycian ophiolite</th>
<th>Lycian mélange</th>
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<tr>
<td>Collins &amp; Robertson (1999)</td>
<td>Série autochtone</td>
<td>Série du Karada</td>
<td>Unité de Yavuz et de Yeleme</td>
<td>Unité de Gümüşlü</td>
<td>Unité de Gülbahar</td>
<td>Nappe ophiolitique</td>
<td>Mélange de Kızıldağ, unité du Domuz Da</td>
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<td>de Graciansky (1972)</td>
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<td></td>
<td>Série de Köyce iz</td>
<td>Nappe des péridotites</td>
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<td>Poisson (1977)</td>
<td>Beyda lar and Susuz Da, Tavas and Boz Da</td>
<td>Tavas Nappe</td>
<td>Ye ilbarak Nappe</td>
<td>Tavas Nappe</td>
<td>Marmaris Nappe</td>
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<td>Özkaya (1990, 1991)</td>
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**Peridotite Nappe**

The Peridotite Nappe (or Marmaris Nappe) is approximately 2 km thick and occupies the highest position in the Lycian pile. This nappe, emplaced during the Campanian-Maastrichtian interval, is locally sealed by shallow-marine limestones of Late Palaeocene-Early Eocene age. Overlying Middle Eocene clastics and debris-flows illustrate the reactivation of the thrustings, before they reached their final position during the Miocene (Poisson, 1977). At the base of the peridotites and close to the contact with the underlying “Diabase Nappe,” several metamorphic slices are found. They are mostly composed of gneiss, micaschists, quartzites, amphibolites and marbles, embedded in a serpentinite matrix. Serpentinites and dolerites are derived from the Peridotite Nappe and are imbricated and mixed with the rocks from the “Diabase Nappe” forming a typical tectonic colored mélange (de Graciansky, 1973). The origin of these metamorphic rocks is unknown and de Graciansky (1968) argued that this material could not be compared with any lithologies belonging to the Menderes Massif. At the base of the peridotites, a thick metamorphic sole presenting typical inverted metamorphism in greenschist/amphibolite facies is present (Juteau, 1980; Thuizat et al., 1981; Çelik, 2002; Çelik et al., 2006). In the Köyceızı mélange of Poisson, (1977) consists of a Late Cretaceous chaotic assemblage of peridotites, amphibolites, gabbros, pillow-lavas, radiolarites, pyroclastic rocks of alkaline affinity and Peronian limestone blocks, and large bodies of Mesozoic shallow-water limestones (Domuz Dağ unit), in an argillaceous to sandy matrix. The whole sequence is thrust by the Peridotite Nappe and by the Domuz Dağ units (de Graciansky, 1972; Bernoulli et al., 1974). The Kızıldağ mélange is thrust over the Yavuz unit, which forms the lowest unit of the Lycian Nappes in the Domuz Dağ, just above the detrital Miocene on top of the Beydağlar autochthonous (Poisson, 1977).

**Origin and Evolution**

As for the Antalya Nappes, the setting of the Lycian Nappes is still controversial and different origins have been proposed for them. Some authors argue that the nappes were thrust southward from a palaeo-position north of the Menderes Massif and lie on/between the latter to the north and the Beydağlar platform to the south (de Graciansky, 1972; Dürr et al., 1978; Gutnic et al., 1979; Şengör and Yilmaz, 1981; Okay, 1989; Collins and Robertson, 1997, 1998, 1999; Gümüş and Erdogan, 2001). Other authors assume a dual origin for the nappes: some of them were rooted north of the Menderes Massif and others have originated between the Menderes Massif and the Beydağlar to the south (Poisson, 1977; Poisson, 1984; Özkaya, 1990; Ersoy, 1993). Poisson (1977) argued that the Peridotite nappe and associated sediments came from the north of the Menderes Massif whereas the other sedimentary thrust sheets came from an intra-continental rift basin between the Menderes and the Beydağlar. According to Poisson (1984), this domain (the Kızıldağ Çorak Göl basin or intra-Tauric trough) corresponds to the eastern prolongation of the Ionia zone of Greece. Based on the Liassic ammonite faunas, this hypothesis was supported by Dommergues et al. (2005),
**FIGURE 2.** Synthetic lithostratigraphic sections of the A, Beydağları (Bucak area) and B, Susuz Dağı (Sinekbeli area) parautochthon, the C, Karadağ, D, Teke Dere, E, Haticana and F, Köyceğiz units (all part of the Lycian Nappes). A and B are compiled from Gutnic et al. (1979); C-E are modified from de Graciansky (1972); F, is modified from de Graciansky (1972), Bernoulli et al. (1974) and Collins and Robertson (1999).
arguing that the taxa clearly indicate a south Tethyan palaeogeographic affinity.

The alternative model presented by Özkaya (1990, 1991) implies that the thrust slices correspond to two distinct tectonic terrains, respectively north and south of the Menderes. Some of the sedimentary sequences end in the Late Cretaceous whereas others terminate in the Early Eocene (Okay, 1989; Özkaya, 1990). The Tefenni Nappe records an evolution of a continental active margin and was emplaced southward in Late Eocene time from a palaeo-position north of the Menderes Massif. The Elmalı, Köyceğiz and Tavas thrust slices were emplaced in Late Miocene time from a palaeo-position between the Menderes and the Beydağları. The upper part of the domain situated between these two stable blocks is characterized by the Alakaya Basin (Özkaya, 1991), composed of Eocene volcanicogenic sediments tectonically sealed by the Tefenni Nappe. Volcanism of this age is also known in the Kyrenia range in North Cyprus (Baroz, 1980; Robertson and Woodcock, 1986) and in the Maden complex in SE Turkey (Aktas and Robertson, 1984; Robertson et al., 2006, 2007). According to Közur et al. (1998), the Tavas Nappe originated in the south of the İzmir-Ankara Belt and was transported to its present position during the Late Cretaceous to Tertiary translation of the Lycian Nappes.

Additionally, the timing and transport direction of the Lycian Nappes were investigated in different regions. It is usually admitted that they were thrust from the NW to the SE during the Late Cretaceous to Burdigalian/Langhian interval (Ricou et al., 1979; Okay, 1989; Collins and Robertson, 1998, 1999). On the northern part of the Menderes Massif, a Mid-Eocene age is assumed for the thrusting of the Lycian Nappes over an Eocene flysch (Okay, 1989; Özer et al., 2001). The northernmost exposures of the Lycian Nappes are found as klippe on the Menderes Massif and linear fabrics, as well as S/C relations indicate a top-to-the-SSW sense of shear (Günogr and Erdogan, 2001). The discovery of widespread HP-LT metamorphism (Fe-Mg-carpholite) at the base of the Lycian Nappes, in klippe on top of the Menderes Massif and in the cover series of the Menderes Massif provide new elements for the understanding of the setting of the Lycian Nappes (Oberhänsli et al., 2001; Rimmelé, 2003; Rimmelé et al., 2003a, 2003b, 2006). These HP-LT assemblages would imply an important burial of at least 30 km during the formation of the accretionary complex (Rimmelé et al., 2003a), a hypothesis contested by Régnier et al. (2007) who are in favor of a single Barrovian-type metamorphism related to crustal thickening. Oberhänsli et al. (2001) explained that in an accretionary complex, off-scrapping from the lower plate and tectonic imbrications in the upper plate could explain the wide distribution of HP-LT relics at the base of the Lycian Nappes. These authors further suggest that if the Lycian Nappes are restored as a north-facing Mesozoic rift and passive margin assemblage, then the abundance of HP-LT relics can be explained by the tectonic imbrications of the frontal part of the passive margin within the southward-advancing prism of the Lycian Nappes. This interpretation is supported by Rimmelé et al. (2006) who stated that the abundance of HP-LT metamorphism in a similar tectono-stratigraphic unit is representative of a well-developed accretionary complex involving many imbricate structures. These authors conclude that the Lycian HP-LT belt could be the result of the evolution of a wide southward-moving accretionary complex over a flat slab of continental material.

AĞILOVASI YAYLA SERIES

The Ağılovası Yayla area (Fig. 3) is situated north of the Teke Peninsula (southern Turkey), north/northeast of Fethiye Gulf and close to the road that connects Fethiye to Çameli. The sections described hereunder were logged in a remote area between 1600 and 2000 m, 4 km south of the village of Taşcilar and north of the Karadağ (2233 m). To complete the description of the Karadağ series, an additional section was logged along the southern margin of the Niş Polje (Fig. 3). The pioneer work of de Graciansky, illustrated by abundant palaeontological data, served as a basis for the understanding of the general stratigraphy of the Ağılovası Yayla and Niş areas (de Graciansky et al., 1967, 1968, 1972). In the olden days, these authors focused principally on shallow-marine faunas and described accurately Palaeozoic to Tertiary microfossils. In these areas, important breakthroughs were made by Közar et al. (1998), Közar and Şenel (1999) and Stampflı and Közar (2006), who discovered and described the first Palaeozoic deep-sea fossils (conodonts and radiolarians), partly associated with a sea mount, partly with a wildflysch sequence. Meanwhile, quite a lot of authors contributed to the comprehension of that part of the Lycian Nappes (Erakman et al., 1982; Şenel et al., 1994; Şenel, 1997; Collins and Robertson, 1997, 1998, 1999; Robertson et al., 2004; Robertson and Ustaömer, 2009a, b; Moix, 2010; Vachard and Moix, 2011; Vachard and Moix, in press).

The composite succession (Fig. 4) logged in Ağılovası Yayla permits the recognition of the Karadağ and the Teke Dere units (Fig. 3). The sections described below frequently present basal truncations and tectonic repetitions. Additionally, recent landslides along the hill slopes disturb the original relationships between the units. Below, we aim to illustrate principally shallow-marine microfauna and microflora. All the carbonate microfacies correspond to shallow-inner ramp deposits either little displaced or preserved as in situ thanatocenoses or proximal tempestites. In this inner ramp environment, no emergence microfaucies have been observed, and we recognize the following biofacies: 0-5 m, rich in dasyyclad algae; 5-10 m, mixed assemblages rich in fusulinids and in algae; 10-20 m, mixed assemblages rich in fusulinids and poor in algae; 20-30 m, accumulations of fusulinids, absence of algae.

Karadağ Sections

The Karadağ-type series belong to the Tavas Nappe (Erakman et al., 1982; Şenel et al., 1994) and start classically with Middle Carboniferous to Late Permian black bioclastic limestones intercalated with sandy and pelitic episodes (Fig. 2). According to de Graciansky (1968, 1972), the Late Carboniferous and the earliest Permian are not exposed. The Triassic period is characterized by large outcrops of quartzites assigned to the late Ladinian (de Graciansky, 1972), or to the Early Triassic (Bernoulli et al., 1974), Ladinian limestones rich in Duostonimidae foraminifers cap the quartzites. This interval is followed by limestones, sandstones and sandstones (Belenkavak “schists”) of Carnian/Norian age. Şenel et al. (1994) separated the Karadağ unit into six formations and summarized them as a continuous carbonate platform ranging from the Late Devonian to the Middle Triassic. From bottom to top, these formations are: the Sakaz (possibly Late Devonian shales and limestones), the Kiloluk (Middle Carboniferous bioclastic limestones, dolomites, dolomitic limestones), the Akkavak (Early Permian crystalline limestones, dolomites, shales), the Saritaş (possibly late Anisian to early Ladinian sandstones), the Karapınar (Ladinian black limestones) and the Belenkavak (Carnian-Norian sandstones, siltstones and shales) formations.

Ağılovası Yayla Autochthonous Series

The oldest shallow-marine sediments identified in the Ağılovası Yayla area belong to the Kiloluk Fm. The sequence starts with dolomites, cherty limestones (dolomitic alteration) and bioclastic limestones containing fusulinids of early Kasimovian age (Pl. 2, Figs. 1-3; see detailed analysis in Vachard and Moix, 2011). Due to recent tectonics, this Late Carboniferous series is brought close to a 160 m thick platform-type development ranging from the Early Permian to the Late Triassic (Figs. 4 and 5A). Although this series strongly resembles the Kasimovian Kiloluk Fm, it is clearly related to the Akkavak Fm described below.

The Ağılovası Yayla autochthonous series starts with thick-bedded gray limestones rich in fusulinids. It is transitional to an alternation of thin-bedded black nodular limestones, massive gray to black limestones, middle-bedded sandy limestones including pelitic horizons, thick-bedded black laminated limestones, and thin-bedded black bioclastic lime-
stones interspersed by argillites (Akkavak Fm). The sedimentation continues with a thick-bedded interval composed of white quartzites (Sartıaq Fm). All the fossil assemblages below the quartzitic beds indicate a Sakmarian age with fusulinids: abundant *Darvatis ex constrictus* Leven and Shcherbovich (PL. 3, Figs. 1-2) and rare *Robustoschwagerina* sp.; rare smaller foraminifers; e.g., *Deckertella composita* Reitlinger (PL. 3, Fig. 3), and relatively common *Permoecalculus aff. kameroni* (Konishi) (PL. 3, Figs. 4, 8). In other localities, the Sakmarian is also characterized by *Climacamina sphaerica* Potiévskaya, *Boultonia cheni* Hoek, *Duktevichtia incrpta* (Schellwien), *D. sp.*, *Quasifususivisella* sp. and *Robustoschwagerina* sp. (PL. 3, Figs. 5-7). The quartzites are followed by thick-bedded gray limestones and thin-bedded bioclastic black nodular limestones, locally with cherts (Karapinar Fm). The limestone levels above the quartizite interval indicate a Middle-Late Triassic age (PL. 4, Figs. 1-10, 12, 13, 16, 18, 19, 22).

The upper part of the section is represented by a wildflysch-like sequence composed of shales, siltstones, sandstones, and conglomerates resting above the underlying limestones. This siliciclastic episode corresponds to the Belenkavak Fm and includes various blocks of Permian age (de Graciansky, 1972; Vachard and Moix, 2011). A Carnian-Norian age was formerly assigned to the upper part of the platform (Senel et al., 1994; Kozur et al., 1998; Stampfl and Kozur, 2006). The exact age of the transition between the underlying limestones and the siliciclastic episode comes from the uppermost carbonate beds of the Karapinar Fm and from limestones interspersed in the first few meters of the Belenkavak Fm. In these horizons, Middle Triassic foraminifers (PL. 4, Figs. 11, 14, 15, 17, 20, 21) and early Carnian conodonts and ostracods have been identified. The conodont fauna is represented by *Pseudofurnirhus muscianus muscianus* van den Boogaard and *Pseudofurnirhus muscianus* n. subsp. B Gullo and Kozur (PL. 5, Figs. 1-5) and the ostracod fauna yielded sculptured Bardiidae and *Polycopsis* spp. (PL. 5, Figs. 6-7).

**Nif Series**

The Nif section shows a development comparable to the Ağğıovas Yapıya autochthonous series described above. This section is situated along the eastern margin of the Nif Polje, in the “Nif imbricate thrust sheets” defined by de Graciansky (1972), south of the village of Arpakçı (formerly Nif Köyü) and north of the town of Fethiye (Fig. 3). According to de Graciansky (1972) and from west to east, the succession starts with Middle Carboniferous to Permian limestones and continues with Early Triassic (?) quartzites, Ladinian limestones and ends with the Çenger Fm (de Graciansky, 1962, 1972). Late Permian limestones are continental molasse-type deposits defined as the Çenger Fm in which Late Triassic fish and reptiles remain were described by Monod et al. (1983) and Buffetaut et al. (1988).

From the general stratigraphy and the identified faunas, it is clear that the Nif section is a lateral equivalent of the Ağğıovas Yapıya autochthonous series. However, no remnants of Palaeoetethyan material (e.g., seamount, accretionary series) have been identified in the upper part of the section logged south of the Nif Polje.

**Teke Dere Sections**

The Teke Dere unit (Fig. 4) belongs to the Tavas Nappe (Erakman et al., 1982; Senel et al., 1994) and was originally described as composed of Early and Late Permian white dolomites and limestones followed by a detrital episode characterized by green arkosic sandstones and graywackes interspersed by diabases (pillow-lavas), black radiolarites and Permian limestones (de Graciansky, 1968, 1972). Late Permian dolomites and limestones conformably overlie the detrital event. The sedimentation continues unconformably and through a karstic surface to red arkosic sandstones corresponding most probably to the Çenger Fm, themselves capped by limestones and dolomites of Liassic age. According to Senel et al. (1994), the Teke Dere unit consists of the early to middle Wordian Çatakdere (crystalline limestones); the Incirbeleni (shales, sandstones, limestone “lenses”, lylides and volcanics) and the early to middle Wordian Nişangah-tepe (dolomites and limestones) formations. These authors assigned to the Incirbeleni Fm a Wordian age because it was sandwiched between the two Wordian formations. Kozur et al. (1998) and Kozur and Senel (1999) highlighted the presence of Mississippian blocks and matrix composing the Incirbeleni Fm. In fact, the Teke Dere unit sensu de Graciansky (1972) is a partial combination of the Belenkavak, Çatakdere, Incirbeleni and Nişangah-tepe formations of Senel et al. (1994).

During the past decade, the Teke Dere unit gave birth to several descriptions, often speculative because mostly devoid of any new biostratigraphic data (e.g., Collins and Robertson, 1998; 1999; Robertson et al., 2004, Robertson and Ustaömer, 2009a, b). Recently, Vachard and Moix (2011) produced a detailed study of the Pennsylvanian and Cisuralian microfauna and microflora associated with the seamount. According to the calcareous algae and foraminifers, the lavas are earliest Kasimovian in age. The shallow-marine limestones associated with the lavas developed from that time up to the Sakmarian-early Artinskian. The microfauna and microflora share biogeographical affinities with the northern Palaeoetethyan borders. They are very similar to the Zollnersee series in the Carnic Alps as well as some Ursals, Donbass or Darvaz assemblages. Because of this faunistic evidence, Vachard and Moix (2011) concluded that the seamount originated in the Palaeoetethys and was accreted to the southern Eurasian margin in post-Artinskian times rather than belonging to the Gondwanan realm. Moix (2010) and Vachard and Moix (in press) investigated the shallow-water limestones at the base of the Nişangah-tepe Fm just above the Mississippian wildflysch-like sequence corresponding to the Incirbeleni Fm of Şenel et al. (1994) and Kozur et al. (1998). They highlighted a very rich and diverse microfauna and microflora of Kubergandian (= Roadian) age. As is the case for the seamount series, the
FIGURE 3. Geologic map between the Çatal Tepe and the Karadağ (Lycean Nappes, SW Turkey); modified from de Graciansky (1972). **Key:** 1, large blocks in melange; 2, Tertiary sediments (with nummulites) of the Innice series; 3, peridotites; 4, wildflysch of Maastrichtian-Eocene age; 5, melange of diabases, breccias, radiolarites and limestones, including large blocks of radiolarites and Senonian pelagic limestone (see 1 above); 6, Dogger to Cenomanian siliceous limestones; 7, Triassic and Liassic limestones and dolomites; 8, Triassic and Liassic limestones and dolomites of the Köyceğiz series; 9, Late Permian green arkoses; 10, Permian limestones and dolomites; 11, Late Triassic red arkoses; 12, Maastrichtian and Eocene sediments of the Innice series; 13, undifferentiated; 14, Late Triassic Belenkavak “schists”; 15, Ladinian limestones and dolomites; 16, Early Triassic quartzites; 17, Middle Carboniferous and Permian calcarenites, sandstones and pelites. The two stars indicate approximately the investigated areas.
and breccias, detrital limestones, calcareous sandstones, slope and shallow-marine limestones (Vachard and Moix, 2011). The Gzhelian to Artinskian platform associated with the Kasimovian volcanic series correspond pro parte to the Çatakdere Fm of Şenel et al. (1994) and to the “Early Permian in the Teke Dere facies” of de Graciansky (1972). In Aşkılı Ovası Yayla area, several outcrops belonging to the main sequence of the seamount were identified (Fig. 6A). These outcrops are always found in a relative low structural position, directly above the Karadağ unit. Different parts of the seamount series have already described (Kozur et al., 1998; Kozur, 1999; Kozur and Şenel, 1999; Göncüoğlu et al., 2000; Stampfl and Kozur, 2006), but only Kozur and Şenel (1999) and Vachard and Moix (2011) presented palaeontological evidence supporting the Late Pennsylvanian to early Cisuralian shallow-marine sedimentation associated with the OIB-type lavas. Robertson and Ustaömer (2009b) presented geochemical analysis of lavas from the Teke Dere unit. These authors argued that the lavas and associated shallow-marine carbonates could be consistent with the development of a platform above rift-related alkali basalts, but the presence of red slope limestones with a rich open sea fauna containing both pelagic gondolellids (Pl. 10, Fig. 9) and transported shallow water conodonts speaks against a platform setting and indicates a slope setting at the margin of a seamount. The major part of the seamount consists of lavas, tuffs and associated rich shallow-water fusulinid limestones and associated slope sediments of latest Moscovian, Kasimovian, Gzhelian and early Cisuralian ages (Pl. 2, Figs. 4-22, see details in Vachard and Moix, 2011; Pl. 10, Figs. 1-9). The first carbonate levels in primary sedimentary contact above the main series of the altered lavas yielded fossil assemblages of earliest Kasimovian age, just above the Moscovian/Kasimovian boundary interval. In that case, it could be a potential equivalent of the limestone N3 of Donbass. The slope series are partly contemporaneous with the seamount sequence and consist of agglomerates of volcanics, pillow lavas with few inter-pillow red limestones, which yielded a rich early Kasimovian Idiognathodus-rich conodont fauna including the pelagic genus Gondolella (Pl. 10, Fig. 9). The thermal overprint deduced from the Conodont Alteration Index (CAI = 1-2) indicates that the seamount series is unmetamorphosed to very low grade metamorphic (Kozur, 1999; Kozur and Şenel, 1999). This main part of the seamount is overlain by a conglomerate rich in volcanic pebbles grading to a Gzhelian to early Artinskian platform.

Laterally in a similar position above the Karadağ unit, several identical but less complete sections were identified. One of these sections consisting of about 50 m of lavas (OIB-type) is followed by 3 m of a monogenic conglomerate composed of well-rounded volcanic elements. This conglomerate is overlain by 1 m of black limestones of early Kasimovian age (Pl. 6, Figs. 1-3) dated with Quasifusulinoides fusiformis Rozovskaya and Protrictites sp. It is followed by 0.5 m of lavas and 2 m of gray to black limestones of early Kasimovian age, with Obsoletes obsoletus (Schelliwien), Quasifusulinoides fusiformis, and Ozaawainella sp. (Pl. 3, Figs. 9-11). The shallow-water bioclastic grainstones rework rare ooids and volcanic fragments. The faunal and floral assemblages are composed of the calcareous algae Eugonophyllum sp., Anthracoporella sp., Gyroporella sp., the algal sponges Claracrusta sp. and Eyfuegella sp.; the smaller foraminifers Bradyina sp., Hemigordius sp.; the fusulinids Ozaawainella sp., Pseudostaffella sp., Schubertella sp., Fusilia sp., Quasifusulinoides sp., Praeboboletes sp., Obsoletes sp.; plus pyritized terrestrial wood, polyxone spicules, bivalves, gastropods, bryozoans, brachiopods, ostracods. These associations indicate a latest Moscovian to early Kasimovian age. The age and the facies succession of this sequence are in perfect agreement with the ones of the main seamount series and could represent a lateral equivalent.

Another isolated sequence consists of a succession of OIB-type lavas, black bioclastic limestones and gray to white azoic calcarensites. Some bioclastic rudstones stratigraphically overlying the lavas yielded the calcareous algae Eugonophyllum sp., Anthracoporella sp., Epimastopora sp., Uvanellopsis fluegelii Vachard and Moix (2011); the
consortium cyanobacteria-foraminifer *Latitubiphytes raurezae* (Vachard and Moix) Vachard et al., 2012; smaller foraminifers *Eotuberitina* sp., *Tubertinita* sp., *Lasiodiscus* sp., *Climacammina sphaerica* Potievskaya, C. sp.; the fusulinids *Nankinella* sp., *Montiparbus* ex gr. *sinuosus* Rozovskaya; plus gastropods, fenestellid bryozoans, and brachiopods (Pl. 6, Figs. 4-6). These middle Kasimovian limestones were deposited at a depth of 5-20 m and yielded the calcareous algae *Clararcrusta catenoides* (Homann) Vachard, *Donezella* hirtipes (Vachard) (Pl. 6, Fig. 16), *Ungurella*? sp.; the consortia cyanobacteria-foraminifers *Tubiphytus obscurus* Maslov, T. sp.; the smaller foraminifers *Tubertinita* sp., *Bradyina* ex gr. *nautiliformis* Möller (Pl. 6, Fig. 9), *Climacammina* sp., *Tetraaxis* sp., *Calcivertella* sp.; the fusulinids *Schubertella* sp., *Boultokia* sp., *Quasifusulina longissima* (Möller) (Pl. 6, Fig. 14), “*Gregariella*” sp. or “*Zigarella*” (two nomina nuda, neither correctly nor formally described) (Pl. 6, Figs. 10-11), *Schelvensientia*? aff. *porrecta* (Sjömana) (Pl. 6, Fig. 12), *Leetina* cf. *acetosensis* (Nogami) (Pl. 6, Fig. 13); plus calcisponges, corals, gastropods, fenestellids and other bryozoans, brachiopods, and crinoids. This rich assemblage indicates that the upper part of this section encloses the Carboniferous-Permian boundary, but the Orenburgian (= latest Gzhelian of other authors) and Asselian stages are poorly developed. The age of the uppermost levels is indeed Early Permian (probably Sakmarian). This sequence presents similar facies to the main seamount series described above, and the ages of both the lavas and the overlying associated platform are identical. Therefore, we interpret this series as representing either a part of the same section duplicated by thrusting or a lateral equivalent of the seamount main sequence.

**Geochemistry of the Seamount**

**Analytical procedures:** Wavelength-dispersive analyses for clinopyroxene major element compositions were made on a JEOL 8200 superprobe electron microprobe fitted with five spectrometers at the Institute of Mineralogy and Geochemistry of the University of Lausanne (Switzerland). The standard procedures are 15 kV and 20 nA with an electron beam of 1 µm width and integrated counting times of 15 s on the background and 30 s on the peak. Synthetic and natural minerals were used as standards. A computer correction program (PAP) was used to calculate the effects of the crystal matrix on the element concentrations (Pouchou and Pichoir, 1991). The accuracy of major element determinations is better than ± 1% of the total values.

Whole rock samples were crushed and ground using a tungsten carbide ring mill and fused into lithium boride glass disks prior to the measurement of whole-rock major-element concentrations by a Philips PW 2400 XRF at the Centre d’Analyse Minérale, University of Lausanne. Whole rock samples were crushed and ground using an Agate ring mill and fused into lithium boride glass disks prior to the measurement of whole-rock trace-element concentrations by laser-ablation ICP-MS mass spectrometry using an Ar-F 193 nm Lambda Physics© Excimer laser coupled with a Perkin-Elmer 6100DRC ICP-MS at the Institute of Mineralogy and Geochemistry, University of Lausanne. Laser settings were 25 kV, 10 Hz yielding a florescence of 140 mJ/cm² on the pit site. The ablation pit size varied from 40 to 80 micrometers depending on mineral size. Results for a given sample are an average of five measurements on an individual pellet with productivity between each measurement better than 1%. NIST610 and 612 glasses were used as external standards, and BCR2 basaltic glass was regularly used as a monitor to check for reproducibility and accuracy of the system. Results were always within ± 6% of the certified values.

**Petrologic, mineralogical and geochemical data:** The relatively high levels of loss on ignition for the sample 149/06 (from 3.61 to 4.45 wt.% for a, b and c) are related to low grade metamorphism and weathering processes (LOI, Table 2). Their contents in large ion lithophile elements (LILE), know to be sensitive to such processes, may have been modified during the very low-grade metamorphism that affected the seamount sequence as confirmed by the CAI of the conodonts (Kozur and Genel, 1999). More precisely, the Rb, Ba and Sr concentrations may not be representative of the primary lava compositions (Table 2).
FIGURE 6. Logs of the Akgılovaz Yayla arc and seamount (one local occurrence) series. Key is on Fig. 2.

Petrography: 149/06 lavas are intersertal basalts constituted of plagioclase laths (50 modal %), prismatic clinopyroxene grains (15 modal %) and acicular oxides (10 modal %) embedded in a glassy groundmass (25 modal %). Clinopyroxene crystals are well preserved, whereas plagioclase laths are altered to sericite + albite while the glass is replaced by smectites.

Mineral chemistry: Sample 149/06a clinopyroxene major element compositions are given in Table 3 and are representative of clinopyroxene compositions for all three studied lavas (149/06a, b and c). Clinopyroxene crystals (Wo 39.3 to 43.1, Table 3) show homogeneous Augite compositions (Fig. 7a, Morimoto et al., 1988) and plot in the alkaline field in the Leterrier et al. (1982) Ti vs. Ca + Na (cpfu) diagram (Fig. 7b). They are Cr-poor and generally display a FeOtot (wt. %), TiO2 (wt. %) and Al2O3 (wt. %) enrichment correlated with a SiO2 (wt. %) and MgO (wt. %) decrease from core to rim within individual grains (Fig. 8).

Whole rock geochemistry: The Late Carboniferous lavas (149/06a, b and c) from the seamount sequence show homogeneous major and trace element compositions characterized by high TiO2 (3.2 to 3.71 wt. %) and relatively low MgO (7.57 to 7.79 wt. %) and Ni (81 to 90 ppm) contents, which suggest olivine fractionation. SiO2 is of 45.71 to 46.24 wt. % while FeOtot is lower than 11.5 wt. %. In the TAS classification diagram [not shown (Le Maitre et al., 1989)], the 149/06 lavas are trachybasalts whilst in the Zr-Nb-Y discrimination diagram (Fig. 9, Meschede, 1986) they plot in/or close to the within plate alkali basalt field. Their high V and Cr values (269 ppm and 76 ppm, respectively)

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reflect the abundance of clinopyroxene and Fe-Ti oxides. All three trachybasalt samples are LREE-enriched relatively to HREE (8.98 < (La/Yb)n < 16.97, Table 2 and Fig. 10a) and yield enriched REE patterns typical of Ocean Island Basalts (OIB). The corresponding multi-element plots (Fig. 10b) are characterized by a relative Nb and Ta enrichment (relatively to La) and relative depletion of HREE and Y. This incompatible element enrichment (highest for Nb and Ta) and HREE depletion are also typical features of Ocean Island Basalts. In addition, incompatible elements known as insoluble in hydrous fluids (McCulloch and Gamble, 1991; Kogiso et al., 1997), such asREE, HFSE and Th, display positive correlation trends in binary diagrams (plotted against Zr), which seem linked to crystal fractionation processes.

**Discussion:** The studied Late Carboniferous trachybasalts (149/06a, b and c) from the seamout sequence display a number of characteristics suggesting that they are Ocean Island Basalts. Indeed, the Nb and Ta enrichment with respect to La as well as the HREE depletion relatively to LREE (8.98 < (La/Yb) < 16.97) are typical of OIB. Binary diagrams using immobile incompatible trace elements such as REE and HFSE against Zr (not shown here) show positive correlations and suggest the occurrence of crystal fractionation and/or variations in the degrees of partial melting assuming a homogeneous mantle source. Clinopyroxenes (Augite, Wo 39.3 to 43.1) show differences in major-element chemistry from phenocryst cores to rims of individual Augite grains. Such variations consist of a TiO2 and Al2O3 enrichment correlated with a MgO depletion from core to rim of clinopyroxene grains. The MgO decrease is likely to reflect the crystal fractionation process. The composition of the interstitial liquid, in which the clinopyroxene crystal rims grew, derived from the parental magma after crystallization of olivine followed by plagioclase. The Carboniferous magmas, although homogeneous in composition, are probably derived from the variable partial melting degrees of an enriched mantle source. These magmas experienced moderate crystal fractionation during magma ascent, as commonly observed in intraplate alkali basalt series.

**Ağlıovas Yayla Siliciclastic Series**

The Ağlıovas Yayla siliciclastic series is a wildflysch-like unit and systematically occupies a high tectonic position above the seamout series. This series corresponds to the Incirilebini Fm of Şenel et al. (1994) and consists of Mississippian siliciclastic turbidities, graywackes, intact small broken formations and large blocks of black radiolitaries, pelagic, partly cherty limestones, siliciclastic rocks and mafic volcanic rocks and tuffs (Kozur et al., 1998). The matrix yielded radiolitarians and conodonts (CAI = 5-6) (PL. 8, Figs. 1-4, 6, 8) of Viséan and Serpukhovian ages (Kozur and Şenel, 1999; Stampfl and Kozur, 2006), whilst the blocks and clasts are mostly Tournaissian (PL. 8, Figs. 5, 7, 9; PL. 9, Figs. 1-8), Viséan or Serpukhovian. Robertson and Ustaömer (2009b) presented an alternative interpretation where the Incirilebini Fm is a tectonic slice complex rather than a sedimentary mélangé. A tectonic slice located at the base of the siliciclastic series consists of MORB-type (pillow-) basalts (Kozur and Şenel, 1999; Göncüoğlu et al., 2000; Stampfl and Kozur, 2006). A few badly preserved Carboniferous broken rarniform conodonts were identified from intra-pillow fillings of red pelagic limestones. This MORB-type basaltic series could be also seen as a block within the wildflysch.

The siliciclastic wildflysch is directly overlain by quartz-rich sandstones (quartzites with condensed iron-rich horizons), conglomerates, sandstones and graywackes, followed by a thick sequence of dolomites and shallow-water limestones without thermal overprint and rich in Guadalupian fusulinids. According to Şenel et al. (1994) and Şenel (1997), the Middle Permian platform overlying the siliciclastic series belongs to the Nişangahşete Fm and lies unconformably above the Incirilebini Fm. Locally, shallow-water carbonates just at the base of the Nişangahşete Fm yielded a well-preserved fauna of Roadian (= Kuberangadian) age described by Moix (2010) and by Vachard and Moix (in press). These bioclastic floatstones to grainstones are partly microbialitic, accumulatively and built at 5-10 m depth. The assemblage is composed of the cyanobacteria: Girvanella sp., Gakhunella sp., Ramovsia sp.; the calcareous algae (Pl. 3, Fig. 12); Permocalculus sp., Gryporella sp., Mizia sp., Likanella sp., Salopekiella sp., Chapavorella sp., Oligoporella? sp., Kantia? sp.; the algiopspores Chuvashovia sp., Ungaredella? sp.; the foraminifera Tadighytes obscurans Maslov; the smaller foraminifers: Estuberritina sp., Diplolphaerina sp., Insolentitheca sp., Endotetra sp., Tettraxis sp., Climacammia sp., Globivulina sp., Septoglobalivulina sp., Pseudovermiporella nigonica (Endô), P. sp.; the fusulinids: Staffella sp., Nankinella sp., Schubertella sp., Neo fusulinella sp., Skinnerella sp., Cancellina sp., Armenina sp.; plus gastropods, bivalves, cherty micrites, brachiopods, and ostracods.

Elsewhere, neither Roadian nor Wordian were identified above the Incirilebini Fm. On the contrary, shallow-water bioclastic rudstones to grainstones deposited at 5-10 m depth yielded a well-preserved fauna of Capitanian (= Midian) age. The assemblage (PL. 7, Figs. 1-13) is constituted of the calcareous algae Gryporella sp., Mizia sp., Gonionopinopsis sp., Likanella spinosa Milanovic (PL. 7, Fig. 6), Salopekiella velobithana Milanovic (PL. 7, Fig. 4), Kochanskyella sp.; the algaospore Claracrusta sp.; the smaller foraminifers Neoendothyra sp., Endotetra controversa Vachard and Razgallah (PL. 7, Fig. 7), Postendothyra sp., Tettraxis sp., Climacammia sp., Globivulina cyprica Reichel (PL. 7, Fig. 10), G. sp., G. 2 n. sp., Paraglobalivulina sp., Dagmarita sp., Neodiscus sp., Hemigordiospis renzi Reichel (PL. 7, Fig. 1), Rectostipulina sp., Pachyphloia sp. (PL. 7, Fig. 10), Fondonia sp.; the fusulinids: Kahlerina pachytheca Kochansky-Devidé and Ramovs (PL. 7, Fig. 5), G. ovalis Chediya (PL. 7, Fig. 8), Pseudokahlerina? sp. (PL. 7, Fig. 12), Nankinella sp., Sphaerulina cf. croatica Kochansky-Devidé (PL. 7, Fig. 11), Danubara sp., Chusenella cf. cheni Skinner and Wilde (PL. 7, Fig. 9), Verbeekina verbeeki (Geinitz) (PL. 7, Fig. 13), Neoschwagerina ex gr. haydeni (Dutuchew) (PL. 7, Fig. 2), N ex gr. marigartae Deprat (PL. 7, Fig. 3), N. sp.; plus gastropods, brachiopods, and ostracods.

**Ağlıovas Yayla Arc Series**

The Ağlıovas Yayla arc series is found in the highest structural position within the Teke Dere unit (Fig. 6B). It is located at the base of a thick Mesozoic platform and basin series composed of the basal Ağlaç (algal limestones, dolomites and dolomitic limestones) and the upper Babadağ (pelagic micrites, cherty micrites, calciturbidites) formations. Red sandstones and siltstones (Cenger Fm?) represent a distinct horizon at the base of the platform, and cover indistinctly different Permian units of the Tavas Nappe (Monod et al., 1983; Kozur et al., 1998). The section starts with massive Capitanian fusulinid-bearing platform limestones, covered and infiltrated by red sandstones and siltstones (Cenger Fm?). After an interval of non-exposure, the succession continues with green sandstones, brecciated limestones including elements of dolomites, black, gray and white limestones. It is overlain by thin-bedded black fractured limestones, calciturbidites, polygenic conglomerates, a few meters of lavas, green sandstones, again a few meters of lavas and graywackes. This succession is stratigraphically overlain by 5-10 m of Capitanian shallow-water limestones, themselves infiltrated by red sandstones and arkoses. Because of the presence of the red sandstones and arkoses at two different levels within the section, it is not clear if the Capitanian platform at the base is an equivalent of the upper one repeated by thrusting or if the series is bracketed between two individual events of subaerial exposure. In any case, these red siliciclastic deposits are likely to correspond to the Late Triassic Çenger Fm of Monod et al. (1983).

This succession is similar to the unit 4 (in the Teke Dere unit) described by Robertson and Ustaömer (2009b), who described a composite section, which begins with volcanlastic sandstones/conglomerates including basal clasts, continuing with a thick brecciated carbonat interval. There is then a sheared contact with hydrothermally altered basalts, overlain with a stratigraphical contact by volcanlastic sandstones, themselves overlain by ribbon chert. The succession ends with an interval of non-exposure, above which come reddish conglomerates.
Still below the Mesozoic platform and basin series, a small block (3 m thick) of bioclastic floatstone in primary sedimentary contact with lavas could represent an equivalent of the upper part of the section described above (see section 3.2.3). These limestones were deposited in an inner platform environment (10-20 m deep). The faunal assemblage indicates a Roadian age and is composed of the smaller foraminifers *Eotubervitina reitlingerae*, *Tuberitina* sp., *Climacammina* sp., *Globivalvulina* sp., *Nodosinelloides* sp., and the fusulinids *Cancellina* spp., plus uncertain Schwagerinoidea. Elsewhere, de Graciansky (1972, p. 132) described calcarenites in primary sedimentary contact with lavas (diabases) dated as Late Permian. The faunistic assemblage includes *Rauserrla* sp., *Kahlerina* sp., and *Climacammina* sp.

### Köyceğiz Sections

The diabase nappe and the Köyceğiz series form the largest outcrops in the Lycian Nappes. According to Bernoulli et al. (1974), the Mesozoic sequences of the Köyceğiz series conformably overlie the red arkoses of the Çenger Fm, itself unconformably lying on Late Permian limestones. The stratigraphic succession of the Köyceğiz series can be subdivided into five main formations (Bernoulli et al., 1974; Okay, 1989; Rimmelé, 2003): (1) the Gereme Fm is made of thick-bedded limestones and massive dolomites ranging from the Middle Triassic to the Middle Liassic, and containing dasyclad algae (e.g., *Gyroporella* spp., *Palaeodasycladus* spp.). The lithological associations and the faunal/floral assemblages suggest a carbonate platform environment, oscillating from shallow subtidal to supratidal settings. The Gereme Fm is overlain by a thick complex ranging from the late Liassic to the Cenomanian; (2) the Çal Dağ Limestone is characterized by alternating pelagic and turbiditic limestones (partly cherty) reworking neritic organisms. The base of the series includes oolitic limestones with *Protopeneroplis* spp., it continues with Calpionellidae-bearing limestones and the uppermost levels of the Çal Dağ Limestone yielded *Globotruncanina* spp. The sharp lithological change between the Gereme Limestone and the Çal Dağ Limestone marks a sudden deepening of the margin. The reworking of neritic organisms in the calciturbidites indicates that platforms persisted on more marginal parts of the basin; (3) the Cenomanian or Turonian Sirna Breccia often overlies the Çal Dağ Limestone and is found below the Çamova flysch. The breccia is composed of fragments of the underlying formations plus angular fragments of cherts. It provides a characteristic horizon for any correlations; (4) the Sirna Breccia or the Çal Dağ Limestone are overlain by the late Turonian to early Senonian Çamova Fm, which consists of a thick pile of elastic sediments interpreted as flysch deposits. The approximate age is yielded by *Globotruncanina* spp. reworked at the base of the series; (5) the late Campanian to early Maastrichtian (possibly Early Tertiary) Karabörtlen flysch consists of shales, siltstones and sandstones, including exotic blocks of pelagic and shallow-marine limestones, radiolarites, lavas, and metamorphic rocks. Neither serpentinities nor peridotitites were found. The flysch is overlain by the “Diabase Nappe” or at places by Middle Miocene alluvial and shallow-water deposits. The Haticana Dağ series represents a lateral variation of the Köyceğiz series and comprises Permain to Liassic shallow-water limestones (the lowermost detrital and volcanic sequences being absent), Liassic to Cenomanian pelagic limestones, Turonian flysch and Late Cretaceous to Palaeocene flysch (de Graciansky, 1972).

In the Bozburun Peninsula, Collins and Robertson (1999) observed Late Triassic volcanic rocks, which are believed to represent the lowest exposed stratigraphic level of the Köyceğiz-type sequence. The Turunç succession (Collins and Robertson, 1999) starts with pillow basalts (transitional MORB-type) whose interstices are filled by micritic carbonate with pelagic bivalves and radiolarians. The volcanic rocks are overlain by pelagic limestones and sandstones, and by calcareous sandstones alternating with volcaniclastic sediments. This mixed sequence is stratigraphically overlain by neritic limestones of inferred Late Triassic/Early Jurassic age. In the Bayır köyü succession (Collins and Robertson,
carbonates. In the Hacticeana Dağ series, the base is characterized by Late Triassic red arkosic sandstones that lie unconformably on various Permian levels (Monod et al., 1983). The Innice series as defined by de Graciansky (1972) is characterized by Maastrichtian calcarenites followed by an alternation of pelagic limestones, calcareous breccias of Late Eocene age (Pliobarian) reworking Maastrichtian shallow-water fossils. It then continues with a polygenic breccia reworking Late Cretaceous, Palaeocene and Early Eocene fossils. It is followed by clayey limestones, and then by ophiolite-derived clastics including pebbles of diabases, amphibolites and sedimentary rocks. De Graciansky (1972) correlated the Innice series with the Köyceğiz series, whereas Collins and Robertson (1998, 1999) correlate it with the Teke Dere thrust sheet.

In Agılıçovaş Yayla area, a thick Mesozoic sequence conformably overlies the red arkosic sandstones (Çenger Fm?). By definition, it corresponds to the Hacticeana Dağ series of de Graciansky (1972). Following partly the opinion of Monod et al. (1983), the Çenger Fm is considered as Rhaetian to Early Liassic by Şenel et al. (1994) and Şenel (1997) and covers indistinctly different older units of the Tavas Nappe (Kozur et al., 1998). This continental to shallow-marine molasse-like sedimentation is followed by the Liassic Ağaçlı Fm (algal limestones, dolomites and dolomitic limestones) including a late Liassic Ammonitico Rosso. This shallow-Marine episode, except the Ammonitico Rosso, corresponds to the Gereme Fm described above (see section 3.3) and in addition presents evidence of oolitic limestones at its base. The sedimentation continues with the late Liassic to Maastrichtian Babadağ Fm (pelagic micrites, cherty micrites, calciturbidites) corresponding to the Çal Dağ Limestone. After an unconformity, the deposition of a Late Palaeocene to Lutetian flysch counting several members ends the series (Şenel, 1997). This detrital episode presents obvious similarities with the Çamova-Karabörtlen assemblage described above. An equivalent of the Sirna Breccia could be seen in one of these members represented by a breccia containing limestone and chert fragments.

**DISCUSSION**

Most of the units found in Agılıçovaş Yayla, and more generally in the Lycian Nappes, can be compared with similar sections and units in Turkey and in the adjacent areas of Greece. In this section, we discuss the series described above and try to place them in time and space in the Tethyan realm (Fig. 11). According to the previous descriptions, it emerges that the tectonic pile in southwestern Turkey is highly composite, and partially documents the Palaeoceanthyan, Neotethyan and Huğlu-Pindos geological histories. Thanks to extensive palaeontological determinations, we can constrain the depositional timing of these series, leading de facto to accurate comparisons. The terranes involved in the geodynamical evolution of the Turkish segment of the Tethysides are characterized by contrasting geodynamical evolution, and can be replaced in the larger paleotectonic frame of the western Tethyan realm. We give below the main steps of this geodynamical evolution, which could be helpful for the understanding of the discussion; and the reader may refer to Stampfli and Kozur (2006) and Moix et al. (2008a) for further details.

The Late Carboniferous Variscan orogeny was formed after the collision of Gondwana and Laurussia-derived terranes induced from the progressive closure of the Rheic Ocean and the concomitant opening of the Palaeoceanthyan south of it. At that time, the Pelagonian, Anatolian and Sakarya GDUs were amalgamated to the southern active margin of Eurasia. The northward subduction of the Palaeoceanthyan below the Eurasian margin was the triggering mechanism detaching ribbon-like terranes along the northern margin of the Gondwana. It also resulted in the opening of the Neotethys in Early Permian time. From that time onward, the southward retreat of the Palaeoceanthyan slab caused the collapse of the Variscan Cordillera. The opening of back-arc basins within the southern margin of Eurasia (e.g., Huğlu-Pindos Ocean) detached several GDUs. The Late Triassic Eocimmerian event was completed when post-Variscan Eurasia-derived GDUs (e.g., Anatolia) collided with Gondwana-derived GDUs (e.g., Taurus). This crucial tectonic event in the Tethysides is outlined by...
widespread large-scale unconformities found along the northern margin of the Taurus GDU and marked by large flysch to molasse deposits frequently sealed by Liassic platforms. Finally, the last amalgamation corresponds to the Alpine cycle and is marked by a quasi-synchronous obduction of SSZ-type ophiolites during the Late Cretaceous and by a general shortening of pre-existing units by nappe emplacements. Most of these units were later re-displaced during the Tertiary convergent and then extensional movements.

Platform Units

As said in the introduction, previous correlations were mostly based on similarities between the most autochthonous external platform of Turkey and Greece. The Beydağları parautochthon of the Lycian Nappes is the most external domain of Turkey and correlates with the pre-Apulian units and the Paxos-Xanthe-Kastellórizo zone of Greece (e.g., Thiébault, 1982). According to Bernoulli et al. (1974), the most autochthonous carbonate platform sequence appearing near Gökçe is nearly identical with the series of the southern Beydağları. This comparison can be extended to the Aegean islands of Chamili, Saforà and Di Adelphi. Significant differences between these “autochthonous” units are interpreted to be the result of the obliquity of Mesozoic palaeogeography and Alpine tectonics. Different plate tectonics syntheses from the East-Mediterranean domain attempted to fit these platform units in a coherent palaeogeography. According to Brunn et al. (1976), they represent the northern border of Gondwana, whereas Biju-Duval et al. (1977) consider them as the southern border of an Apulian-Anatolian plate. These platform units are also regarded as part of the Anatolian microcontinent, representing the southern margin of a “northern Neotethyan Ocean” (Dercourt et al., 1986; Robertson and Dixon, 1984; Robertson et al., 1996; Sengör and Yilmaz, 1981) or the extension of the Afro-Arabian plate by Ricou (1980). The Beydağları are also considered to be a typical Cimmerian Block sensu Şengör (1979), forming the Cimmerian Greater Apulia terrane (Stampfl et al., 1991, 2003) whose eastward continuation is the Taurus GDU (Moix et al., 2008a).

The Beydağları general stratigraphy as described above is not recognizable everywhere in the massif. Whereas the Late Triassic to Late Cretaceous platform development and the Senonian to Danian pelagic interval seem to be homogeneous through the entire massif, the presence and the age of the ophiolitic olistostrome considerably differ from one part to another. In general, these olistostromes were deposited during the Palaeocene (post-Danian) to early Ypresian (ante-Illerdian) interval, but some sections show no evidence of ophiolitic material on their top, e.g., south of Korkuteli, in the Gökçe window (Gutnic et al., 1979). The absence of intercalations of ophiolitic olistostromes would suggest that the nappes have not passed over, or even have not reached this external domain. The new Pozan Göl section described above (see section 2.1.1) in the Beydağları shows the input of ophiolitic debris already during the early Senonian, much earlier than expected. This could suggest a more internal position for this part of the Beydağları.

In the Menderes Massif, the unconformity between the “core” and the “cover” series is often interpreted as a transitional facies from the underlying schists to the upper marbles (Şengör, 1984; Özer et al., 2001). The identification of a basal metaconglomerate in the transition from “core” to “cover” series, together with Triassic magmatic events, could be seen as the signature of the Eocimmerian event related to the closure of the Palaeotethys (e.g., Dora et al., 2001; Koralay et al., 2001). Above the conglomerates, shallow-water limestones were deposited from the Late Triassic to the Campanian. The flexuration of the massif is marked by the deposition of Scaglia-type limestones during Campanian-Maastrichtian times. An ophiolitic olistostrome deposited during the
FIGURE 10. a, Chondrite-normalized REE patterns for samples 149/06a, b and c (Hoffman, 1988). The MORB plot is from Saunders and Tarney (1984). b, Primitive-mantle-normalized multi-element spidergrams of samples 149/06a, b and c (Hoffman, 1988). The MORB plot is from Saunders and Tarney (1984), the OIB plot is from Hoffman (1988).
late Maastrichtian/Early Palaeocene to Late Eocene interval (Bozkurt and Oberhansli, 2001 and references therein) is found above the deep-water strata. At places, Palaeocene and Ypresian sediments were found below the ophiolitic olistostome (Boray et al., 1973), and Gutnic et al. (1979) reported Early Eocene ages (Nummulites spp.) for the uppermost part of the Menderes Massif (Kirişçalı marble) below the ophiolitic olistostome. Other “cover series” of the Menderes Massif, e.g., the Çarık Gölü and the Tekkely Tepe sections of Sarp (1976), are characterized by a Late Cretaceous ophiolite obduction (see also Özer, 1998). Because of the early flexure of the platform and the Late Cretaceous obduction event, we do not regard these “cover series” as Menderes-Tauric sedimentary cover of a Pan-African basement, but as slivers of metamorphic Anatolian-derived nappes at the base of the Lycian Nappes system.

**Neotethyan Series**

The Ağlıovaş Yayla autochthonous and Nif series described in this paper are characterized by a platform succession ranging from the Sakmarian to the Middle-Late Triassic (Fig. 5). The lower parts of the sections correspond to the Akkavak Fm, whereas the upper parts may be assigned to the Sartaş and/or Karapinar formations. In the investigated part of the Tavas Nappes, the Late Devonian Sakaz Fm was not recognized, and only the upper part of the Middle Pennsylvanian (Moscovian) Kiloluk Fm was identified below the Permain-Triassic series. De Graciansky (1972) described several outcrops presenting Moscovian bioclastic limestones, dolomites and dolomitic limestones (i.e., the Kiloluk Fm of Senel, 1997). Because of the misinterpretation of some fusulinids, the so-called “Moscovian” of de Graciansky (1972) is Kasimovian in age, the true Moscovian being absent or limited to its uppermost part.

The ~40 Ma hiatus between the Sakmarian and the Middle-Late Triassic is outlined by the deposition of quartzites, and/or locally sandstones. The flexure of the platform in Middle Triassic times is outlined by the deposition of nodular, partly cherty limestones. The upper part of the platform is often punctuated by calciturbidites and debris-flow deposits, shortly preceding the deposition of a wildflysch from the early Carnian onward. This detrital episode corresponds to the Belenkavak Fm, and the latter locally includes various blocks (olistoliths) of shallow-water Permian limestones, quartzites and breccias. The Ağlıovaş Yayla seamount series is found above the Permian to Middle-Late Triassic platform and could be also interpreted as a larger block within the wildflysch. The presence of Late Triassic carbonate beds interpersed in graywackes above the seamount might be in favor of this interpretation. On the contrary, the large lateral extent of the seamount series above the Karadag unit would rather suggest a tectonic slice within the Teke Dere successions. It is to note that no remnants of Palaeotethyan material (e.g., seamount) were found so far in the equivalent of the Belenkavak Fm in the upper part of the section logged south of the Nif Polje. This could be due to a different position of the series within the Tauric passive margin.

In Turkey, the discovery of two new localities rich in *Pseudofurnishius murcianus* and one new locality rich in *Theelia tuberculata* Kristan-Tollmann is critical for any palaeogeographic reconstructions. The *Pseudofurnishius murcianus* conodont fauna was assigned to different late Anisian to Cordevolian ages (e.g., van den Boogaard, 1966; Kozur and Mosler, 1971, 1972, 1973; Hirsch, 1973; Kozur, 1972, 1980, 1993; Kozur and Simon, 1972; Kozur et al, 1974; Ramovš, 1977, 1978; van den Boogaard and Simon, 1973; Eicher and Mosher, 1974; Hirsch anderry, 1974; Nicora, 1981; Bandel and Waksmundzki, 1985; Gullo and Kozur, 1991; Marquez-Aliaga et al., 1996). Finally, a middle or late Longobardian to Cordevolian age of the *P. murcianus* fauna was generally accepted (see discussions in Kozur, 1980, and Gullo and Kozur, 1991). Kozur (1980) pointed out that in the Cordevolian only *Pseudofurnishius murcianus* occurs, a sub-species on which only the platform rudiments are present on the inner side of the blade, whereas the outer side has neither platform rudiments nor lateral denticles. In the middle and late Longobardian, *Pseudofurnishius* with platform rudiments or denticles on the outer side of the blade are present (*Pseudofurnishius murcianus praecursor* Gullo and Kozur).

The first *Pseudofurnishius* of Turkey were found by Gedik (1981) and Nicora (1981). Nicora (1981) found a rich *Pseudofurnishius* fauna in the Tareaç Limestone of the Geyik Dağ autochthonous series (Pisidian Triassic) exposed west and southwest of Seydişehir in southern Turkey. The Triassic rocks rest on Cambrian-Ordovician strata and start usually with Anisian shallow-water deposits overlain by ammonoid- and conodont-bearing deeper water sediments of Ladinian and early Carnian age (Monod, 1977). The Tareaç Limestone was deposited on the southern part of the Tauric Autochthon, south of the Triassic Apulian-Tauroide High, where either no Triassic was deposited or the deposition began during the Rhetaian. During the Triassic up to the Cordevolian, the Apulian-Tauroide High separated the Neotethyan fauna with the Longobardian to Cordevolian *Pseudofurnishius murcianus-Theelia tuberculata* fauna toward the south and the northern Tetynyan fauna, which occurs up to the Cordevolian in the Hığlu-Pindos Ocean and its shelves (including the Antalya Nappes), to the north. As pointed out by Kozur (2000), during the Julian the Apulian-Tauroide High was broken, and since this time the faunas of the Neotethys and these of the Tetynyan areas (Palaeotethyan back-arc) immediately north of the Tauric Autochthon became almost identical. Nicora (1981) pointed out that the morphological character of the *Pseudofurnishius* fauna from the Tareaç Limestone indicates a Cordevolian age. We agree with this age because all the material of Nicora (1981) belongs to *P. murcianus murcianus* and partly to *P. murcianus* n. subsp. B Gullo and Kozur, which is restricted to the Cordevolian according to Gullo and Kozur (1981).

Our fauna from the top of the Karapinar Fm and the immediately following base of the Belenkavak Fm of the Karadag unit consists of dominating *P. murcianus murcianus* and few *P. murcianus* n. subsp. B Gullo and Kozur. Therefore, it belongs clearly to the Cordevolian upper *P. murcianus Zone*, as is also the case for the *Pseudofurnishius* fauna of the Tareaç Limestone (Pisidian Triassic) described and correctly dated by Nicora (1981). The ostracods show moderate water depths below the storm wave base. Only in this level (and at still greater water depths) sculptured Bairdiidae occur, in which nodes and ribs disintegrated into numerous hollow spines (Pl. 5, Fig. 6). However, typical deep-water ostracods are missing. *Polycopsis* n. sp. ex *gr. cincinattata* (Apostolescu), a *Polycopsis* with narrow high ribs, occurs in moderately deep water below the storm wave base and in deep water. The presence of several typical sculptured Bairdiidae without disintegration of the nodes and ribs indicates that the water depth was around 100 m, estimating warm water in a water depth at 70 to 100 m or not much deeper.

*Pseudofurnishius murcianus* cannot be used for palaeoecological interpretations. It is one of the few surface dwellers among the Triassic conodonts, which occurs in rich monospecific faunas in anoxic sediments. However, it occurs also in oxygen-rich sediments (red pelagic limestones with some red chert intercalations in the Sosio Valley in Sicily). *P. murcianus* occurs also in very shallow water deposits, such as gypsum-bearing dolomites in Spain, but also in deep-water sediments, like in the Vâlani Nappes in Romania or in the late Ladinian and Cordevolian of the Sosio Valley (Kozur, 1979; Gullo and Kozur, 1991). On the other hand, this occurrence of *P. murcianus* in all different facies, in which conodonts may occur, often at the tolerance boundary for conodonts in monospecific faunas, makes this species an excellent palaeoecographic marker.

Especially interesting is the palaeogeographic significance of the occurrence of the *Pseudofurnishius murcianus* fauna in the Karadag unit. The Triassic part of the latter is similar to the Pisidian Triassic of the southern Tauric Autochthon with *Pseudofurnishius* and *Theelia tuberculata*. This fauna is characteristic for the Westmediterran-Arabian faunal province of Kozur and Mostler (1971, 1972, 1973, finally re-defined by Kozur, 1980, junior synonym: Sephardic faunal province of Hirsch, 1973). Whereas this faunal province was in the beginning mainly found
in the western Mediterranean area (e.g., Spain, Baleares), subsequently it could be shown that it occurs in the entire Neotethys south of the Cimmerian microcontinent (e.g., Gullo and Kozur, 1991; Kozur, 2000; Stampfl and Kozur, 2006). Thus, the southern Tauric-Autochthon formed by the Pisidian Triassic and the Karadağ unit of the Lycian Nappes belongs to the northern shelf of the Neotethys. The early Carnian sediments rich in Pseudofurnishius murcianus and Theelia tubercul are typical indicators for the Neotethyan domain of the Westmediterranean-Arabian autochthonous and Nif seamount compositive section contains the most complete unit). The Teke Dere part of the Tavas Nappe in the Ağlıovaş area overthrust the Tauric-Autochthon during the Cimmerian orogeny and, after this event, the Rhetaian to early Liassic Ceng Cener Fm deposited and sealed the thrust. Importantly, the Ağlıovaş composite section is the only section in Turkey (Fig. 4) where a very complete Palaeotethyan sequence (Teke Dere unit) overlies tectonically a marginal Neotethyan sequence (Karadağ unit).

Kozur (2000) reported the occurrence of Theelia tuberculata in the Tarasçı Limestone, in which Nicora (1981) found Pseudofurnishius. The Theelia tuberculata fauna is characteristic of the same area in which Pseudofurnishius occurs (Westmediterranean-Arabian faunal province). We have now found a second occurrence of the Theelia tuberculata (Pl. 5, Fig. 8) fauna in limestone pebbles of a polygenic Late Triassic molasse-type conglomerate at the Saklıkent resort in a peculiar unit of unknown tectonic position below the Upper Antalya Nappes. Other pebbles in the same conglomerate contain Pseudofurnishius, plus several Palaeozoic shallow-marine and pelagic pebbles. Before the recognition of palaeogeographic limits for the Theelia tuberculata fauna, the latter was regarded to be restricted to the Cordevolian in the stratigraphic level of the Cordevolian Theelia koeveskallensis Zone (Mostler, 1973). However, Saddedin and Kozur (1992) have proven that the Theelia tuberculata fauna occurs only in the Westmediterranean-Arabian compositive province in the shelf seas of the Neotethys. They could also prove that the Theelia tuberculata fauna has a somewhat longer stratigraphic range as formerly assumed, ranging from the late Longobardian to the Cordevolian. The Theelia tuberculata fauna is a typical shallow water fauna. Except for the dominating Theelia tuberculata (Pl. 5, Fig. 8), Theelia sp. (Pl. 5, Fig. 9) and Acanthotheelia c. oertlii Kozur and Simon (Pl. 5, Fig. 10) occur. The latter is also a representative of the Theelia tuberculata holothurian sclerite fauna (Kozur and Simon, 1972). As in our fauna there are only holothurian sclerites of the Theelia tuberculata fauna, and the age of pebbles is Longobardian or Cordevolian. The source area for the pebbles must be south of the Apulian-Tauride High on the marginal shallow shelf of the Neotethys. The shallow water limestones of the source area must be rich in Theelia tuberculata, which even dominates in pebbles. As the rich holothurian and conodont faunas of the Longobardian and Cordevonian of the Antalya Nappes do not contain either any holothurians of the Theelia tuberculata fauna or Pseudofurnishius murcianus, a derivation from the Antalya Nappes and from the Huglu-Findoş Ocean and its shelves or any other origin north of the Tauric Autochthon can be excluded.

The Karadağ unit is the lowest tectonic unit of the Tavas Nappe and represents the most relative autochthonous in the Lycian Nappes. It is a carbonate platform ranging (with several, partly long gaps) from Late Devonian to Middle/Late Triassic and represents a typical Devonian-Carboniferous shallow-water Gondwana shelf development (de Graciansky, 1972; Kozur et al., 1998; Stampfl and Kozur, 2006). The Palaeozoic development of the Karadağ series is also comparable to similar sections in the Alborz range in NE Iran (Stampfl, 1978). The large hiatus of about 40 Ma between the Sakmarian and the Middle Triassic could be compared to a rift shoulder related to the Neotethyan (= East-Mediterranean) rifting. We have proved that the Late Triassic succession of the Karadağ unit shows the same faunistic character as the Geyik Dağ autochthon, with identical conodont and holothurian species. Additionally, the Ladinian to early Cordevolian Karapinar Fm in the Lycian Nappes could be an analogue of the Tarsaçı Fm in the Geyik Dağ autochthon, and the Carnian Belenkavak Fm might be compared with the flysch-like Sarpıar Dere Fm, although the latter was deposited most likely in a piggy-back basin.

Thus, we regard the Ağlıovaş Yayla autochthonous and Nif series as being part of the southern margin of the Taurus GDU and we consider the Karadağ unit as part of the Cimmerian Taurus terrane (Moix et al., 2008a), either in situ or displaced during the Late Cretaceous-Tertiary final setting of the Lycian Nappes. The Eocimmerian event is confirmed by the fact that several of the described units are unconformably overlain by a Late Triassic red continental sequence (de Graciansky, 1972), interpreted as Cimmerian molassic-type continental deposits. Similar clastic deposits are known in the Taurus parautochthonous series, e.g., the Çağr Fm (Gutnic et al., 1979) and the Late Triassic Çamiç Member of the Gevne Fm ( Özgül, 1997). Globally, the Eocimmerian event is identified all along the Taurus GDU, marked by widespread clastic continental deposits, by large-scale unconformities, and by pre-Jurassic thrustings sealed by extensive Early to Middle Jurassic carbonate platforms unifying the composite Anatolian-Tauric domain (Moix et al., 2008a).

**Palaeotethyan Series**

The Ağlıovaş composite section contains the most complete Palaeotethyan fauna of Turkey. From the descriptions above, it appears that the Teke Dere succession cannot be seen as a single unit, but as a composite unit containing different parts of the Palaeotethyan successions. All together, the Teke Dere unit potentially represents accretionary series tectonised in a prism and/or fore-arc environment (Kozur et al., 1998; Kozur, 1999; Kozur and Senel, 1999; Stampfl and Kozur, 2006; Moix, 2010; Vachard and Moix, 2011; Vachard and Moix, in press). The Teke Dere series always overlies tectonically the Karadağ unit. The absence of Jurassic to Tertiary deposits in the Karadağ unit could be the result of the pre-Jurassic emplacement (Eocimmerian event) of the Teke Dere unit on the latter (Erkman et al., 1982). The fact that several Permian units are unconformably overlain by Late Triassic red arkosic molasse-like continental sequences also supports Late Triassic orogenic movements, and could be correlated with similar events through the Taurus terrane (de Graciansky, 1972; Erkman et al., 1982; Monod and Akay, 1984; Moix et al., 2008a).

**Seamount**

As said above, the Ağlıovaş Yayla seamount series could be seen as a tectonic slice at the base of the Teke Dere imbricate structures. The different sections logged in Ağlıovaş Yayla indicate almost the same age for the OIB-type lavas (earliest or middle Kasimovian) and the associated Gzelbian to early Artinskian platform rocks are more or less developed. Palaeogeographical affinities can be deduced from the rich and diverse assemblages of foraminifers and algae (Moix, 2010; Vachard and Moix, 2011; Vachard and Moix, in press). From the Kasimovian to the Sakmarian, the faunal affinities of the seamount are extensively shared with the Carnic Alps, Karawanken, Croatia and also with the Aladag unit in southern Turkey. The early Artinskian is relatively particular, without faunal affinity with the Carnic Alps, but it can be compared with Hydra (Greece) and Istria (Italy). The Roßdian presents biogeographical affinities with the Darvaz, northern Pamir, and the Sakarya zone of Turkey. Elsewhere in Turkey, Palaeotethyan seamounts were recognized in the Sakarya zone, between the Istanbul and Zonguldak zones to the north and the composite Anatolian–Tauric domain to the south. The basement of the Sakarya zone consists of a widespread Triassic subduction-accretion series, called the Karakaya complex in its western part (Okay et al., 1996). The latter comprises two main tectonostratigraphic units, the lower Niğde unit of Early to Middle Triassic age (Kaya and Mostler, 1992; Kozur et al., 2000) and the upper Hodul unit of Late Triassic age (Okay and Altiner, 2004), both stratigraphically overlain by Jurassic platforms. The highly deformed and metamorphosed Niğde unit is considered to represent Permo-Triassic oceanic plateau (Okay, 2010).
FIGURE 11. Palinspastic maps of the Tethyan realm for the Late Triassic (230 Ma: above) and the Late Carboniferous (300 Ma: below) periods (Lat/Long WGS84 coordinates system). In black are the dispersed parts of Turkey (by courtesy of C. Hochard and G.M. Stampfl, 2009 unpublished).
In Central Iran, a “Variscan” accretionary wedge sheds light on the evolution of the Palaeotethyan northern margin (Bagheri, 2007; Bagheri and Stampfli, 2008). This wedge is composed of (1) the Carboniferous-Middle Permian Anarak and Kabudan seamounts accreted during the Permian, and (2) the Permo-Triassic Doshakh accretionary complex, which was emplaced before the final closure of the Palaeotethys. This “Variscan” accretionary complex is tectonically sandwiched between the Turan GDU (Eurasian-derived) and the Cimmerian Central Iranian Blocks (Yazd, Tabas and Lut blocks), derived from Gondwana. This configuration is in many points similar to the Ağlıyovas Yayla composite section, the autochthonous series belonging to the Taurus GDU (Gondwana-derived) and the Teke Dere imbricate thrust sheets belonging to the Eurasian realm.

**Active Margin Environment**

The Mississippian wilddyslych-like Ağlıyovas Yayla siliciclastic series belongs clearly to the Teke Dere imbricate thrust sheets. As stated by Stampfli and Kozur (2006), the Incirbeleni Fm comprises some intact successions, and the presence of these mixed lithologies within turbiditic siliciclastic sediments could be seen as a fore-arc or an accretionary-type sequence (in upper plate position). The ages found both in the matrix and in the elements indicate that the subduction/accretion of the Palaeotethyan sea floor began at least in the Viséan, and most probably during the Middle Permian Anarak and Kabudan seamounts accreted to the north. The siliciclastic Karamaz “Fm” was first defined by Eren et al. (2004). There, different kinds of metamagmatic rocks show MORB, continental arc and within plate characteristics. The Palaeozoic units are covered unconformably by Triassic to Cretaceous metasedimentary units. The Palaeozoic sequences are interpreted to represent the northern Palaeotethys passive, then active margin. The northward subduction of the Palaeotethys Ocean from the Carboniferous onward induced the development of a magmatic arc and fore-arc sequences (Carboniferous-Permian). The following Triassic sequences are seen as the signature of back-arc opening and detachment of the Anatolian GDU from the southern Eurasian active margin.

In the western end of the Eastern Taurides, the Cataloturan Nappe (Aladag Mountains) is imbricated with ophiolites and other Palaeozoic-Mesozoic series during its Late Cretaceous emplacement. The basal part of the Cataloturan Nappe is known as the Nohutluk Fm and is characterized at its base by Mississippian deep-water sediments made of cherts and volcanic/ volcanioclastic rocks of late Tourmaisian/early Viséan age (Tekeli et al., 1984; Göncüoğlu et al., 2007). The upper part of the Nohutluk Fm is made of shallow-water limestones of late Viséan age (Okaycucu and Vachard, 2006). According to Kozur et al. (1998), the Nohutluk Fm occupies a similar tectonic position as the Tasav Nappe. However, the general succession could be better compared with a Carnic-type evolution (e.g., Venturini et al., 2009), which represents a Palaeotethyan northern margin development.

Remnants of the Palaeotethys suture zone in the internal and external Hellenides have been outlined by Stampfli et al. (2003). Some sequences correspond to Triassic fore-arc basin (Tyros), to accretionary prism remnants (Arna) or to accretionary prism back-stop (Sitia). The Talea Ori-Mani and Phyllite Quartzite domains of the external Hellenides represent the Palaeotethys southern margin and slope, whereas the northern margin corresponds to the Pelagonian cordillera characterized by magmatic activity in Late Carboniferous times.

Although the exact tectonic position of this peculiar series still remains uncertain, the Ağlıyovas Yayla arc series is also seen as a Palaeotethyan slice within the Teke Dere imbricate structures. It shows Capitanian shallow-water limestones on top of an alternation of calciturbidites, sandstones, lavas, graywackes and conglomerates. This Capitanian platform is in turn infiltrated by red sandstones and arkoses, at the base of a thick Mesozoic pile related to the Huglu-Pindos Ocean. Other pieces of this succession are found as dismembered units, in the same tectonic position below the Mesozoic platform. At places, the age of the lavas is noticeably older and the determined taxa yielded a Roadian age. The sedimentological aspect and facies succession of these series suggest a deposition in a fore-arc or arc environment, therefore situated in an upper plate position. In this case, the Teke Dere imbricate structures would include also a remnant of the Palaeotethyan arc, which is so far the missing piece of the puzzle. However, this interpretation needs to be still proven by additional investigations (e.g., geochemistry of the lavas, petrology of the sandstones). The Capitanian assemblages found in a few levels within the series look like typically Neotethyan with strong Indosinian influences. Paradoxically, the algal microflora has a north Palaeotethyan affinity and is especially known in Croatia (ten common species) but scarcely known until northeastern Thailand (Vachard and Moix, in press).

**Huglu-Pindos Series**

Non-metamorphic remnants of the Huglu-Pindos Ocean are significant to achieve correlations between the Hellenic system to the west, and the Anatolian-Tauric one to the east. In this context, Pindos-type series identified from Greece to Turkey bring strong constraints for any plate tectonic reconstructions in these regions. Various geological syntheses in Greece, extending occasionally to western Turkey, allow characterizing the Pindos-like sequences in continental Greece (Pindos series), in the Peloponnese (Olonos series), in Crete (Ethia, Mangassa and Lentas series), in Karpathos (Xindothio series), in Rhodes (Prophitos Ilias series), and in Tilos (Kreati series). Both the tectonic position and a high convergence of facies successions suggest that the classical Pindos series of Greece are an equivalent of the Köycegiz series in the Lycian
Nappes. Although reconstruction of stratigraphic sequences is hampered by small and discontinuous outcrops, the Köyceğiz series in southwestern Turkey extends in several islands of the southeastern Aegean Sea, like Symi, Tilos, Chalki, Kos, Rhodes, Karpathos and Crete (Bernoilli et al., 1974). In Greece, the Pindos units originated along the northern border of the Siťia-Pindos terrane of the external Hellenides. Most of the nappes found in southern Turkey have their origin along the northern margin of the Anatolian terrane, which forms the eastward prolongation of the Siťia-Pindos terrane. Characteristic series belonging to these nappes are the Köyceğiz series in the Lycian Nappes (Bernoilli et al., 1974), part of the Antalya Nappes including a flexure during the Campanian (Moix et al., 2009), the Hugu and Boyal Tepe units in the Baysar–Hoyran Nappes (Gutnic et al., 1979; Andrew and Robertson, 2002), some exotic sequences found at the base of the Mersin ophiolite (Moix et al., 2007), and comparable sequences found in Elbisian (Tekin and Bedi, 2007a, b). Hence, the passive margins of both the Anatolian and Siťia-Pindos terranes represent the southern margin of the Triassic Palaeoetethyan back-arc Hugu-Pindos Ocean (Moix et al., 2008a), the Hugu part of it being in Turkey and the Pindos part in Greece.

The Pindos (-Onos) series in continental Greece and Peloponnese were studied in detail by Fleury (1980), and later synthesized by Degnan and Robertson (1998). In Greece, the Pindos domain is located between the Gavrovo-Tripolitza platform (Greater Apulia) and the Pelagonian units, and is usually characterized by a continuous sequence of pelagic facies from the Late Triassic to the Palaeocene, followed by a Palaeocene–Oligocene flysch (e.g., Fleury, 1980; Richter and Müller, 1993). The evolution of the Hugu-Pindos Ocean and its margins is outlined by five main depositional events, often mixed together: (1) a basal part characterized by a mainly Carnian (Middle to Late Triassic at places) flyschoid formation, called “détritique triasique” by Fleury (1980) in continental Greece. In the Peloponnese, Degnan and Robertson (1998) proposed the name Priolithos for this formation and showed the orogenic origin of the re-sedimented clasts. This base includes a localized to widespread occurrence of volcanic, volcanioclastic and detrital rocks; (2) Late Triassic cherty limestones and Hallstatt Limestones associated with the detrital and/or the volcanic units; (3) a Mesozoic to Palaeogene continuous pelagic sequence; (4) the occurrence of a Late Cretaceous flysch; and (5) another flysch episode during the Palaeogene.

The Hugu-Pindos signal is separated into a Pindos sub-signal on the Greek transect and a Hugu sub-signal on the Turkish transect (Moix and Stampfl, 2009). The Pindos sub-signal is characterized by shallow water limestones from the Permian to the Anisian, followed by a rapid deepening during the middle Carnian, or already at places during the late Ladinian. Extensive mafic volcanism occurs during the middle to late Carnian interval. Stampfl et al. (2003) have shown the presence of early to middle Carnian basaltic lava flows and tuffs in the Pindos basal sequence (i.e., Priolithos Fm) in eastern Crete. RIE distribution and other discriminative diagrams show a dominant volcanic arc affinity with a minor E-MORB signature, confirming a Carnian back-arc position for the Hugu-Pindos Ocean, as formerly suggested by Pe-Piper and Piper (1984). A similar volcanic episode was recognized at the base of the Köyceğiz series in southwestern Turkey (Collins and Robertson, 1999). Widespread siliciclastic deposits during the middle Carnian are either interstratified or immediately followed by pelagic sediments in late Carnian time. The pelagic conditions persist throughout the Mesozoic and stop with the 2nd Pindos flysch during the Palaeocene/Oligocene. The Sirna Breccia forming a relevant horizon in the Köyceğiz series can be seen as an equivalent of the Pindos 1st flysch. The Pindos sub-signal is also identified in sections in the Peloponnese, where late Cordovelian (Trachyceras noah Zone) pelagic limestones associated with laves were recognized (Tsolfias, 1969; Degnan and Robertson 1998). The early Carnian Trachyceras noah Zone was also identified in nodular limestones in Crete, probably in blocks within the Eocene 2nd Pindos flysch (Creutzburg et al., 1966; Tsolfias, 1972). The Hugu sub-signal is marked by a rapid deepening during the middle Carnian above shallow water limestones. The middle to late Carnian interval is characterized by the deposition of widespread mafic and intermediate volcanism (Pietra Verde-like green tuffs), interspersed by pelagic and reworked limestones. The pelagic sedimentation continues during the Late Triassic (cherty limestones), and passes to a locally well-developed Toarcian Ammonitico Rosso, itself followed by Dogger radiolarian cherts. Like the Sirna Breccia, the Toarcian Ammonitico Rosso forms also a relevant horizon, which can be followed over wide areas in southern Turkey and is also present in the Liassic Ağçu Fm described in the Mesozoic succession of Ağhuvaş Yayla.

Here below, we aim to propose accurate correlations of the Köyceğiz-like series with sequences in Greece and Turkey. In eastern Crete, the Mangassa series comprises in its lower part Late Triassic detritism interstratified with pelagic limestones which yielded Halobia spp. and Aulacoceras spp., plus foraminifers (Bonneau and Zambetakis, 1975; Zambetakis-Lekkas, 1977). Reworked Famennian (Late Devonian) pelagic conodonts have been also found (Bonneau and Aubouin, 1987). This implies a plausible derivation of parts of the Mangassa series from the Palaeoetethys. This is consistent with the models proposed by Stampfl and Kozur (2006) who argued that the Hugu-Pindos Ocean is a Palaeoetethyan back-arc which opened in the Palaeoetethyan arc, making therefore possible a reworking from the accretionary prism. In the Mangassa series, pelagic limestones in the lower part yielded Epigondolella rigoi Kozur and E. quadrata Orchard, characteristic of the early Laciian interval. Similar pelagic limestones including Epigondolella rigoi Kozur were found interstratified within sandstones at the base of the Lentas unit in southern Crete (Moix, 2010; Vachard et al., in press). In Karpathos, the Xindothio unit occupies the highest tectonic position. The lower part of this unit comprises pelites and marls with ammonoids, early Norian pelagic Halobia-bearing limestones, sandstones and microconglomerates including Aulacoceras sp., followed by a Mesozoic pelagic sequence (Davidson Monett, 1974). Conodonts in the pelagic limestones at the base of the unit yielded Epigondolella quadrata Orchard, E. rigoi Kozur, Noehindeodella dropla (Spasov and Ganev), and Norigondolella navicula (Huckriede), characteristic of the early to middle Laciian interval. Hallstatt Limestones of the Carnian-Norian boundary (Carnepigondolella orchardi Zone) related to the Xindothio unit have been identified. However, a primary contact between these pelagic limestones and the rest of the Xindothio series can neither be proven nor excluded.

In Rhodes, the Prophitis Ilias unit is made of Late Triassic flyschoid deposits with Aulacoceras sp., marls and Halobia-bearing pelagic limestones, followed by a pelagic Mesozoic sequence preceding an early to middle Maastrichtian flysch (Mutt et al., 1970; Lebouleger, 1975). Pelagic limestones interstratified at the base of the detrital interval yielded late Carnian radiolarians (early Tuvalian Spongotoritellus spinosus Zone), plus middle to late Carnian conodonts including Paragondolella noah (Hayashi) and P. carpathica (Mock). In Tilos, the base of the Kreati unit includes tufts and pillow-lavas, turbiditic sandstones, and Late Triassic Halobia-bearing limestones, all followed by a Mesozoic pelagic series ending with a Late Cretaceous flysch (Roussos, 1978). Pelagic limestones associated with thick lava deposits at the base of the series yielded late Ladinian to early Carnian conodonts including Paragondolella foliata Budarov and Gladigondolella multi-elements, whereas middle late Carnian limestones associated with sandstones yielded Paragondolella noah (Hayashi) and P. carpathica (Mock).

In the Baysar-Hoyran Nappes (southern Turkey), the Hugu series is characterized by the deposition of typical green tufts at its base followed by the Hugu Limestone, assumed to be Middle Triassic at the base and Cenomanian-Campanian at the top (Monod, 1977; Gutnic et al., 1979). According to Kozur (1997c), the Hugu-type limestones begin in the late Carnian and range to the latest Triassic. Late Cretaceous limestones are tectonic slices and do not present the end of a very condensed continuous limestone sequence from the Late Triassic to the Late Cretaceous. Early to Middle Jurassic radiolarites are known from the
Huglu-type area. In the Oyuklu Dağ unit near Ermenek, Carnian green tuffs are overlain by the middle-late Norian Huglu cherty limestones. However, the contact between these limestones and the tuffs was not directly observed, thus it is well possible that the limestones start already during the latest Carnian (Gökdeniz, 1981; Gallet et al., 2007). The Late Triassic cherty limestones are transitional to a poorly developed Ammonitico Rosso, followed by late Pliensbachian to early Toarcian cherty limestones, themselves overlain by Aalenian to early Bajocian radiolarian cherts. In the surroundings, massive neritic limestones form a paleotopography filled by late Carnian pelagic limestones in Hallstatt Limestones facies belonging to the Tropites subbulatus Zone. Nevertheless, the relationship between these Hallstatt Limestones and the tuffs is not demonstrated (Gökdeniz, 1981). The brownish altered laves and tuffs found at the base of the Huglu tuffites and above turbiditic sandstones are interstratified by pelagic limestones, which yielded the Carnian ammonoid Joannites cymbiformis (Wulfen). In the Bęşhehir-Hoyran Nappes, the Boyaî Tepe series is characterized by Late Triassic to Early Jurassic shallow marine limestones, overlain by a very condensed succession of Toarcian Ammonitico Rosso, radiolarites and pelagic limestones ranging from the Liassic to the early Senonian. The uppermost part of the series is represented by breccias reworking mostly cherts but also a few volcanics, overlain by the Zekerya wildflysch. Because of the early arrival of the flysch, the Boyaî Tepe series were likely situated in a distal arrival within the Anatolian margin (Moix et al., 2008a).

In the Tavançayrî block in the Sorgun ophiolitic mélangé, the Huglu-type green tuffs conformably overlie well-dated Hallstatt Limestones belonging to the late Julian Trachyceras austriacum Zone. These limestones overlie a paleotopography made of massive neritic and reefal limestones (Moix et al., 2007). This proves a latest Julian to earliest Tuvalian age for the initiation of the tuffitic development, and its end is marked by the deposition of the overlying Huglu Limestone, which is from place to place either latest Tuvalian (Carnepeigniodella orchardi Zone) or earliest Norian (Epigondolella quadrata Zone) in age. The Late Triassic pelagic limestones end probably during the Rhaetian and are overlain by a breccia, itself followed by late Bajocian radiolarian cherts (Moix et al., 2011). At places, a well-developed Toarcian Ammonitico Rosso may be present. It includes the genera Hildoceras, Porphoceras and Calliphylloceras. This Ammonitico Rosso may be correlated to the well-known successions found in allochthonous successions in Turkey, such as the Boyaî Tepe and the Oyuklu Dağ units in the Bęşhehir-Hoyran Nappes (Gutnic and Monod, 1970; Özgül, 1976; Gökdeniz, 1981), the Gökgöl unit near Dinar (Gutnic et al., 1979), the Gümuşülü and the Domuz Dağ units in the Lycian Nappes (Brönnimann et al., 1970; Poisson, 1977; Gutnic et al., 1979; Dommergues et al., 2005), the Uçkub section in the Bornova flysch zone (Okay and Alliner, 2007) and the Şenköy Formation in the Pontides (Kandemir and Yılmaz, 2009). The easternmost occurrence of Huglu-type development is known in the Köseşahya Nappe near Elbistan (Tekin and Bedi, 2007a, b). There, the tuffitic deposition ends during the late Carnian and the pelagic limestones are well developed in the Norian. However, the attribution of these series to the Gülbahar unit of the Lycian Nappes is still debatable.

CONCLUSIONS

The succession of the tectonostratigraphic units logged in Ağlıovası Yayla is highly composite. The Karadağ unit forms its base and is represented by a Gondwana-derived carbonate platform belonging to the Taurus GDU. The intermediate part is represented by the Teke Dere unit, which contains different fragments of the Palaeoetethyan succession. The upper part is represented by a thick Mesozoic series related to the Huglu-Pindos Ocean. The recognition of these various units brings new constraints and new tools to develop accurate correlations from Greece to Turkey.

(1) Neotethys: The Ağlıovası Yayla autochthonous and Nif series show a platform development ranging from the Sakmarian to the Middle-Late Triassic. The successions include a ~40 Ma hiatus between the Sakmarian and the Middle-Late Triassic and the flexure of the platform in Middle Triassic time. The Late Triassic interval is marked by the deposition of a wildflysch-like sequence including olistoliths. The uppermost part of the platform below the wildflysch yielded Pseudofurnishius spp. This is only the third locality known in Turkey where this conodont fauna was identified. The faunal assemblage is characteristic for the Psidian Triassic (Westmediterran-Arabian Province), and Pseudofurnishius spp. are typical indicators for the Neotethyan domain sensu stricto and its marginal seas. The Karadağ unit represents the most relatively autochthonous in the Lycian Nappes and its Late Triassic succession is very similar to the Geyik Dağ autochthon. The above-mentioned large hiatus can be attributed to a rift shoulder related to the Neotethyan (= East-Mediterranean) rifting. Thus, we regard the Ağlıovası Yayla autochthonous and Nif series as being part of the southern margin of the Taurus GDU and we consider the Karadağ unit as part of the Cimmerian Taurus terrane.

(2) Palaeoethys: Several Palaeoetethyan remnants are found in the Teke Dere unit. These vestiges include a thick and widespread sequence of Pennsylvanian OIB-type basalts, a small slice of Carboniferous MORB-type basalts, a Mississippian siliciclastic wildflysch dated by the matrix and the blocks, and a potential Middle Permian arc/fore-arc affinity. The palaeobiogeographical faunal affinities of the seamount sequence and the Middle Permian platform overlying the siliciclastic Mississippian flysch (Nigangaltape Fm) show a north Palaeoetethyan origin. They are comparable with the Carnic Alps, Slovenia and Croatia, rather than with Greece (Attica, Crete) or with the Taurus GDU. In this part of the Lycian Nappe system, the onset of Palaeoethyan subduction (not later than Viséan), the subduction of the spreading axis (late Serpukhovian to early Moscovian), the subduction of a seamount (Sakmarian), and the time of closure of the Palaeoethyan Ocean and the nappe thrusting on its former southern passive margin (Late Triassic) can be dated. The Teke Dere series always overlay tectonically the Karadağ unit. The absence of Jurassic to Tertiary deposits in this unit could be the result of the pre-Jurassic emplacement. Moreover, several Permian units are unconformably overlain by Late Triassic red arkosic molasse-like continental sequences. The latter are interpreted to be related to Late Triassic orogenic movements inferred as the Cimmerian event.

(3) Huglu-Pindos: The Huglu-Pindos-type sequences, both in Turkey and in Greece, are related to the latest extensional events leading to back-arc openings in the Variscan cordillera during the Late Triassic (i.e., opening of the Huglu-Pindos Ocean). These events are marked by widespread volcanism (Huglu tuffitic series) and led finally to the onset of a passive margin setting that lasted until the Late Cretaceous obduction of supra-subduction type ophiolites over the north Anatolian margin. This obduction was sealed in many places by a Maastrichtian platform, but in eastern Anatolia, the obducting front passed over the terrane and continued its course to the southwest, following roll-back of the Neotethyan slab toward the East-Mediterranean domain (Moix et al., 2008a). The condensed units of Liassic age in Pindos-type sequences suggest a common origin for these nappes, along the northern passive margin of the Anatolian and Sîtia-Pindos terranes. The Liassic condensed level marks a starvation stage, followed by the generalized thermal subsidence of the margin. In order to find this margin sequence in the external parts of Greece and Turkey, it had to be transported with ophiolites or ophiolitic mega-olistostromes originating from the north.

(4) Correlations: Previous correlations between Greece and Turkey were mainly based on comparisons between the most external “autochthonous” platforms of both domains, and with facies convergence between Mesozoic sequences. However, most of these correlations were not inferred to one or several oceanic domains. Taking into account the identification of Palaeoethyan, Neotethyan and Pindos units in the Lycian Nappes, new tools and precise correlations can be proposed: (A) The typical Neotethyan succession of the Karadağ unit is very similar to the Geyik Dağ autochthon near Seydişehir in the Central Taurides. The Ladinian Karapinar Fm in the Lycian Nappes could be compared with
the Taraşcı Fm of the Geyik Dağ, and the Carnian Belenkavak Fm might be an equivalent of the flysch-like Sarpıar Dere Fm. (B) Some parts of the Teke Dere unit can be compared with similar units in Turkey, and in adjacent areas. Seamounts related to the Palaeotethys are identified in the Triassic Karakaya complex in Turkey, and in Iran where they occupy a similar position between Gondwana and Eurasia-derived GDUs. The Mississippian Incirbeleni Fm is comparable with the Karareis unit in the Karaburun Peninsula. These Carboniferous siliciclastic series represent the northern active margin of Palaeotethys, with the development of fore-arc flyschoid basins followed by the accretion of seamounts. They can be regarded as Palaeozoic mélanges deposited in a fore-arc basin, in relation with the northward subduction of the Palaeotethys Ocean. Similar units are also found in Chios, Lesvos, in the Internal Hellenides, and in the Aladağ Mountains. Until now, the Ağırıovaş Yayla arc series interpreted to represent fragments of the Palaeotethyan arc has no equivalent elsewhere in Turkey, except maybe in Konya. In Ağırıovaş Yayla, at least four distinct times of magmatic activities were identified: a Late Carboniferous one related to the seamount, and Roadian, Capitanian, and Late Permian ones most probably related to the Palaeotethyan arc or fore-arc series. (C) The classical Pindos-type series in Greece, the Köyceğiz and Haticama Dağ series in the Lycian Nappes, part of the Antalya Nappes, the Beyşehir-Hoyran Nappes, broken-formations in the Mersin mélange, and the Köseyahya Nappe in Elbistan; all this composite assemblage represents segments of the northern Mesozoic passive margin of the Anatolian GDU (Hugha-Pindos back-arc basin margins), including its flexure during the Late Cretaceous (from Cenomanian to Senonian) and its thrusting by ophiolitic nappes during the Maastrichtian. The ophiolitic nappes correspond to a Late Cretaceous obduction from an intra-oceanic subduction zone onto a passive margin-type sequence (Oman-style). This nappes pile was then displaced again during the Tertiary. Similar Pindos-type units are found in Crete, in several islands of the Dodecanese and in allochthonous nappes in southern Turkey.

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PLATE CAPTIONS

PLATE 1. Middle to Late Eocene foraminifers association of the Beydağlar and Geyik Dağ autochthonous. Scale bars = 0.250 mm. Figs. 1, 3, Turborotalia cerroazulensis s.s. (Cole) – T. c. cocoaensis (Cushman) (transit.), sample 11/06. Figs. 2, 4, Turborotalia cerroazulensis s.s., sample 11/06. Fig. 5, Morozovella sp., sample 423/07. Fig. 6, Acarinina sp., sample 423/07. Figs. 7-8, Acarinina bullbrooki Bolli, sample 423/07. Fig. 9, Morozovella sp. and Acarinina sp., sample 423/07.

PLATE 2. Late Pennsylvanian-Early Permian microfauna and microflora. Scale bars = 0.500 mm. Figs. 1, 3, Protriticites variabilis Bensh, sample 144/06, early Kasimovian. Fig. 2, Protriticites pseudomontiparatus Putrya, sample 144/06, early Kasimovian. Fig. 4, Protriticites sp., oblique transverse section, sample 174/06, Moscovian-Kasimovian boundary interval. Fig. 5, Praeobsoletes cf. tethydis (Igo), subaxial section, sample 150/06, earliest Kasimovian. Fig. 6, Archaelithophyllum missouriense Johnson, longitudinal section, sample 150/06, earliest Kasimovian. Fig. 7, Obsoletes cf. darvasicus Leven, subaxial section, sample 175/06, early Kasimovian. Fig. 8, Eugonophyllum sp., longitudinal section in a bifurcated specimen, sample 171/06. Fig. 9, Obsoletes confusus Kireeva, irregularly folded polar extremities of two whorls in subaxial section, sample 171/06, early Kasimovian. Fig. 10, Latitubiphytes rauzerae (Vachard and Moix) Vachard et al., longitudinal section, sample 169/06, early Kasimovian. Fig. 11, Quasifusulinoides fusiformis (Rozovskaya), subaxial section (right), sample 171/06, early Kasimovian. Figs. 12-14, Obsoletes aff. paraovoides Bensh, axial sections, sample 172/06, early Kasimovian. Fig. 15, Montiparus sp., axial section, sample 153/06, middle Kasimovian. Fig. 16, Uvanellopsis fluegelii Vachard and Moix, oblique transverse section, sample 169/06, early Kasimovian. Figs. 17-18, Gyroporella prisca Kochansky-Devidé. Fig. 17, Oblique section, sample 176/06, middle Kasimovian. Fig. 18, Oblique transverse section (bottom) with a transverse section of Montiparus sp. (top), sample 176/06, middle Kasimovian. Fig. 19, Tunefactus cf. expressus (Anosova), axial section, sample 153/06, middle Kasimovian. Figs. 20-21, Rauzerites aff. immutabilis (Shcherbovich), Gzhelian. Fig. 20, Cigar shaped axial section, sample 148/06. Fig. 21, Inflated fusiform axial section, sample 148/06. Fig. 22, Schwagerina (sensu stricto = Globifusulina) ex gr. krotowi (Schellwien), axial section, sample 137FR, Asselian/Sakmarian.

PLATE 3. Late Pennsylvanian-Late Permian microfauna and microflora. Scale bars = 0.500 mm. Figs. 1-2, Darvasites eocontractus Leven and Shcherbovich, sample 329/07, Sakmarian. Fig. 1, Axial section. Fig. 2, Subaxial (left) and transverse sections. Fig. 3, Deckereilla composita Reitlinger, oblique axial section, sample 329/07, Sakmarian. Figs. 4, 8, Permocalculus aff. kanmerai (Konishi). Fig. 4, Two subaxial sections, sample 303/07, Sakmarian. Fig. 8, Axial section with conceptacles (top), sample 303/07, Sakmarian. Fig. 5, Climacammina sphaerica Potieskaya and Boultonia cheni Ho (right, bottom), sample 306/07, Sakmarian. Fig. 6, Dutkevitchia cf. complicata (Schellwien), several axial and oblique sections, sample 306/07, Sakmarian. Fig. 7, Dutkevitchia sp. (subtransverse section; left bottom), Quasifusulina sp. (two subaxial sections; centre and left top) and Robustoschwagerina sp. (subaxial section; right), sample 334/07, Sakmarian. Fig. 9, Obsoletes obsoletus, axial section, sample 315/07, early Kasimovian. Fig. 10, Quasifusulinoides fusiformis (Rozovskaya), subaxial section, sample 316/07, early Kasimovian. Fig. 11, Ozawanella sp., subaxial section, sample 316/07, early Kasimovian. Fig. 12, Clavaporella sp. (2 specimens, left); Mizia sp. (top, right); Kantia? sp. (bottom, right), sample 341/07, Middle Permian. Fig. 13, Tubiphytes obscurus Maslov in a sandy calciturbidite, probable reworking from the Capitanian bioconstructions, sample 310/07. Fig. 14, Colaniella ex gr. minima Wang, oblique subaxial section, sample 310/07, late Changhsingian reworking.

PLATE 4. Late Triassic, Carnian foraminiferan association of the Ağlıovaşı Yayla autochthonous series. Figs. 1-3, Aulotortus ex. gr. sinuosus (Weysnchenk), sample 340/07. Figs. 1-2, Centered axial section; note the lenticular shape of the test which appears strongly recrystallized, the last whorl of the deuteroloculus is still visible because filled by micrite. Fig. 3, Off-centre axial section resulting in the sub-circular shape of the test. Figs. 4-5, Prorakusia salaji
di Bari and Laghi?, slightly off-centre axial sections; the initial part of the spire is recrystallized, even though the other whorls are partially visible thank to the micritisation, the specimen in Fig. 4 shows a planispiral juvenile stage followed by a streptospiral adult stage characteristic of the genus as well as the typical perforations of the Aulotortidae, transversally cut. Fig. 4, Sample 327/07. Fig. 5, Sample 326/07. Fig. 6, Triadidiscus sp., sample 340/07, a relatively flat form that externally looks like the genus Involutina but does not correspond to that genus because no pillars exist in the umbilical zone. Figs. 7-8, Endoteba ex gr. controversa Vachard and Razgallah, sample 128FR. Figs. 9-10, Endoteba ex gr. obturata (Brönnimann and Zaninetti) emend. Fig. 9, Sample 128FR. Fig. 10, Sample 166/06. Fig. 11, Endotebanella kocaeliensis (Dager) emend., sample 165/06. Figs. 12-13, Endotriada tyrrhenica Vachard, Martini, Rettori and Zaninetti. Fig. 12, Sample 166/06. Fig. 13, Sample 138FR. Figs. 14-15, Piallina tethydis Rettori and Zaninetti, sample 165/06. Fig. 16, “Trochammina” alpina Kristian-Tollmann, sample 340/07. Fig. 17, Reophax sp., sample 165/06. Figs. 18-19, Variostoma sp. Fig. 18, Sample 340/07. Fig. 19, Sample 366/07. Figs. 20-22, Agathammina austroalpina Kristian-Tollmann and Tollmann. Figs. 20-21, Sample 165/06. Fig. 22, Sample 366/07.

PLATE 5. Triassic microfossils. Scale bar = 100 µm. Figs. 1-3, Pseudofurnishius murcianus murcianus van den Boogaard, Ağılıyovaș Yayla, SW Turkey, black nodular limestones within sandstones, siltstones and shales of the basal Belenkavak Fm of the Karadağ unit, southern part of Tauric autochthon below the Lycian Nappes, sample 167/06, Cordevolian. Fig. 1, Upper view, rep.-no.: 3 _07_1_167这件07_61. Fig. 2, Lateral view, rep.-no.: 3 _07_1_167这件07_62. Fig. 3, Lateral view, rep.-no.: 3 _07_1_167这件07_63. Fig. 4, Pseudofurnishius murcianus murcianus van den Boogaard, upper view of a specimen with broken posterior blade, Ağılıyovaș Yayla, SW Turkey, dark limestones from the top of the Karapinar Fm of the Karadağ unit, southern part of Tauric autochthon below the Lycian Nappes, sample 328/07, Cordevolian, rep.-no.: 1_31_3这件2009_328这件07_62. Fig. 5, Pseudofurnishius murcianus n. subsp. B Gullo and Kozur, 1991, Ağılıyovaș Yayla, SW Turkey, dark limestones from the top of the Karapinar Fm of the Karadağ unit, southern part of Tauric autochthon below the Lycian Nappes, sample 328/07, Cordevolian, rep.-no.: 1_31_3这件2009_328这件07_61, a, lateral view, b, upper view. Fig. 6, Sculptured Bairdiidae, left valve, former ventral rib and former elongated oblique anterodorsal and posterodorsal ribs disintegrated in lines of short hollow spines, such a feature occurs only in such sculptured Bairdiidae which lived below the storm wave base, Ağılıyovaș Yayla, SW Turkey, dark limestones from the top of the Karapinar Fm of the Karadağ unit, southern part of Tauric autochthon below the Lycian Nappes, sample 328/07, Cordevolian, rep.-no.: 1_31_3这件2009_328这件07_66. Fig. 7, Polycopsis n. sp. ex gr. P. cincinnata, (Apostulescu), Ağılıyovaș Yayla, SW Turkey, dark limestones from the top of the Karapinar Fm of the Karadağ unit, southern part of Tauric autochthon below the Lycian Nappes, sample 328/07, Cordevolian, rep.-no.: 1_31_3这件2009_328这件07_68. Fig. 8, Theelia tuberculata Kristian-Tollmann, upper view, Saklıkent resort, southern Turkey, Longobardian to Cordevolian limestone pebble (sample K) of a polygenic Late Triassic molasse-type conglomerate of unclear tectonic position, rep.-no.: 3_31_3这件2009_328这件07_29. Fig. 9, Theelia sp., upper view, Saklıkent resort, southern Turkey, Longobardian to Cordevolian limestone pebble (sample K) of a polygenic Late Triassic molasse-type conglomerate of unclear tectonic position, rep.-no.: 3_31_3这件2009_328这件07_30. Fig. 10, Acanthotheelia cf. oertlii, Kozur and Simon, transitional form to the Theelia tuberculata group, upper view, Saklıkent resort, southern Turkey, Longobardian to Cordevolian limestone pebble (sample K) of a polygenic Late Triassic molasse-type conglomerate of unclear tectonic position, rep.-no.: 3_31_3这件2009_328这件07_33.

PLATE 6. Late Pennsylvanian-Early Permian microfauna and microflora. Scale bars = 0.500 mm. Figs. 1, 3, Quasifusulinoides fusiformis (Rozovskaya), Moscovian-Kasimovian boundary interval. Fig. 1, Subaxial to axial section, sample 313/07. 3, Subaxial section (left), sample 313/07. Figs. 2-3, Protriticites sp., Moscovian-Kasimovian boundary interval. Fig. 2, Oblique axial section (right), sample 313/07. Fig. 3, Oblique transverse section. Figs. 4-5, Montiparatus ex gr. sinusus Rozovskaya, middle Kasimovian. Fig. 4, Axial section, sample 342/07. Fig. 5, Axial section, sample 342/07. Fig. 6, Uvanellopsis fluegelii Vachard and Moix, oblique subtransverse section, sample 343/07, early Kasimovian. Fig. 7, Rausertes aff. rugosus (Rozovskaya), axial section, sample 351/07, Gzhelian. Fig. 8, Rausertes cf. elongatissimus (Rozovskaya), several sections, sample 352/07, Gzhelian. Fig. 9, Bradyina ex
PLATE 7. Microfauna and microflora from the Capitanian (= Midian). Scale bars = 0.500 mm. Fig. 1, Hemigordiopsis renzi Reichel, axial section, sample 342/07. Fig. 2, Neoschwagerina ex gr. haydeni (Dutkevich), subaxial section, sample 342/07. Fig. 3, Neoschwagerina ex gr. margaritae Deprat, oblique section, sample 342/07. Fig. 4, Salopekiella velebitana Milanovic, axial section showing 10 articles, sample 325/07. Fig. 5, Kahlerina pachythesa Kochansky-Devidé and Ramovš, axial section, sample 356/07. Fig. 6, Likanella spinosa Milanovic, transverse section, sample 356/07. Fig. 7, Endotetaba controversa Vachard and Razgallah, transverse section, sample 342/07. Fig. 8, Kahlerina ovalis Chediya, axial section, sample 356/07. Fig. 9, Chusenella cf. cheni Skinner and Wilde, axial section, sample 356/07. Fig. 10, A, Neodiscus? sp., B, Globivalvulina cyprica Reichel and C, Pachyphloia sp., sample 356/07. Fig. 11, Sphaerulina cf. croatica Kochansky-Devidé, axial section, sample 325/07. Fig. 12, Pseudokahlerina? sp., axial section, sample 356/07. Fig. 13, Microfacies with A, Verbeekina verbeeki (Geinitz), B, Globivalvulina? n. sp., C, Neoschwagerina sp., sample 325/07.

PLATE 8. Conodons from the Early Carboniferous Palaeotethyan accretionary complex in the upper tectonic unit of a section SW of the Nişangah Hill, 1000 m E of Ağlıovaşı Yayla, northeast of Fethiye, Tavas Nappe, Lycian Nappes system, SW Turkey. The specimens are housed in the Institut für Geologie und Paläontologie, Universität Innsbruck, Austria. Figs. 1-3, Gnathodus bilineatus (Roundy), sample K 60, thin limestone bed within greenish and reddish shales, beginning of the shallowing upward sequence, uppermost Viséan to Serpukhovian. Fig. 1, x 90, rep.-no. 21-1-99/I-1-16. Fig. 2, rep.-no. 21-1-99/I-21. Fig. 3, x 70, sample K 60, rep.-no. 21-1-99/I-18. Fig. 4, Mestognathus cf. bipluti Higgins, x 50, sample K 60 (see Figs. 1-3), rep.-no. 21-1-99/I-13. Figs. 5, 7, Gnathodus delicatus Branson and Mehl, x 200, sample K 61A, upper Tournaisian cherty limestone olistolith within the siliciclastic turbidites. Fig. 5, rep.-no. 21-1-99/I-30. Fig. 7, rep.-no. 21-1-99/I-29. Fig. 6, Kladognathus sp., Sc element, x 100, sample K 60 (see Figs. 1-3), rep.-no. 21-1-99/I-20. Fig. 8, Lochriea ziegleri Nemirovskaya, Perret and Meischner, x 100, sample K 60 (see Figs. 1-3), rep.-no. 21-1-99/I-17. Fig. 9, Gnathodus typicus Cooper, x 150, sample K 75, big limestone block with some chert layers within siliciclastic turbidites, upper Tournaisian to lower Viséan rep.-no. 21-1-99/I-14.

PLATE 9. Conodonts from the Early Carboniferous Palaeotethyan accretionary complex in the upper tectonic unit of a section SW of the Nisangah Hill, 1000 m E of Ağlıovaşı Yayla, northeast of Fethiye Tavas Nappe, Lycian Nappes system, SW Turkey. The specimens are housed in the Institut für Geologie und Paläontologie, Universität Innsbruck, Austria. Fig. 1, Gnathodus typicus Cooper, lateral view, x 150, sample K 75, big limestone block with some chert layers within siliciclastic turbidites, upper Tournaisian to lower Viséan rep.-no. 21-1-99/I-15. Figs. 2-3, 8, Gnathodus delicatus Branson and Mehl, x 200, sample K 61, upper Tournaisian olistolith of grey, pelagic limestone within siliciclastic turbidites. Fig. 2, rep.-no. 21-1-99/I-24. Fig. 3, rep.-no. 21-1-99/I-25. Fig. 8, rep.-no. 21-1-99/I-26. Figs. 4, 6-7, Bispathodus sp., sample K 61 (see Figs. 2-3, 8). Fig. 4, Upper view, anterior carina and free blade broken away, x 200, 27. Fig. 6, Lateral view, rep.-no. 21-1-99/I-10. Fig. 7, Detail of Fig. 6, node of the carina with micro-ornamentation, x 2000. Fig. 5, Gnathodus cf. typicus Cooper, x 150, sample K 61 (see Figs. 2-3, 8), rep.-no. 21-1-99/I-23.

PLATE 10. Specimens from sample K 79/98, small lenticular intercalation (?)intra-pillow filling) of upper Moscovian-middle Kasimovian red pelagic slope limestone between mafic volcanics of the seamount sequence in a section SW of
the Nisangah Hill, 1000 m E of Ağlıovaş Yayla, northeast of Fethiye, Tavas Nappe, Lycian Nappes system, SW Turkey. The specimens are housed in the Institut für Geologie und Paläontologie, Universität Innsbruck, Austria. **Figs. 1-5, 7-8, *Idiognathodus delicatus* Gunnell.** **Fig. 1,** x 70, rep.-no. 21-1-99/I-6. **Fig. 2,** x 100, rep.-no. 21-1-99/I-2. **Fig. 3,** x 70, rep.-no. 21-1-99/I-9. **Fig. 4,** x 100, rep.-no. 21-1-99/I-8. **Fig. 5,** x 100, rep.-no. 21-1-99/I-5. **Fig. 7,** x 100, rep.-no. 21-1-99/I-4. **Fig. 8,** x 100, rep.-no. 21-1-99/I-3. **Fig. 6, *Idioprioniodus* sp., Sc element, x 100, rep.-no. 21-1-99/I-1. **Fig. 9, *Gondolella magna* Stauffer and Plummer, x 150, rep.-no. 21-1-99/I-7. **PLATE 1**