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 Karada, Teke Dere, Köyce iz and Haticena units. The lowermost Karada 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 wildflysch-like formation. The discovery of the Cordevolian (early Carnian) Pseudofurnishius murcianus murcianus conodonts fauna on top of the platform is of crucial importance. This fauna characterizes the Westmediterran-Arabian Province and is a typical indicator for the [...]
PALAEOTETHYAN, NEOTETHYAN AND HUĞLU-PINDOS SERIES IN THE LYCIAN NAPPES (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 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 Silurian turbidite. The discovery of the Cordevonian (early Carnian) Pseudofurnishius murcianus murcianus conodont fauna on top of the platform is of crucial importance. This fauna characterizes the Westmediterranean-Arabian Province and is a typical indicator for the Neothethyan 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 wulffish-like 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 Hatiçeana series 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 Anommonitico Rosso. It continues with late Liassic to Maastrichtian pelagic limestones and calciturbidites. A Late Palaeocene 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 Nappe is in reality highly composite and includes dismembered units belonging to the Palaeothethyan, Neothethyan and Hugu-Pindos realms. The Karadağ unit belongs to the Cimmerian Taurus terrane and was part of the northern passive margin of the Neothethys (= East-Mediterranean); the Teke Dere succession is composed of several thrust sheets of Palaeothethyan origin. Palaeothethyan remnants found as subduction-accretionary complexes or reworked during the Eocimmerian orogenic event provide a strong means to identify and locate the Palaeothethyan suture zone; the sedimentological evolution of the Köyceğiz and Hatiçeana series is in many points similar to classical Pindos sequences. These series originated in the Hugu-Pindos Ocean along the northern passive margin of the Anatolian (Turkey) and Sittia-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, Palaeothethys and Neothethys. The Palaeothethys-(Neo) Tethys sensu stricto concept of Kahler (1939) and Hertisch (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 Palaeothethys-(Neo) Tethys concept of Kahler (1939) is basically the same as the one of Stöcklin (1974) and Stampfli (1978): the Palaeothethys is located between the Variscan active margin to the north and the Cimmerian blocks, and the Neothethys between the latter and the Gondwana passive margin to the south. As Stöcklin (1974) and Stampfli (1978) were the first to use the term Neothethys in agreement with the priority Palaeothethys-(Neo) Tethys concept of Kahler (1939) and Hertisch (1940), the term Neothethys has to be used only in this priority-supported modern sense. Thus, the use and abuse of the terms Palaeothethys, Neothethys 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 et al., 2010) is introduced here, emending the term “terrane” used so far. It describes the present-day smallest continental/oceanic 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 plateaus, 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 always keeps its present-day shape. A terrane is potentially composed of several GDUs, thus it has both geohistoric 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 Beydağlar platform to the SE and the Menderes Massif to the NW (Fig. 1). The Lycian Nappes are derived from the İzmir-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 Tauran terrane (e.g., Beydağlar, 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-Zagrides continuum was mainly based on correlations between the platform and the Menderes form the autochthonous nappes and their parautochthons 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-Zagrides continuum was postulated and discussed (Philippson, 1914; Kober, 1915; Kossmat, 1924; Renz, 1940; Brunn, 1960; Nebert, 1961; Ricou 1973; Özgül 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 platform series 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-Höyran 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**

**Paraautochthonous**

Both the Beydağlar 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 Beydağlar-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 Sandıklı (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 Bozkır Nappes (e.g., Özgül, 1976; Monod, 1977; Gutnic et al., 1979; Özgül, 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 Hirmantian glaciation event was recognized in several Tauric sequences (Monod et al., 2003) and the Late Triassic to Liassic interval is marked by the Eocimmerian unconformity. This event is characterized by a large detrital input of polygenic, partly pelagic material (Gutnic et al., 1979; Akay, 1981; Altıner, 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; Bagheri, 2007; Bagheri and Stampfli, 2008), and record the opening and closure of both Palaeo- and Neotethys.

In the Geyik Dağ autochthons on the road between Taşköprü and Alanya near the village of Muzvaş (Dumlugözü), 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, Nummulites sp., Asterocyclina sp., and Sphaerogypsinia 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., Morelowella sp. (Pl. 1, Figs. 5, 9), Acarinina sp. (Pl. 1, Figs. 6, 9), A. bullbrooki (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 platform units were not reached by the ophiolitic nappes at all (Koç et al., 1997).

**Beydağlar**

Ricou et al. (1979) subdivided the Beydağlar into a western and an eastern part. On its western flank, the stratigraphic sequence ends during the Burdigalian/Langhian interval, and is tectonically over lain 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 Beydağlar is thrust over the western Beydağlar, after the Burdigalian/Langhian and before the Serravalian/Tortonian molasse of the Antalya Basin.
In its northern part (Bucak area), the Beydağlar 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 Beydağlar 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 Beydağlar 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 Graciesky, 1968, 1972).

South of İmecik 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 white chalk followed by 2 m of debris-flow including ophiolitic elements. It continues with 2 m of green and red siltstones and argillites with nodules of micritic limestones. These nodules yielded Cuneolina sp. and Pseudorhapydionina 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., Globigerinatheka sp., Subbotina sp., plus Rotaliidae, Cibicididae, Anomalinidae, 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., Rotalia sp., Sphaerogypsina sp., Microcodium sp., and lithoclasts of Late Cretaceous age with Cuneolina sp. Another sample yielded Nummulites sp., Discocyclina sp., Assilina sp., Rotalia sp., and 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 Palaeocene 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 molasse-type deposits. Hayward (1984) studied the Miocene clastic sediments between Kang and Finike and deduced both an eastern and western provenance for this material. Sediments lying on the Beydağlar 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 Beydağlar, 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 (Akdağ), posterior to Burdigalian (or Langhian) flysch deposits, which marked the emplacement of the nappes. This new assemblage is finally sealed by Tortonian conglomerates (Gutnic 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; İğil and Tekeli, 2001). The Menderes Massif underwent a complex polyphase metamorphic history and four distinct episodes of magmatic activity were identified during the Protrozoic, Cambrian, Middle Triassic and Tertiary (Bozkurt and Oberhänsl, 2001; Koralay et al., 2001; İğil et al., 2004; Koralay 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., 2004). 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, 1966; Özgül, 1976; şengör, 1984; Satr and Friedrichsen, 1986; Oberhänsl et al., 1997; Oberhänsl et al., 1998; Bozkurt and Oberhänsl, 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, 1966; şengör, 1984; Satr and Friedrichsen, 1986; Konak et al., 1987), whereas others consider this contact as intrusive (e.g., Bozkurt et al., 1993, 1995; Erdoğan and Gungör, 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 granitoids 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; Satr and Friedrichsen, 1986; Hetzel and Reischman, 1996; Hetzel et al., 1998; Loos and Reischman, 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, phylmites, 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, phylmites and black marbles (i.e., Güktepe Limestone) assigned to the Permo-Carboniferous (Önay, 1949; Okay, 2001). This age is questionable since Late Cretaceous radiiats 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-LT paragenesis (Rimmelé et al., 2003b). Above the conglomerates, Bozkurt and Oberhäuserl (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 radiis-bearing marbles with thin micaschist intercalations (Özer, 1998), late Campanian/Maastrichtian thin-bedded red pelagic marbles (Özer, 1998), and late Maastrichtian/Early Eocene Oecene (Özer et al., 2001) ophiolitic meta-olistostrome and flysch, containing serpentinities, metagabros, eclogites and varied blocks of marbles embedded in a chlorite/alphite 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; şengör 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 Haticeana 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 Gümüldü, the Gülbahar and the Domuz Dağ units occupy a high position in the tectonic pile and are essentially composed of carbonates and radiolarites. The Yavuz and the Yealmere units are characterized by a strong detrital input and are situated just above the Beydağlar. Additionally, there are some Tertiary detrital units (flysch-like), an ophiolitic melange and an ophiolitic nappe sensu stricto. Özkaya (1990) subdivided the Lycian allochthonous slices into four major units, which are from bottom to top the Elmalı, the Köyceğiz and the Yavuz 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 Yeğilbarak, the Tavas, the Bodrum, the Dumanlıdak, the Domuz Dağ and the Gülbahar nappe (şengör, 1997; şengör et al., 1994). According to şengör 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 Yeğilbarak Nappe separated into the Gömbü and the Yavuz units (şengör, 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 parautochthonous, (2) the Lycian thrust sheets, (3) the Lycian melange, (4) the Lycian ophiolite 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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<td>de Graciansky (1972)</td>
<td>Série autochtonie</td>
<td>Série du Karada</td>
<td>Unité olistostromique</td>
<td>Série du Tekedere, du Hattieana Da et de Innice</td>
<td>Série de Köyce iz</td>
<td>Nappe des péridotites</td>
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<td>Poisson (1977)</td>
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<td>Unité de Yavuz et de Yeleme</td>
<td>Unité de Gümüslü</td>
<td>Unité de Gülbahtar</td>
<td>Nappe ophiolitique</td>
<td>Nappe des Kızlaç Da, unité du Domuz Da</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 mélangé (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 Köyceğiz metamorphic sole and in the Yeşılova area, the ages are ranging from 82.3 ± 4.6 to 113.4 ± 2.4 Ma with an average of 91 Ma. Isolated metamorphosed diabase dykes cut the peridotites and locally unmetamorphosed dykes cut both the metamorphic sole and the amphibolites (Juteau, 1980), yielding ages ranging from 63.6 ± 1.6 to 81.4 ± 2.2 Ma. Both dikes present an island arc signature and are interpreted to be subduction-related (Çelik and Chiaradia, 2007).

The “Diabase Nappe” is composed of basaltic pillow-lavas and dolerites in association with Late Cretaceous pelagic limestones, radiolarites, graywackes, calcareous and limestone breccias, suggesting its emplacement in the Wilhjysch basin during the Late Cretaceous/Early Tertiary (Bemoulli et al., 1974). The Lycian mélangé tectonically overlies the Lycian thrust sheets and is composed of two intergradational but tectonically juxtaposed units. It is regarded as an accretionary prism related to the subduction of a “Mesozioc Tethyan Ocean” by Collins and Robertson (1997). A lower layered tectonic mélangé is composed of dismembered thrust sheets and detached blocks of pelagic limestones and radiolarites in a sheared shaly matrix (Danelian et al., 2006). The upper ophiolitic mélangé comprises blocks and dismembered thrust sheets of ophiolitic lithologies (“Diabase Nappe”) including harzburgites, gabbros, diabases, basaltic, radiolarites and both neritic and pelagic limestones, within a deformed matrix of terrigenous sediments (Danelian et al., 2006). In the Domuz Dağ, the ophiolitic mélangé (= Kızlaç Dağ mélangé of Poisson, 1977) consists of a Late Cretaceous chaotic assemblage of peridotites, amphibolites, gabbros, pillow-lavas, radiolarites, pyroclastic rocks of alkaline affinity and Permain limestone blocks, and large bodies of Mesozoic shallow-water limestones (Domuz Dağ unit), in an argillaceous to sandy matrix. The whole sequence is thrust over the Peridotite Nappe and by the Domuz Dağ units (de Graciansky, 1972; Bernoulli et al., 1974). The Kızlaç Dağ mélangé 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 Beydağları 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 paleo-position north of the Menderes Massif and lie on/between the latter to the north and the Beydağları platform to the south (de Graciansky, 1972; Dürr et al., 1978; Guthnic et al., 1979; Şengör and Yilmaz, 1981; Okay, 1989; Collins and Robertson, 1997, 1998, 1999; Gungör 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 Beydağları to the south (Poisson, 1977; Poisson, 1984; Özkyaya, 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 Beydağları. According to Poisson (1984), this domain (the Kızlaç-Çorak Göl basin or intra-Tauric trough) corresponds to the eastern prolongation of the Ionian zone of Greece. Based on the Liassic ammonite faunas, this hypothesis was supported by Dommegues et al. (2005),
FIGURE 2. Synthetic lithostratigraphic sections of the A, Beydağları (Bucak area) and B, Susuz Dağı (Sinekcibeli area) parautochthon, the C, Karadağ, D, Teke Dere, E, Hatische 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 Özçay (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; Özçay, 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 (Özçay, 1991), composed of Eocene volcanogenic 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 (Akteğ and Robertson, 1984; Robertson et al., 2006, 2007). According to Kozur 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 (Güngör and Erdoğan, 2001). The discovery of widespread HP-LT metamorphism (Fe-Mg-carpholite) at the base of the Lycian Nappes, in klippen 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 (Oberhansli et al., 2001; 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. Oberhansli et al. (2001) explained that in an accretionary complex, off-scraping 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 front 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.

**Ağlıovası Yayla Series**

The Ağlıovası 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 Nit 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 Ağlıovası Yayla and Nit 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 Kozar et al. (1998), Kozar and Şenel (1999) and Stampfli and Kozur (2006), who discovered and described the first Palaeozoic deep-sea fossils (conodonts and radiolarians), partly associated with a seamount, 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 Üstaömer, 2009a, b; Moix, 2010; Vachard and Moix, 2011; Vachard and Moix, in press).

The composite succession (Fig. 4) logged in Ağlıovası 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 microfacies have been observed, and we recognize the following bioclasts: 0.5 m, rich in dasyclad 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 (Bernoulí et al., 1974). Ladinian limestones rich in Duostominidae foraminifers cap the quartzites. This interval is followed by limestones, sandy limestones 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 Sakız (possibly Late Devonian shales and limestones), the Kiloluk (Middle Carboniferous bioclastic limestones, dolomites, dolomitic limestones), the Akkavak (Early Permian crystalline limestones, dolomites, shales), the Sarıtaş (possibly late Anisian to early Ladinian sandstones), the Karapınar (Ladinian black limestones) and the Belenkavak (Carnian-Norian sandstones, siltstones and shales) formations.

** Ağlıovası Yayla Autochthonous Series**

The oldest shallow-marine sediments identified in the Ağlıovası 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 Ağlıovası 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-beded interval composed of white quartzites (Sırağa Fm). All the fossil assemblages below the quartzitic beds indicate a Sakmarian age with fusulinids: abundant Darvatis eocrocutatus Leven and Scherbovich (Pl. 3, Figs. 1-2) and rare Robustoschwagerina sp.; rare smaller foraminifers; e.g., Deckerkella composita Reitlinger (Pl. 3, Fig. 3), and relatively common Permoeculaceus aff. kamenari (Konishi) (Pl. 3, Figs. 4, 8). In other localities, the Sakmarian is also characterized by Climacocammina sphaerica Potievskaya, Boultonia cheni Ho, Dutkevitchia cf. complicata (Schellwien), D. sp., Quassifusulina sp. and Robustoschwagerina sp. (Pl. 3, Figs. 5-7). The quartzites are followed by thick-beded gray limestones and thin-beded bioclastic black nodular limestones, locally with cherts (Karapinar Fm). The limestone levels above the quartzitic 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 (Şengel et al., 1994; Kozur et al., 1998; Stampfli 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 Pseudofurnishius murcianus murcianus van den Boogaard and Pseudofurnishius murcianus n. subsp. B Gullo and Kozur (Pl. 5, Figs. 1-5) and the ostracod fauna yielded sculptured Bairdiidae and Polycopsis spp. (Pl. 5, Figs. 6-7).

Nif Series

The Nif section shows a development comparable to the Aglıgovaş Yayla autochthonous series described above. This section is situated along the southern margin of the Niş Polje, in the “Nif imbricate thrust sheets” defined by de Graciansky (1972), south of the village of Arpakç (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 deposition of the Late Triassic Belenkavak “schists.” This Karadag-type unit is overlain by the Teke Dere unit, which is made of Permian limestones, overlain by red arkoses and Late Triassic to Liassic shallow-water limestones.

As for the Ağlıgovaş Yayla autochthonous series, the Nif section (Fig. 5B) is Sakmarian in age and the limestone development is about 20 m thick (Pl. 3, Figs. 6, 8). The series consists of 2 m of greenish to gray massive limestones, 5 m of yellowish to gray limestones, 2 m of black medium-beded limestones with corals and shells, 3 m of thin-beded marly limestones, 1 m of black-gray nodular limestones, 1 m of thin-beded marly limestones and several hundreds of meters of sandstones and quartzites. Only the Sakmarian interval is illustrated in Fig. 5. Apparently, de Graciansky (1972) did not recognize this distinctive section because no Sakmarian limestones were described in the “Nif imbricate thrust sheets.” South of the Nif Polje, the Ladinian limestones and dolomites rich in Duostominidae foraminifers directly overlie the quartzitic interval indicate a Middle-Late Triassic age (Pl. 4, Figs. 3, 13-14), as well as (not illustrated) Archaeolithoporella hidensis Endô, Verbeekina sp. (a fragment) and several fragments of veenekoinoids and schwagerinoids of Wordian or Guadalupian age. Due to the identification of Colaniella, this assemblage indicates at least a Changhsingian age, but from the geological context, it can be considered as Triassic calciturbidites reworking Permian shallow-water material like in the Neotethyan domain of the Sosio Valley or in the Lercara “Fm” in Sicily (e.g., Carcione et al., 2004). Middle Permian limestones of the Teke Dere unit tectonically overlie the upper part of the Belenkavak “schists.” One bioclastic grainstone yielded the calcareous algae Gyroporella sp., Mizia sp., Clavoporella sp.; the smaller foraminifers Eotubertina sp., Globivalvulina sp., Neodiscus sp., Nodosinelloides sp.; the fusulinid Nankinella sp., plus gastropods, crinoids, ostracods and bivalves. These Middle Permian limestones are stratigraphically overlain by red arkoses, sandstones and siltsstones assigned to the Early Triassic by de Graciansky (1972). Further investigations along the western ridge of the Çal Dag have shown that, at least in this place, the red clastics are Late Triassic in age. The red arkosic sandstones are continental molasse-type deposits defined as the Çenger Fm in which Late Triassic fish and reptiles remains 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 Niş section is a lateral equivalent of the Ağlıgovaş Yayla autochthonous series. However, no remnants of Palaeoetethyan material (e.g., seaamount, accretionary series) have been identified in the upper part of the section logged south of the Niş Polje.

Teke Dere Sections

The Teke Dere unit (Fig. 4) belongs to the Tavas Nappe (Erakman et al., 1982; Şengel 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 this 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 Şengel et al. (1994), the Teke Dere unit consists of the early to middle Wordian Çatakdere (crystalline limestones); the Incirbeleni (shales, sandstones, limestone “lenses”, lydites and volcanics) and the early to middle Wordian Nişangıhtepe (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 Şengel (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 Nişangıhtepe formations of Şengel 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 Pennsylvania and Cisuralian microfauna and microflora associated with the seaamount. 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 seaamount 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 Nişangıhtepe Fm just above the Mississippian wildflysch-like sequence corresponding to the Incirbeleni Fm of Şengel 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 seaamount series, the...
FIGURE 3. Geologic map between the Çatal Tepe and the Karadağ (Lycian 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.
Yayla Seamount Series

enel (1999) and ovas

Yayla seamount section is about 150 m thick enel, 1999). This main part of the seamount is overlain by a con-

Yayla area, several outcrops belonging to the main sequence of

unit, several enel et al. (1994) and to the

lu et al., ovas

Yayla modified

ovas

rane in Turkey (e.g., Karakaya Complex, NE of Bursa, SW of Ankara, N of Izmir).

Roadian assemblages confirm a northern Palaeotethyan affinity for these limestones. The faunas share particular biogeographical tendencies with the Darvaz, northern Pamir, and different outcrops in the Sakarya ter-

rane in Turkey (e.g., Karakaya Complex, NE of Bursa, SW of Ankara, N of Izmir).

FIGURE 4. Synthetic lithostratigraphic section of Ağlıovaş Yayla modified from Vachard and Moix (2011). Key is on Fig. 2.

Ağlıovaş Yayla Seamount Series

The main Ağlıovaş Yayla seamount section is about 150 m thick and ranges from the earliest Kasimovian to the Sakmarian-early Artinskian period (Fig. 4). It consists of a succession of lavas, tuffs, conglomerates 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 cor-

respond 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 Ağlıovaş 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 been already described (Kozur et al., 1998; Kozur, 1999; Kozur and genel, 1999; Göncüoğlu et al., 2000; Stampflí and Kozur, 2006), but only Kozur and genel (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 basalts, 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 se-

quence 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 Alter-

ation Index (CAI = 1-2) indicates that the seamount series is unmetamorphosed to very low grade metamorphic (Kozur, 1999; Kozur and genel, 1999). This main part of the seamount is overlain by a con-

glomerate 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 (Schellwien), Quasifusulinoides fusiformis (Rozovskaya and Protricithe 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 (Schellwien), Quasifusulinoides fusiformis, and Ozawa-inella 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 foraminifers Bradynia sp., Hemigordius sp.; the fusulinids Ozawa-inella sp., Pseudostaffella sp., Schubertella sp., Fusiella sp., Quasifusulinoides sp., Praeobsoletes sp., Obsoletes sp.; plus pyritized terrestrial wood, polyaxon spicules, bivalves, gastropods, bryozoans, brachiopods, ostracods. These associations indicate a latest Moscovian to early Kasimovian age. The age and the facies succession of this se-

quence 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 calcarens.

Some bioclastic mudstones stratigraphically overlying the lavas yielded the calcareous algae Eugonophyllum sp., Anthracoporella sp., Epimastopora sp., Uvanellopsis fluegelii Vachard and Moix (2011); the
More precisely, the Rb, Ba and Sr concentrations may be related to the Yayla autochthonous and Nif series. Key taxa include Tuberitina sp., Bradyina fusulinids, and Moix) Vachard et al., 2012; smaller foraminifers consortia cyanobacteria-foraminifers Tubiphytes obscurus Maslov, T. sp.; the smaller foraminifers Tubertitina sp., Bradyina ex gr. nautiliformis Möller (Pl. 6, Fig. 9), Climacamina sp., Tetraxis sp., Calicvertella sp.; the fusulinids Schubertella sp., Boultonia 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), Schellsienia aff. porrecta (Sjömoja) (Pl. 6, Fig. 12), Leetna cf. atetsensis (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 borate 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 borate 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 reproducibility 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 Allovasy 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 FeO$_{eq}$ (wt. %), TiO$_2$ (wt. %) and Al$_2$O$_3$ (wt. %) enrichment correlated with a SiO$_2$ (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 TiO$_2$ (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. SiO$_2$ is of 45.71 to 46.24 wt. % while FeO$_{eq}$ 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)

<p>| TABLE 2. Major- (wt. %) and trace-element (ppm) analysis for whole rock samples 149/06a, b and c. (Eu/Eu*) = Eu/(Sm+Gd/2), XMg = Mg/Mg+Fe and (La/Yb)nc = (La/Yb) normalized to chondrites. |
|-----------------|-----------------|-----------------|------------------|
| sample          | 149/06b         | 149/06c         | 149/06a          |
| SiO$_2$         | 45.96           | 45.71           | 46.24            |
| TiO$_2$         | 3.71            | 3.47            | 3.20             |
| Al$_2$O$_3$     | 15.91           | 16.09           | 16.31            |
| Fe$_2$O$_3$     | 11.53           | 11.34           | 11.10            |
| MnO             | 0.23            | 0.19            | 0.18             |
| MgO             | 7.57            | 7.79            | 7.88             |
| CaO             | 5.16            | 5.21            | 5.18             |
| Na$_2$O         | 4.60            | 4.58            | 4.51             |
| K$_2$O          | 0.61            | 0.55            | 0.40             |
| P2O$_5$         | 0.66            | 0.57            | 0.46             |
| LOI             | 4.29            | 4.45            | 3.61             |
| SUM             | 100.24          | 99.95           | 99.09            |
| Cs               | 0.37            | 0.55            | 0.33             |
| Rb               | 5.76            | 5.62            | 4.93             |
| Ba               | 167.34          | 169.13          | 152.19           |
| Th               | 3.47            | 3.21            | 3.36             |
| U                | 1.09            | 1.01            | 0.90             |
| Nb               | 45.68           | 50.21           | 44.65            |
| Ta               | 2.85            | 2.79            | 2.83             |
| Pb               | 2.40            | 2.53            | 2.62             |
| Sr               | 317.50          | 330.33          | 319.13           |
| Zr               | 223.36          | 220.19          | 211.54           |
| Hf               | 5.19            | 5.27            | 5.36             |
| Y                | 37.72           | 32.94           | 25.15            |
| La               | 51.04           | 41.52           | 32.00            |
| Ce               | 62.28           | 70.84           | 64.06            |
| Pr               | 7.69            | 9.13            | 7.72             |
| Nd               | 42.48           | 36.71           | 33.06            |
| Sm               | 7.13            | 7.01            | 6.92             |
| Eu               | 2.44            | 2.79            | 2.33             |
| Gd               | 6.40            | 6.68            | 6.51             |
| Tb               | 0.99            | 0.96            | 0.94             |
| Dy               | 4.90            | 5.77            | 5.64             |
| Ho               | 0.98            | 1.18            | 1.04             |
| Er               | 2.53            | 2.88            | 2.75             |
| Tm               | 0.41            | 0.39            | 0.36             |
| Yb               | 2.03            | 2.36            | 2.18             |
| Lu               | 0.27            | 0.35            | 0.32             |
| Y/Nb             | 0.83            | 0.66            | 0.63             |
| (La/Yb)nc       | 16.97           | 11.88           | 9.89             |
| Eu/Eu*          | 1.08            | 1.23            | 1.05             |
| XMg              | 0.34            | 0.33            | 0.33             |</p>
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Yayla siliciclastic series is a wildflysch-like unit (Pl. 7, Fig. 6), whilst the blocks and the Middle Permian platform overlying the siliciclastic series belongs to the TLG (Calcarea) Fm yielded a well-preserved fauna of Roadian (= Kubergandian) age (Kozur and Milanovic, 2006). A few badly preserved Carboniferous broken ramiform conodonts were identified from intra-pillow fillings of red pelagic limestones. This succession is stratigraphically overlain by 5-10 m of Capitanian (= Midian) age. The assemblage (Pl. 7, Figs. 1-13) is constituted of the calcareous algae Gypoporella sp., Mizia sp., Gonionoplis sp., Likanella spinosa Milanovic (Pl. 7, Fig. 6), Salopekia velobitiana Milanovic (Pl. 7, Fig. 4), Kochanskyella sp.; the algosponge Claracrusta sp.; the smaller foraminifers Neoeoendothyra sp., Endotetix controversa Vachard and Razgallah (Pl. 7, Fig. 7), Postendothyra sp., Tetratetix sp., Climacammina sp., Globivalvulina sp., Septoglobivalvulina sp., Pseudoveinoporella nippagica (Endô), P. sp.; the fusulinids: Staffella sp., Nankinella sp., Schubertella sp., Neofusulinella sp., Skinnerella sp., Cancella sp., Armenina sp.; plus gastropods, bivalves, byssozoans, brachiopods, and ostracods.

Elsewhere, neither Roadian nor Wordian were identified above the Incirbeleni 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 Gypoporella sp., Mizia sp., Gonionoplis sp., Likanella spinosa Milanovic (Pl. 7, Fig. 6), Salopekia velobitiana Milanovic (Pl. 7, Fig. 4), Kochanskyella sp.; the algosponge Claracrusta sp.; the smaller foraminifers Neoeoendothyra sp., Endotetix controversa Vachard and Razgallah (Pl. 7, Fig. 7), Postendothyra sp., Tetratetix sp., Climacammina sp., Globivalvulina cyprica Reichel (Pl. 7, Fig. 10), G. sp., G. 2 n. sp., Paraglobivalvulina sp., Dagmarita sp., Neodiscus sp., Hemigordiospis renzi Reichel (Pl. 7, Fig. 1), Rectostipulina sp., Pachyphloia sp. (Pl. 7, Fig. 10), Frondina sp.; the fusulinids Kahlertina pachytheca Kochansky-Devidé and Ramovš (Pl. 7, Fig. 5), G. ovalis Chediy (Pl. 7, Fig. 8), Pseudokahlertina? sp. (Pl. 7, Fig. 12), Nankinella sp., Sphaeracina cf. croatica Kochansky-Devidé (Pl. 7, Fig. 11), Danbarula sp., Chusenella cf. cheni Skinner and Wilde (Pl. 7, Fig. 9), Verbeekia verbeeki (Geinitz) (Pl. 7, Fig. 13), Neoschwagerina ex gr. haydeni (Dutkevich) (Pl. 7, Fig. 2), N. ex gr. maritiae Deprat (Pl. 7, Fig. 3), N. sp.; plus gastropods, brachiopods, and ostracods.

**Ağlıovası Yayla Siliciclastic Series**

The Ağlıovası Yayla siliciclastic series is a wildflysch-like unit and systematically occupies a high tectonic position above the seamount series. This series corresponds to the Incirbeleni Fm of Şenel et al. (1994) and consists of Mississippian siliciclastic turbidites, graywackes, intact and partly cherty limestones, siliciclastic rocks and mafic volcanic rocks and tuffs (Kozur et al., 1998). The matrix yielded radiolarians and conodonts (CAI = 5-6) (Pl. 8, Figs. 1-4, 6, 8) of Viséan and Serpukhovian ages (Kozur and Şenel, 1999; Stampflí and Kozur, 2006), whilst the blocks and clasts are mostly Tournaisian (Pl. 8, Figs. 5, 7, 9; Pl. 9, Figs. 1-8), Viséan or Serpukhovian. Robertson and Ustaömer (2009b) presented an alternative interpretation where the Incirbeleni 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; Gönçüoğlu et al., 2000; Stampflí and Kozur, 2006). A few badly preserved Carboniferous broken rammiform 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 and graywackes, followed by a thick sequence of dolomites and black, gray and white limestones. It is overlain by thin-bedded black fractured sandstones, brecciated limestones including elements of dolomites, black, gray and white limestones. It is over lain 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 Çengel 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 volcanioclastic sandstones/conglomerates including basalt clasts, continuing with a thick brecciated carbonate interval. There is then a sheared contact with hydrothermally altered basalts, overlain with a stratigraphical contact by volcanioclastic sandstones, themselves overlain by ribbon chert. The succession ends with an interval of non-exposure, above which come reddish conglomerates.
interacted as a transgressive conglomerate at the base of a Mesozoic carbonate platform succession.

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 *Eotuberitina 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 *Rauserella* *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 *Globotruncanite* 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 *Globotruncanite* 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 serpentinines nor peridotites were found. The flysch is overlain by the “Diabase Nappe” or at places by Middle Miocene alluvial and shallow-water deposits. The Hicatea Dağ series represents a lateral variation of the Köyceğiz series and comprises Permian 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 interspecies 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 köy succession (Collins and Robertson,
1999), andesitic lavas are overlain by conglomerates including blocks of radiolarian cherts in a matrix of volcanioclastic sandstones and conglomerates. This is overlain by chaotic conglomerates including blocks of pelagic limestones. This clastic episode is followed by the deposition of pelagic bivalve-rich limestones.

According to de Graciansky (1972), the Köyceğiz, the Teke Dere and the Hatticanea Dağ series form a composite assemblage and correspond to lateral variations within the same palaeogeographical domain. Collins and Robertson (1998, 1999) argued that their “Teke Dere succession” is a combination of the Teke Dere and Hatticanea Dağ (and also Innice and Sarsala) series of de Graciansky (1972). Although the Mesozoic development of the Hatticanea Dağ series is comparable to the Köyceğiz series, the base differs. As shown above, the sedimentation in the Köyceğiz series starts during the Late Triassic with shallow-water carbonates. In the Hatticanea 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, calcarenites and breccias of Late Eocene age (Priabonian) 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 Agılıpovaş Yayla area, a thick Mesozoic sequence conformably overlies the red arkosic sandstones (Çenger Fm?). By definition, it corresponds to the Hatticanea 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 Ağaqlı 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 Agılıpovaş 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 Palaeotethyan, Neotethyan and Huğulu-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 palaeotectonic 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 Stampfl 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 Palaeotethys 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 Palaeotethys 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 Palaeotethyan slab caused the collapse of the Variscan Cordillera. The opening of back-arc basins within the southern margin of Eurasia (e.g., Huğulu-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 Göcek is nearly identical with the series of the southern Beydağları. This comparison can be extended to the Aegean islands of Camili, Sáfora 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 (Stampli 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 Göcek 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 Maasstrichtian/Early Palaeocene to Late Eocene interval (Bozkurt and Oberhänsli, 2001 and references therein) is found above the deep-water strata. At places, Palaeocene and Ypresian sediments were found below the ophiolitic olistostrome (Boray et al., 1973), and Gutnic et al. (1979) reported Early Eocene ages (*Nummulites* spp.) for the uppermost part of the Menderes Massif (*Kyrtalagke* marbles) below the ophiolitic olistostrome. Other “cover series” of the Menderes Massif, e.g., the Çarak Göl and the Tekkeyal 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-Taurid 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 Middle Pennsylvanian (Moscovian) Kiloluk Fm, which was identified below the Permian-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 succession. It is not 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 tubercula* 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 Mostler, 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 and Gerry, 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 *P. murcianus* occurs, a sub-species on which only the platform rudiments are present on the inner side of the blades, 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 Taraçı Limestone of the Geyik Dag autochthonous series (Psidian Triassic) exposed west and southwest of Seydeqir 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 Taraçı Limestone was deposited on the southern part of the Tauric Autochthon, south of the Triassic Apulian-Tauride High, where either no Triassic was deposited or the deposition began during the Rhaetian. During the Triassic up to the Cordevolian, the Apulian-Tauride High separated the Neotethyan fauna with the Longobardian to Cordevolian *Pseudofurnishius murcianus-Theelia tubercula* fauna toward the south and the northern Tethyan fauna, which occurs up to the Cordevolian in the Huglu-Pindos Ocean and its shelves (including the Antalya Nappes), to the north. As pointed out by Kozur (2000), during the Julian the Apulian-Tauride High was broken, and since this time the faunas of the Neotethys and these of the Tethyan areas (Palaotethyan 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 Taraçı 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 Taraçi Limestone (Psidian 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. *cincinnata* (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 Nappe 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 palaeogeographic marker.

Especially interesting is the palaeogeographic significance of the occurrence of the *Pseudofurnishius murcianus* fauna in the Karadagunit. The Triassic part of the latter is similar to the Psidian Triassic of the southern Tauric Autochthon with *Pseudofurnishius* and *Theelia tubercula*. 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; Stampfli 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 mucianus* and *Theelia tuberculata* are typical indicators for the Neotethyan domain of the Westmediterranean-Arabian conodont province and do occur only in the Neotethys sensu stricto and its marginal seas. The oceanic sequences north of the Tauric Autochthon belong to independent Tethyan oceans and not to a so-called “northern branch of the Neotethys.” We assume that 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 Rhetaetan to early Liassic Cenger 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 Tarasçi 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 Saklıklı resort in a peculiar unit of unknown tectonic position above 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 koestkallensis* Zone (Mostler, 1973). However, Saddedin and Kozur (1992) have proven that the *Theelia tuberculata* fauna occurs only in the Westmediterranean-Arabian conodont 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 early 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 *Acanthotheleia c. ortelli* 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 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 Cordevolian of the Antalya Nappes do not contain either any holothurians of the *Theelia tuberculata* fauna or *Pseudofurnishius mucianus*, a derivation from the Antalya Nappes and from the Huglu-Findos 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 autochthons 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 Alborez 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 Taraşçı Fm in the Geyik Dağ autochthon, and the Carnian Belenkovak 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 Yałyaya 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 Çayırm Fm (Gutnic et al., 1979) and the Late Triassic Çamiçi 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 thrusings 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 succession. 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 (Erkan 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; Erkan et al., 1982; Monod and Akay, 1984; Moix et al., 2008a).

### Seamount

As said above, the Ağlıovaş Yałyaya seamount series could be seen as a tectonic slice at the base of the Teke Dere imbricate structures. The different sections logged in Ağlıovaş Yałyaya indicate almost the same age for the OIB-type lavas (earliest or middle Kasimovian) and the associated Gzhelian to early Artinskian platforms 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 Ropian 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 Nilüfer 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 Nilüfer unit is considered to represent Permo-Triassic oceanic plateau (Okay,
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).
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 Nohulturuk Fm and is characterized at its base by Mississippian deep-water sediments made of cherts and volcanic/volcaniclastic rocks of late Tourmaisian/early Viséan age (Tekeli et al., 1984; Güngözülu et al., 2007). The upper part of the Nohulturuk Fm is made of shallow-water limestones of late Viséan age (Okayucu and Vachard, 2006). According to Kozur et al. (1998), the Nohulturuk Fm occupies a similar tectonic position as the Tavas Nappe. However, the general succession could be better compared with a Carnian-type evolution (e.g., Venturini et al., 2009), which represents a Palaeotethys 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 Ağlıovası 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, limestones, 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 yield a Ropian 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 Indoasian 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 Mois, 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 Peloponnesian (Olonos series), in Crete (Ethia, Mangassa and Lentes series), in Karpathos (Xindithio series), in Rhodes (Prophitis Ilia 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 Köyceğiz series in the Lycian...
Nappes. Although reconstruction of stratigraphic sequences is hampered by small and discontinuous outcrops, the Köyceğiz series of southwestern Turkey extends in several islands of the southeastern Aegean Sea, like Symi, Tilos, Chalki, Kos, Rhodes, Karpathos and Crete (Bermoulli 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 (Bermoulli et al., 1974), part of the Antalya Nappes including a flexure during the Campanian (Moix et al., 2009), the Huğul and Boyalı Tepe units in the Besehir–Hoyran Nappes (Gutnic et al., 1979; Andrew and Robertson, 2002), some exotic sequences at the base of the Mersin ophiolite (Moix et al., 2007), and comparable sequences found in Elbistan (Tekin and Bedi, 2007a, b). Hence, the passive margins of both the Anatolian and Siťia-Pindos terranes represent the southern margin of the Triassic Palaeotethyan back-arc Huğul-Pindos Ocean (Moix et al., 2008a), the Huğul part of it being in Turkey and the Pindos part in Greece.

The Pindos (–Olonos) 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 Huğul-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 oрогenic 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 Huğul-Pindos signal is separated into a Pindos sub-signal on the Greek transect and a Huğul sub-signal on the Turkish transect (Moix and Stampfli, 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 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 tufts), interspersed by pelagic and redeposited 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 Sima 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 Ağılıfı Fm described in the Mesozoic succession of Ağılovaş 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 Palaeotethys. This is consistent with the models proposed by Stampfli and Kozur (2006) who argued that the Huğul-Pindos Ocean is a Palaeotethyan back-arc which opened in the Palaeotethyan 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 Lacian 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 Mesoozoic pelagic sequence (Davidson Monett, 1974). Conodonts in the pelagic limestones at the base of the unit yielded Epigondolella quadrata Orchard, E. rigoi Kozur, Neohindeodella dropla (Spasov and Ganey), and Norigondolella navicula (Huckriede), characteristic of the early to middle Lacian interval. Hallstatt Limestones of the Carnian–Norian boundary (Carnepigondolella orbardi 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 Mesoozoic sequence preceding an early to middle Maastrichtian flysch (Muttit et al., 1970; Leboulenier, 1975). Pelagic limestones interstratified at the base of the detrital interval yielded late Carnian radiolarians (early Tuvalian Spongotoritripus sp.). This unit, plus middle to late Carnian conodonts including Paragondolella noah (Hayashi) and P. carpathica (Moc). 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 clay deposits at the base of the series yielded late Ladinian to early Carnian conodonts including Paragondolella foliata (Badurov and Gladigondolella multi-elements), whereas middle late Carnian limestones associated with sandstones yielded Paragondolella noah (Hayashi) and P. carpathica (Moc).
Huglu-type area. In the Öyuklu 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 tuftfis 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 subbullatus Zone. Nevertheless, the relationship between these Hallstatt Limestones and the tuftfis is not demonstrated (Gökdeniz, 1981). The brownish altered lavas and tuftfis found at the base of the Huglu tuftfis and above turbiditic sandstones are interstratified by pelagic limestones, which yielded the Carnian ammonoid Joannites cymbiformis (Wulfen). In the Beştehisar-Hoyran Nappes, the Boyalı 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 Sononian. 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 Boyalı Tepe series were likely situated in a distal position within the Anatolian basin (Moix et al., 2008a).

In the Tavuşcaşar in the Sorgun ophiolitic mélangé, the Huglu-type green tufts conformably overlie well-dated Hallstatt Limestones belonging to the late Julian Trachyceras austriacum Zone. These limestones overlie a paleotopography made of massive neritic and reeval limestones (Moix et al., 2007). This proves a latest Julian to earliest Tujalian 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 Tujalian (Carneipil existing orchard Zone) or earliest Norian (Epigondolella quadrata Zone) in age. The Late Triassic pelagic limestones extend 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, Porpoceras and Calliphylloceras. This Ammonitico Rosso may be correlated to the well-known successions found in allochthonous sequences in Turkey, such as the Boyalı Tepe and the Öyuklu Dağ in the Beştehisar-Hoyran Nappes (Gutnic and Monod, 1970; Özgül, 1976; Gökdeniz, 1981), the Gökgöl unit near Dinar (Gutnic et al., 1979), the Çumüşli and the Domuz Dağ units in the Lycian Nappes (Brønnimann et al., 1970; Poisson, 1977; Gutnic et al., 1979; Dommergues et al., 2005), the Urb section in the Bornova flysch zone (Okay and Alliner, 2007) and the Şenköl Formation in the Pontides (Kandemir and Yilmaz, 2009). The easternmost occurrence of Huglu-type development is known in the Köseayha Nappes 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 Ağlıovaş Yayla is highly composite. The Karadağ unit forms its base and represents the Göndwana-derived carbonate platform belonging to the Taurrus GDU. The intermediate part is represented by the Teke Dere unit, which contains different fragments of the Palaeeothyan 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 between Greece and Turkey.

(1) Neothethys: The Ağlıovaş 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 Neothethyan 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 Neothethyan (= East-Mediterranean) rifting. Thus, we regard the Ağılovvaş 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) Palaeothethys: Several Palaeothethyan 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 sequence. The palaeobiogeographical faunal affinities of the and Pindos-type sequences, both in the Yayla autochthonous and Nif series as being part of the south-ehir-Hoyran l u-Pindos Ocean. The recognition of these various units brings new autochthon. The units in the Lycian Nappes (Brønnimann et al., 1970; Öktem and Bedi, 2007a, b). There, the Hallstatt Limestones are transitional to a poorly developed Huşuçaşar Fm in the Pontides (Kandemir and Yilmaz, 2009). The condensed units of Liassic age in Pindos-type sequences and the time of closure of the Paleothethyan Ocean and the nappe thrusting on its former southern passive margin (Late Triassic) can be dated. The Teke Dere series always overlap 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 Eocimmerian 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 obducing front passed over the terrane and continued its course to the southwest, following roll-back of the Neothethyan 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 Sitia-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 Palaeeothethyan, Neothethyan and Pindos units in the Lycian Nappes, new tools and precise correlations can be proposed: (A) The typical Neothethyan 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 Tarama 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 Palaeoetethys 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 Incircelbeni Fm is comparable with the Karareis unit in the Karaburun Peninsula. These Carboniferous siliciclastic series represent the northern active margin of Palaeoetethys, 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 Palaeoetethys Ocean. Similar units are also found in Chios, Lesbos, in the Internal Hellenides, and in the Aladağ Mountains. Until now, the Ağırəsəs Yayla arc series interpreted to represent fragments of the Palaeoetethyan arc has no equivalent elsewhere in Turkey, except maybe in Konya. In Ağırəsəs 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 Palaeoetethyan arc or fore-arc series. (C) The classical Pindos-type series in Greece, the Köyceğiz and Hittlee Dağ series in the Lycian Nappes, part of the Antalya Nappes, the Beyşehir-Hoyran Nappes, broken-formations in the Mersin mélangé, and the Köseyahya Nappe in Elbistan; all this composite assemblage represents segments of the northern Mesozoic passive margin of the Anatolian GDU (Hugh-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 subduction 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 1. Middle to Late Eocene foraminifers association of the Beydağları 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 pseudomontiparus 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, Archaeolithophyllum 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, longitudinal 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, Rausertes 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, Deckerella 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, Ozawainella 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 Ağlıovası Yayla autochthonous series. Figs. 1-3, Aulotortus ex. gr. sinuosus (Weynschenk), 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 whors 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, Triadiddous 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, Endotebanailla kocaeliensis (Dager) emend., sample 165/06. Figs. 12-13, Endotriada tyrhenica Vachard, Martini, Rettori and Zaninetti. Fig. 12, Sample 166/06. Fig. 13, Sample 138FR. Figs. 14-15, Piallina tethys Vachard and Moix, oblique subtransverse section, sample 165/06. Fig. 16, “Trochammina” alpina Kristan-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 Kristan-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, Aşığısı 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_06_71. Fig. 2, Lateral view, rep.-no.: 3_07_1_167_06_72. Fig. 3, Lateral view, rep.-no.: 3_07_1_167_06_73. Fig. 4, Pseudofurnishius murcianus murcianus van den Boogaard, upper view of a specimen with broken posterior blade, Aşığısı 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_2009_328_07_62. Fig. 5, Pseudofurnishius murcianus n. subsp. B Gullo and Kozur, 1991, Aşığısı 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_2009_328_07_61, a, lateral view, b, upper view. Fig. 6, Sculptured Bairdidae, 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 Bairdidae which lived below the storm wave base, Aşığısı 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_2009_328_07_66. Fig. 7, Polycopsis n. sp. ex gr. P. cincinnata, (Apostulescu), Aşığısı 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_2009_328_07_68. Fig. 8, Theelia tuberculata Kristan-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_2009_K 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_2009_K 30. Fig. 10, Acanthotheelia cf. oerttii, 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_2009_K 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, Montiparus ex gr. sinuosus 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, Raurerites aff. rugosus (Rozovskaya), axial section, sample 351/07, Gzhelian. Fig. 8, Raurerites 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 pachytheca Kochansky-Devidé and Ramovš, axial section, sample 356/07. Fig. 6. Likanella spinosa Milanovic, transverse section, sample 356/07. Fig. 7. Endoteba 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. 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 Ağlıovas Yaşa, 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. 21-1-99/1-16. Fig. 2, rep.-no. 21-1-99/1-21. Fig. 3, x 70, sample K 60, rep.-no. 21-1-99/1-18. Fig. 4, Mestognathus cf. bipluti Higgins, x 50, sample K 60 (see Figs. 1-3), rep.-no. 21-1-99/1-13. 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. 21-1-99/1-30. Fig. 7, rep.-no. 21-1-99/1-29. Fig. 6, Kladognathus sp., Sc element, x 100, sample K 60 (see Figs. 1-3), rep.-no. 21-1-99/1-20. Fig. 8, Lochriea ziegleri Nemirovskaya, Perret and Meischner, x 100, sample K 60 (see Figs. 1-3), rep.-no. 21-1-99/1-17. 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. 21-1-99/1-14.

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 Ağlıovas Yaşa, 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. 21-1-99/1-15. 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. 21-1-99/1-24. Fig. 3, rep.-no. 21-1-99/1-25. Fig. 8, rep.-no. 21-1-99/1-26. 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. 21-1-99/1-10. 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. 21-1-99/1-23.

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 Ağlıo-establishment 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**