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FIRST FINDING OF LATE SILURIAN CONODONTS FROM THE "ORTHOCERAS LIMESTONES", CAMDAG AREA, NW TURKEY: PRELIMINARY CONSTRAINTS FOR THE PALEOGEOGRAPHY

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Abstract

The Paleozoic succession of the Camdag area is located between the Paleozoic rocks of the Istanbul and Zonguldak terranes in NW Turkey and has a key location for the paleogeographic position of these terranes. The Silurian deposits in this area includes from bottom to top: the Black Shale Member (gray to greenish gray, well cleaved shales with minor black siltstone and limy shale interlayers), the Shale - Limestone Member (black shales with limestone and dolomitic limestone interlayers), and the Shale-Siltstone Member (alternation of black shales, light gray quartz-rich siltstones with few limestone lenses) that is concordantly followed by Lower Devonian deposits. The "Orthoceras Limestones" of the middle member yielded a poorly preserved conodont fauna indicating a Pridoli age. By this, the Paleozoic of the Camdag is considered to be the eastern continuation of the Istanbul Terrane. Moreover, this new finding of Late Silurian black shale – "Orthoceras Limestone" assemblage in NW Turkey, which is a wide spread paleogeographic marker in the Carnic Alps and elsewhere in Europe may help to correlations with coeval and analogous facies of other paleobiogeographic areas in the peri-Gondwanan realm.

Introduction

In North Anatolia, the E-W trending Paleozoic-Mesozoic rocks cropping out between Istanbul and Cide (Fig.1) belong to the alpine Central Rhodope -Pontide fragment of Sengör and Yilmaz (1981) or Istanbul Unit of Okay (1989). The Paleozoic formations in this unit are classically known as the "Paleozoic of Istanbul" and were incorporated to the Istanbul Nappe of Sengör *et al* (1984).

The Istanbul Nappe was considered to be a continuous tectonic unit that consists of a Cadomian crystalline basement with oceanic and island arc-type rocks (e.g. Göncüoglu *et al*., 1996-1997, Ustaömer and Rogers, 1999), unconformably overlain by a Paleozoic sequence, extending without any major depositional breaks from Ordovician to Late Carboniferous (e.g. Görür *et al*., 1997). According to Sengör *et al*. (1984) this Paleozoic succession is characterized during the Ordovician-Early Silurian period by graben-facies deposits followed by Atlantic-type continental margin sediments of Late Silurian-Late Devonian age. It is prevalently accepted that the "Istanbul Nappe" was part of the eastern European "Hercynian chain". During Cretaceous it has been rifted from the Moesian platform, drifted towards south and collided with the Cimmerides (Okay *et al*., 1994) during the early Eocene.

In a recent work (Göncüoglu *et al*., 1996-1997) it has been shown that the alpine units in northern Anatolia include quite different pre-alpine tectonostratigraphic units or terranes. These terranes correspond to the remnants of active and passive continental margins, arc and suture complexes, associated with Cadomian, Caledonian, Hercynian and/or Cimmerian events.

New stratigraphic results based on a careful review of the previous data and additional micropaleontological findings in the Paleozoic sequences in the area between Istanbul and Zonguldak (Göncüoglu, 1997; Göncüoglu and Kozur, 1998, 1999) have largely changed the former picture. It has been shown that there are considerable differences in the stratigraphy of the eastern and western parts of the "Istanbul Nappe" of Sengör *et al*. (1984) that can't be simply ascribed to lateral facies changes or local uplifting events as previously proposed (e.g. Kaya, 1978; Önalan, 1982; Gedik, 1988; Aydin *et al*., 1987, Derman and Tuna, 2000). In their new model Göncüoglu and Kozur (1998, 1999) suggested that the "Istanbul Nappe" actually includes two different terranes: "Istanbul Terrane s.s." in the west and the "Zonguldak Terrane" in the east.

The most characteristic differences between the Paleozoic successions of these terranes are the following (Kozur and Göncüoglu, 2000):

-a post Silurian-pre-Emsian regional unconformity accompanied with a Late Silurian thermal event in the Zonguldak Terrane contrasting with the continuous deposition in the Istanbul Terrane within the same time-span.

- deposition of shallow-water carbonates and clastics during the Tournaisian - lower Namurian in the Zonguldak Terrane contrasting with the deposition of radiolarian cherts and flysch-type sediments during the Tournaisian and Viséen in the Istanbul Terrane.

Even if much remains for the detailed distribution of the units in NW Anatolia, the Istanbul Terrane mainly covers Istanbul and Gebze areas, whereas the Zonguldak Terrane is represented by the Paleoz oic outcrops in the Zonguldak, Amasra and Safranbolu regions (Fig. 1). The Paleozoic rocks of the Camdag region, which are located geographically between Istanbul and Zonguldak terranes, remained an uncertain entity, as there was no detailed stratigraphic work in this area, which may help to identify its original position. Previous studies (Kipman, 1974; Kaya, 1982; Aydin *et al*., 1987) only suggested that there were no Silurian rocks encountered and hence the Camdag Zone must have remained as an elevated "paleohigh" through most of the Ordovician and Silurian.

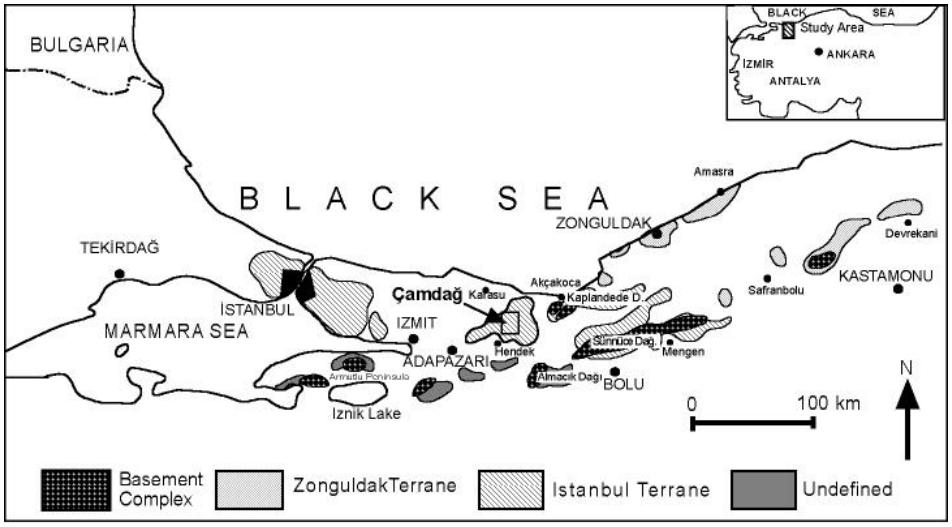

Figure1

Figure 1: Distribution of the Paleozoic rock-units in NW Anatolia and the location of the study area.

In this study the authors will present their preliminary field data and fossil findings from the "Orthoceras Limestones" of the Camdag.

The Late Silurian-Early Devonian stratigraphy of the study area will be correlated with the Istanbul and Zonguldak areas in Turkey and with those of the eastern Balkan tectonic units in Bulgaria in order to eval uate its paleogeographic position in regard with the Gondwanan/Peri -Gonwanan terranes.

Geology and stratirgaphy

The Camdag "Massif" is located to the NE of Adapazari and covers an area of ca 400 km^2. The southern part of the massif is mainly represented by N-dipping clastic-siliciclastic rocks of ?Ordovician age (Kaya, 1982; Aydin *et al*., 1987). The central

and northern parts are occupied by a roughly E-W trending anticline, dissected by numerous south-verging thrust-faults. The border between the southern and central-northern parts seems to be an important tectonic boundary.

The generalized columnar section of the Camdag area with a brief description of the rock-units is given in Figure 2. During the field-study the authors mainly concentrated on the Silurian-Lower Devonian rocks, which will be described in detail.

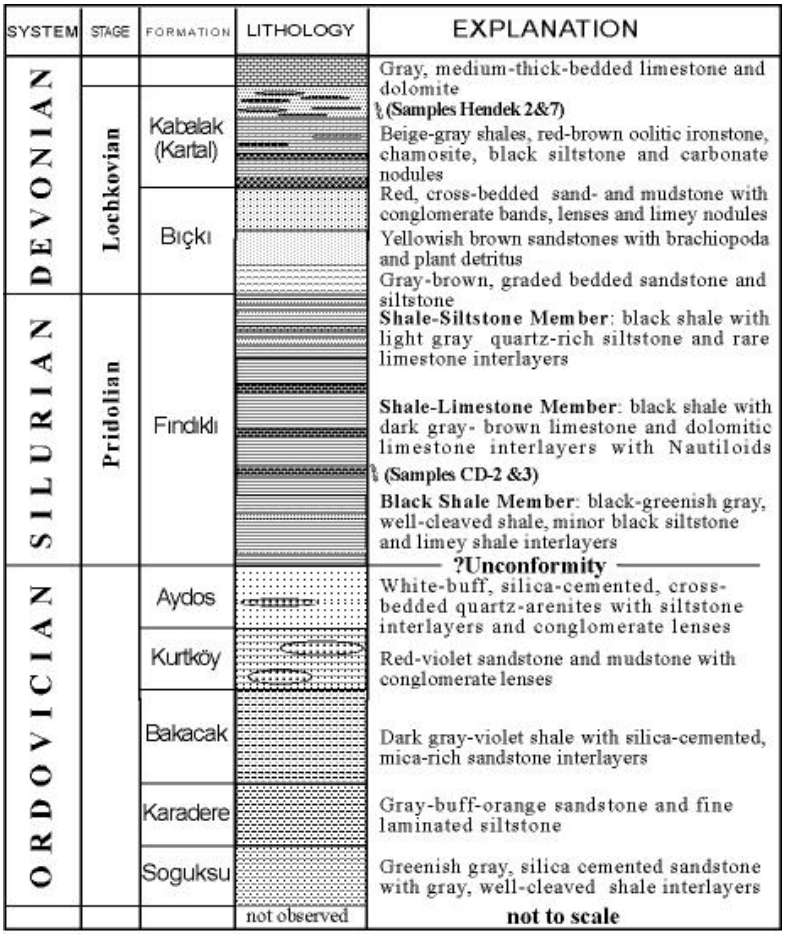

Figure 2

Figure 2: Generalized columnar section of the Paleozoic rocks in Camdag area.

The studied part of the Upper Silurian-Lower Devonian rocks is located between Mollahasan Tepe and Kuruderе Village on the Hendek-Karaali road in the central part of the Camdag (Fig. 3). The studied section starts at the main fault at the Süngüt road-junction where recrystallized, thick-bedded Devonian limestones juxtapose the violet-red-gray silica-cemented, slates with sandstone interlayers that resemble the Ordovician Bakacak Formation.

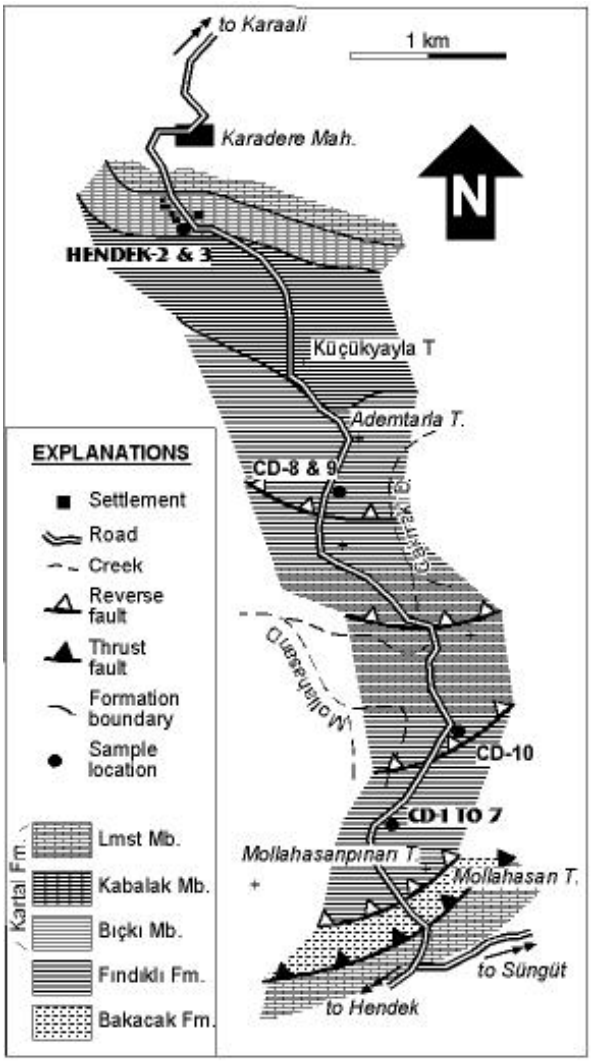

Figure 3

Figure 3: Road-map of the studied Upper Silurian-Devonian succession in central-northern Camdag area.

Upwards they are followed by a thick and monotonous succession of gray to greenish gray, well cleaved shales with minor black siltstone and limy shale interlayers. This succession was established first by Kipman (1974) in the northern part of Camdag area as the Yayla Formation of the Camdag Group but erroneously assigned to Lower Devonian. It is also part of the Silurian Findikli Formation of Yazman and Cokugras (1984) that was recognized first in the Kaplandede Dag area (Fig.1) to the west of the study area and was later mapped in several parts of the Paleozoic belt in the eastern Istanbul Nappe (*sensu* Sengör et al., 1984). The contact to the underlying Bakacak Formation is sharp and highly sheared. Moreover, the very typical variegated coarse clastic rocks of the Kurtköy Formation and the quartzites of the Aydos Formation (compare with Figure 2) are not represented here. We therefore suggest that this contact is a thrust-fault rather than an unconformity. The

lower part of the succession is informally named here as the Black Shale Member of the Findikli Formation. It grades into black shales with limestone and dolomitic limestone interlayers (Shale-Limestone Member). The limestones are intensively folded, dark gray to brown in color, and very rich in cephalopods, crinoids and brachiopods (Fig. 4).

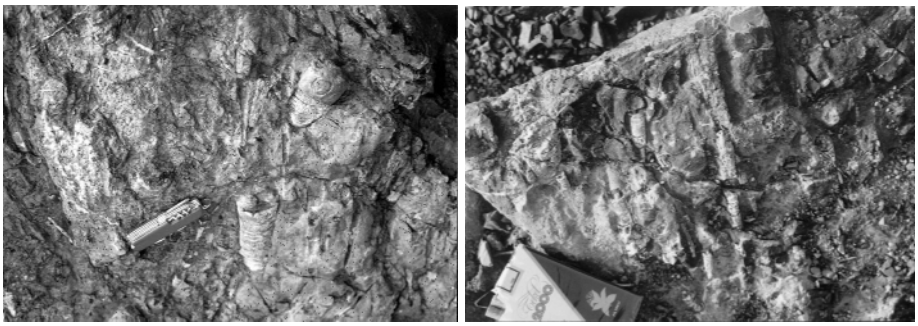

Figure 4: Mesoscopic occurrence (a) of the "Orthoceras Limestone" and the parallel orientation of the orthocone shells (b) on the road cuttings along the Hendek-Karaali road.

Only two samples (CD-2 and CD-3) from the first limestone band along the road cuttings yielded a poorly preserved conodont fauna. The Shale-Limestone Member is repeated down the section at least 3 times along south verging thrust faults, and is isoclinally folded so that the apparent thickness of 1100 meters does not reflect the original thickness. The upper part of the Findikli Formation is represented by an alternation of black shales, light gray quartz-rich siltstones with few limestone lenses (Shale-Siltstone Member). The thickness of quartz-rich bands varies between 7-10 m. Individual limestone bands reach up to 7 m in thickness and occur as lens-shaped bodies. They display transitional contacts to the surrounding black limy shales. Within individual packages by increasing lime content they grade into thin-bedded, dark gray limestones and finally into gray, massive limestones in the central part. These limestones are characterized by up to 30 cm long orthocone cephalopods (Orthoceratidae, according to preliminary determination of Dr. Olga K Bogolepeva, Uppsala). The cephalopod cones are oriented with their long axes in a unidirectional position, which may indicate current and/or storm wave transportation. The most typical exposures of the Shale-Siltstone Member are found between the shale quarries and the fountain to the south of Ademtarla Tepe along the road (Fig. 3).

The Shale-Siltstone Member shows a gradational contact to the overlying Kartal Formation of Kaya (1973) that was locally named as the "Bicki Formation" by Kipman (1974). In the studied section this formation starts with gray to brown sandstones with some gray siltstone layers and grades upward into yellowish-brown

sandstones. The individual sandstone layers show graded bedding and are characterized by an enrichment of brachiopoda and plant-detritus in their basal part. Few brachiopoda-rich limy sandstone lenses are encountered. These sandstones are followed by red sandstones and mudstones and contain red colored conglomerate bands and lenses. The succession is typified by well-developed cross-bedding and includes rare limestone nodules. Towards top beige and gray shales with bands of red Fe-oolites, chamositic limestone bands and black siltstones with carbonate nodules dominate over sandstones. This part of the succession is also characterized by the presence of brachiopod, crinoids and bivalvia-rich carbonate nodules and concretions, up to 20 cm in diameter. In two of these concretions (Sample no: Hendek 2 and Hendek 7) very close to the end of studied section at the southern outskirts of Karadere Mahallesi we found single conodonts of Lower to lowermost Devonian age (Göncüoglu et al., in prep.). Thick-bedded dolomites and limestones with Amphipora sp represent the uppermost part of the studied section.

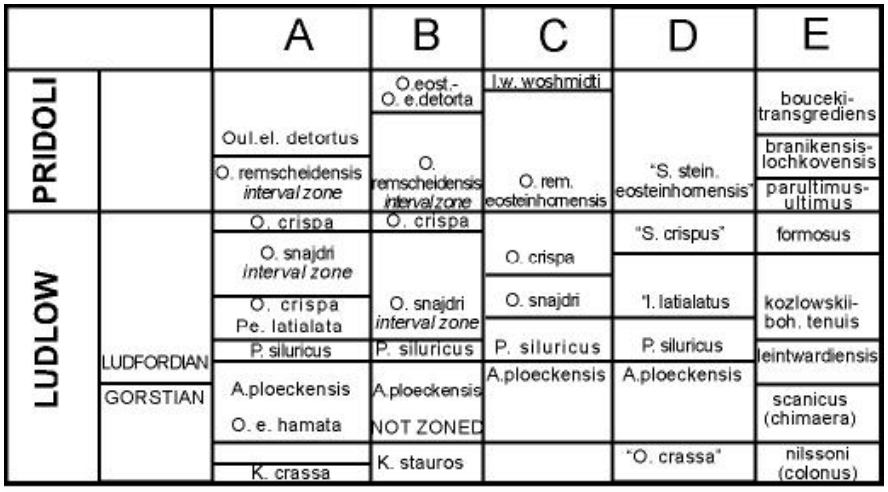

Figure5

Figure 5: Upper Silurian conodont and graptolite zonation. Column A: Corradini and Serpagli, 1999; Column B: Silurian Times, No 3, 1995 (in Corradini and Serpagli, 1999); Column C: Aldridge and Schonlaub, 1989 (in Corradini and Serpagli, 1999); Column D: Walliser, 1964; Column E: Graptolite Zonation, Silurian Times, No 3, 1995 (in Corradini and Serpagli, 1999). The correlation chart is modified from Corradini and Serpagli (1999).

The detailed stratigraphy of the overlying Devonian rocks in the Camdag area is beyond the scope of this study and will not be evaluated in this work but is given in Kipman (1974) and Derman and Özcelik (1993).

Conodont faunule

Only two samples (CD-2 and CD-3) of twelve from the Shale-Limestone Member of the Findikli Formation yielded some conodonts, illustrated in Plate 1. Numerous limestone samples from the Black Shale and Shale-Siltstone members are barren of

any fauna. Similarly, only two samples (Hendek-2 and Hendek-7) from the carbonate concretion-rich upper part included some conodont fragments of stratigraphic value.

From the Shale-Limestone Member, the conodont abundance is extremely low. All the elements are poorly preserved and fragmentary, which makes taxonomic determinations difficult. The conodont Colour Alteration Index (CAI) value is 5, indicating heating temperatures in the range of 300-480° C (Epstein et al., 1977; Rejebian et al., 1987).

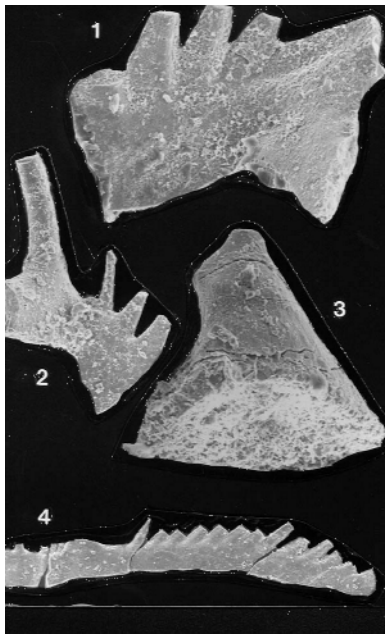

Plate I

All illustrated samples are from the Hendek-Karaali road-section in the Camdag area, NW Turkey. Figure 1: *Ozarkodina eosteinhornensis*? (Walliser) Sc element, lateral inner view, Sample CD-2, rep. No: CD-2/2, x250; Figure 2: *Oulodus elegans*? (Walliser), Sc element, Sample CD-3, rep. No: CD-3/3, x170; Figure 3: *Pseudooneotodus*? sp. Sample CD-3, rep. No: CD-3/5, x230; Figure 4: *Ozarkodina excavata*? (Branson and Mehl). Sc-Sd element, Sample CD-2, rep. No: CD-2/1, x100.

All samples are reposited in the archives of the Paleontology Department of the General Directorate of Mineral Research and Exploration (MTA), Ankara.

Sample CD-2 contains posteriour process of S elements that have been attributed with doubt to *Ozarkodina excavata*? (BRANSON & MEHL). These fragments exhibit denticles of uniform size that decline toward the posterior. Only one ramiform element is assigned with doubt to *Ozarkodina eosteinhornensis* (WALLISER)?. This partially broken Sc? element with small elliptical basal cavity confined to the area beneath the cusp seems to be continued as a very narrow groove under the processes. The descendent anterior process which forms with the posterior process an angle of approximately 110°, resemble in these aspects to *Ozarkodina eosteinhornensis* (WALLISER), but the denticles of the anterior process

are bigger and more widely spaced than the corresponding species. For this reason we assigned this element to *O. eosteinhornensis* (WALLISER)?.

From the sample CD-3, elements of *Oulodus elegans* (WALLISER)? and *Pseudooneotodus*? sp. were found. Only one fragmentary Sc element with prominent cusp and curved downward anterior process supporting long and discrete denticles has been assigned with doubt to *Oulodus elegans* (Plate 1, Fig. 1).

Due to the scarcity of conodont data, only a tentative age could be assigned to the Shale-Limestone Member of the Findikli Formation.

The stratigraphic range of *Oulodus elegans* (including both subspecies) is approximately from the middle Ludfordian to the uppermost Pridolian. Cooper (1980) erected the *Ozarkodina eosteinhornensis* Superzone that starts above the *Ozarkodina crispa* Datum. In Sardinia, *O. eosteinhornensis* is found with *Ozarkodina remscheidensis* below the first occurrence of *Icriodus woschimdti* (Oliveri and Serpagli, 1990).

Walliser (1964) proposed the first Silurian conodont zonation based on the Cellon Section of the Carnic Alps (Austria). The author recognized twelve successive first appearance zones. Several of Walliser's biozones have been widely applied, but some difficulties to recognize his complete scheme in other parts of the world justify the proposal of local zonations. (see Corradini and Serpagli, 1999).

Walliser (1964) was the first to identify the "eosteinhornensis Zone" within the entire interval of the Pridoli Series. Several years later, upon the base of new findings in detailed studies in other areas, two conodont zones were recognized for the Pridolian times. According to the global scheme reported in Silurian Time No:3, much of the Pridoli could be characterized by the *Ozarkodina remscheidensis* interval Zone, being its uppermost part identified by the coexisting of *Ozarkodina eosteinhornensis* and *Oulodus elegans detorta*. From Sardinia, Corradini and Serpagli (1999) proposed a Silurian conodont biozonation and provided detailed information about word-wide occurrence of *O. eosteinhornensis*.

Although no index species have been found yet in the Silurian materials of the Camdag area, a Pridolian age could be tentatively attributed to the Shale-Limestone Member of the Findikli Formation.

Within this time interval, conodont faunas, as well as carbonatic episodes have been summarized by Garcia-Lopez et al. (1996) from a large region that extends from Ardennes to western and central Sahara. In that large area "Orthoceras Limestones" of Pridoli age mainly occur in the Armorican and Mouthomet Massifs, as well as in the Eastern Pyrenees. On the other hand, Vai (1999) claims that the black anoxic shales intercalated with micritic orthoceratid limestones represent the

dominant facies almost the entire circum-Mediterranean Silurian. Most of these occurrences are characterized by oriented orthocone shell distribution, as it is the case in Camdag area. This feature is attributed to bottom currents associated with storm-wave activity (e.g. Gnoli et al., 1980) in an environment with alternating oxygenated low submarine calcareous seamounts and shallow purely shelly anoxic depressions only a few hundred meters deep.

Correlation with the units in NW Turkey and surrounding areas

Although the presence of the Silurian rock-units in the Istanbul area is known since the pioneering studies of Tchihatcheff (1864) our knowledge on their distribution and stratigraphy in NW Anatolia is still very fragmentary.

Comparatively detailed work on the Silurian is mainly performed in the Istanbul area (Paeckelmann, 1938; Yalcinlar, 1956; Baykal and Kaya, 1965; Haas, 1968; Kaya, 1988; Önalan, 1982). For the Ludlowian part of the Silurian succession that may be correlated with the Camdag succession the most reliable and detailed data is given in Paeckelmann and Sieverts (1932), Haas (1968) and Kaya (1973).

In our correlation we will use the original stratigraphic nomenclature and fossil determinations of Haas (1968) for the reasons of priority. As some of the conodont species mentioned in the original study are now in morphotaxonomy and are included in several apparatuses in multi-elemental taxonomy we have used the new taxonomic names or have put them in quotation marks.

According to Haas, (1968) the Ludlowian succession in eastern Istanbul (Gebze area, Figure 6) is mainly characterized by the “Akviran Serie”. It corresponds to the Dolayba Limestone of Kaya (1973). The lowermost formation (Cakillidere Schichten) of the “Akviran Serie” is made up of gray, irregularly bedded, fine-grained limestones with *Kockelella* sp. and *Polygnathoides siluricus* BRANSON and MEHL, so that this unit has been ascribed to the *siluricus*- Biozone of Walliser (1964). They are followed by stromatopora and tabulata-rich, irregularly bedded limestones (“Untere Pelitli Schichten” ascribed to *latialatus* and *crispus* zones of Ludlowian) that grade into nodular limestones (Obere Pelitli Schichten). The latter include *Ozarkodina crispa (*WALLISER) at its basal part (“Flaserkalke” of Haas, 1968) and *Ozarkodina steinhornensis eosteinhornensis* (WALLISER), *Ozarkodina confluens* (BRANSON and MEHL), *Ozarkodina excavata* (BRANSON & MEHL) and *Ozarkodina remscheidensis* (ZIEGLER) in the following part with big nodules. These findings indicate a transition between *crispa* and *eosteinhornensis* biozones of Walliser (1964) and hence the Ludlowian-Pridolian boundary according to the new

stratigraphic nomenclature. Haas (1968) mentioned that the trilobites in this member have strong affinities to Baltic and Wales fauna. Upwards follows a ca. 200 m thick formation with black, thin-bedded limestones (Kirechane Schichten) and bituminous limestones (Osmanoglu Dere Folge) that contain only *O. steinhornensis eosteinhornensis* (WALLISER), whereas the overlying black to gray limestones with well-developed flaser stucture (Cakal Dere Folge) include *Icriodus woschmidti* ZIEGLER, *Ozarkodina remscheidensis* (ZIEGLER), O. *steinhornensis remscheidensis* (WALLISER), *O. wurmi* BISCHOFF and SANNEMANN and "*Trichonodella inconstans*" WALLISER. Based on this conodont data Haas (1968) suggested that this assemblage represents the *woschmidti* biozone of Walliser (1964) and the Silurian-Devonian boundary is located within these limestones ("Flaserkalke" of the Cakal Dere Folge).

The "Akviran Serie" in the Istanbul area is conformably overlain by the "Marmara Serie" of Haas (1968). The lowermost formation of this unit is represented by the "Soganli Schichten" which includes in its lower part (nodular limestones of the "Untere Soganli Schichten") *Ancyrodelloides trigonica* BISCHOFF and SANNEMAN, *Icriodus latericrescens* BRANSON and MEHL and some other forms indicative for Siegenium. The upper part of this formation is represented by bluish gray shales with carbonate nodules (Obere Soganli Schichten). Next to *Icriodus latericrescens beckmanni* ZIEGLER, *Polygnathos linguiformis* HINDE *and Ozarkodina steinhornensis steinhornensis (*ZIEGLER) this unit contains big Orthoceratidae and Cyrthoceratidae and has been ascribed to Emsian. Haas (1968) mentioned that the trilobites in this unit have similarities with the Pragian and Marocco fauna. With the occurrence of the first chamositic nodules and layers within a carbonate-rich sandstone matrix the next formation (Kartal Schichten of Haas, 1968) starts. This unit is very rich in brachiopods and has been dated as Upper Emsian.

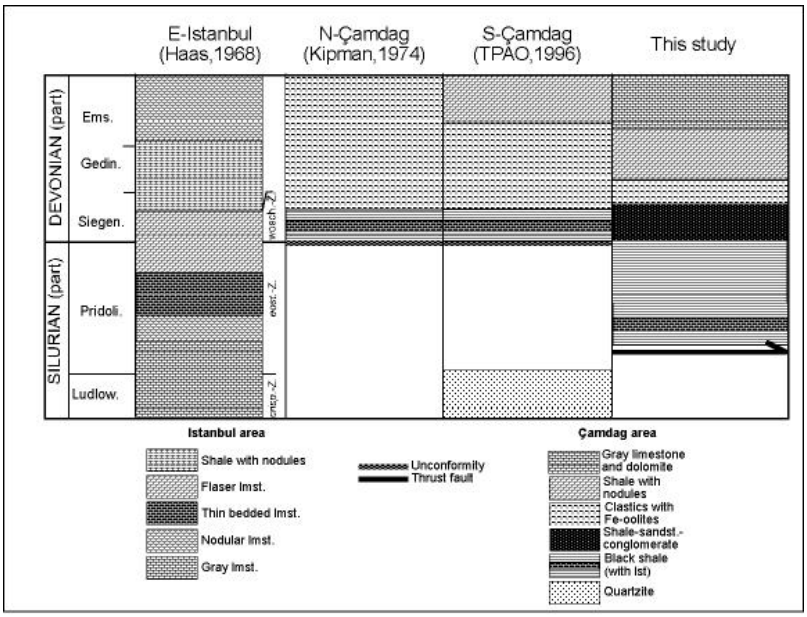

Figure 6

Figure 6: Correlation chart of Upper Silurian and Lower Devonian rock-units in NW Anatolia.

The depositional environment of the Upper Silurian and Lower Devonian rock-units in the Istanbul area have been discussed in detail by Haas (1968), Kaya (1978), and Önalan (1982). There is an overall agreement that the lower part of the succession (including the "Untere Pelitli Schichten") is represented by reef-type carbonate deposition. Starting with the deposition of flaser and nodular limestones (Obere Pelitli Schichten) of Early Pridolian age a transition to basin-type deposition is suggested, that prevailed during the deposition of Icmeler and Osmanoglu Dere formations of Late Pridolian age. A shallowing-upwards and transition to typical Hercynian-type deposition is manifested for the Siegenian rocks (uppermost part of the "Akviran Serie" and the "Marmara Serie" of Haas, 1968).

Compared with the Istanbul area, there are only very limited data on the Late Silurian–Early Devonian rock-units in the Camdag area and to the east of it, which had been mainly studied by the Turkish Petroleum Corporation (TPAO). In Kipman (1974) and in the unpublished maps of TPAO (1983, 1985) the Upper Silurian black shales and limestones in the Camdag area (described in this study) were considered as the lower part of the Devonian Kartal Formation. On the other hand, further east in the Kaplandede Dagi area Yazman and Cokugras (1983) regarded the same rocks as a new formation (Findikli Formation) that was later discovered in Yigilca, Eregli and Mengen areas (Aydin and Sahintürk, 1986; Aydin *et al.*, 1987). The age data in these areas are very limited and is based on a single graptolite finding (*Pristiograptus dubius* (SUESS) in Aydin *et al.*, 1987). The misidentification of the Upper Silurian

black shales and limestones in the Camdag area lead Aydin *et al*. (1987) and also Derman and Tuna (2000) to the following tectonic conclusion: “The Silurian rocks were either not deposited or eroded in the Camdag area. The Devonian succession is discordant on older units that indicate an important tectonic event during the Taconian phase of the Caledonian orogeny”.

The Paleozoic succession in the Karadere-Zirze area (Safranbolu), representative for the Zonguldak terrane, was studied by Dean et al. (1997, 2000). In this area, the Silurian succession (Findikli Formation) in its topmost part is represented by black, monograptid graptolite-bearing shales with *Monograptus flemingii* (Salter) and *Pristiograptus* cf. *parvus* (Ulst), indicative for the upper part of the Wenlock series. The black shales are unconformably overlain by Devonian conglomerates and carbonates. The “Orthoceras Limestones” found in the Camdag were not encountered in this succession.

In Bulgaria, Silurian sediments were encountered in the Balkan (Svoge anticlinorium and Kraishte section) and in the Meosian (subsurface data from the boreholes R-2 Vetrino and R-3 Gomotartsi) terranes (Yanev, 1992, 1998; Sachanski, 1998). Pridolian sediments in the Balkan Terrane are included in the Yaboukov Dol formation, and are mainly made up of greenish gray colored, laminated slates with siltstone interlayers and rare crinoidal limestone nodules. In the Meosian terrane, the Pridolian part of the succession is represented by argillites that include chitinozoa (Lakova, 1985). Compared with the Camdag succession, the Bulgarian Pridoli sediments lithologically resemble the “Shale Siltstone Member” of the Findikli Formation. Both in Turkish and Bulgarian successions, Silurian sediments are concordantly covered by Lower Devonian deposits, which strongly contrasts with the distinct Lower Devonian unconformity in the Zonguldak terrane.

Conclusions

The Camdag area has a key position in the aerial distribution of the Istanbul and Zonguldak terranes in NW Anatolia. In the previous studies (Kozur and Göncüoglu, 1999) the Camdag area was considered as a part of the Zonguldak Terrane. The Zonguldak Terrane is characterized among other features by a pelagic deposition all around the Silurian and a distinct Caledonian-time discordance (Kozur and Göncüoglu, 2000).

Our new data clearly shows that the Upper Silurian in Camdag area is represented in this area by black shales and Cephalopod-bearing limestones. Moreover, there is no unconformity between the Silurian and Devonian rocks, that may suggest a “Caledonian” event. We therefore assume that during the Late

Silurian – Early Devonian period the same event-succession was achieved in both Istanbul and Camdag areas and thus both areas should be considered as parts of the same terrane (Istanbul Terrane of Göncüoglu and Kozur, 1998).

Considering the depositional features of the Pridolian rock units, the Camdag area should be more basinal than those in the Istanbul area. Similar to Istanbul, the Lochkovian in the Camdag area is characterized by a coarsening-upward sequence. By this, the Camdag area should be considered as the eastern continuation of the Istanbul Terrane during the Silurian-Early Devonian time interval.

An up to date account of Late Silurian "Orthoceras Limestones" is given in Holland et al (1994) and Ferretti et al (1999). According to these reviews, Pridoli black shales with benthic and shallow pelagic assemblages associated with "Orthoceras Limestones" occur in the Prague Basin (lowermost Pridoli), SW Sardinia (lower Pridoli), Carnic-Dinaric area and Uralian-Cordilleran area. Thus, our new finding is the first data with similar assemblages from NW Turkey.

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