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Early Paleozoic Evolution of the NW Gondwanaland: Data from Southern Turkey and Surrounding Regions

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Abstract

The Lower Paleozoic rock-units in the Eastern Mediterranean can be separated into two distinct zones: the Northern Zone (Carpathian-Balkan, Istanbul, Zonguldak and Main Range terranes) and the Southern Zone (Tauride-Anatolide, SE Anatolian-Arabian, and Central Iranian terranes). A Gondwanan /Perigondwanan origin can only be properly indicated for the Southern Zone, whereas the Early Paleozoic paleogeographic positions of smaller terranes (e.g. Istanbul Terrane) of the Northern Zone remains questionable.

During the Infracambrian-Early Cambrian time in the Southern Zone, the Pan-African consolidated NW Gondwanan pericratonic margin was rifted by back-arc extension or transtension, which is represented by the deposition of fault-controlled continental sediments.

The late Early Cambrian-Late Cambrian period in the Southern Zone is designated by a regional transgression from northeast suggesting a rapid subsidence in the area to the northwest of Arabian-Tauride platform and hence opening of a relatively deep basin to the north.

The Lower Ordovician in the Southern Zone comprising the Tremadoc and Arenig Series is characterized by a monotonous siliciclastic deposition. Towards the end of Early Ordovician shallowing upward sequences and formation of NW-SE trending highs were noticed. The stratigraphic hiatuses, unconformities and irregular distribution of the Caradoc-Ashgill deposits in the Southern Zone has been ascribed to glacio-eustatic sea-level changes.

The Early Silurian (Aeronian-Telychian) deepening and deposition of black shales that follows the regression around the Ordovician-Silurian boundary in the Southern Zone is also very probably related to the relatively rapid global sea-level rise. To the north of the Tauride-Anatolide Platform, Wenlock and Late Silurian are represented by deep marine (basinal) sediments with oceanic basalts.

The generation of an accretionary complex in the northern margin of the Taurides together with the regional regression in the southern Taurides and SE Anatolia at the uppermost Silurian-Lower Devonian boundary and the regional unconformity at Lower Devonian (Middle Lochkovian) is very probably related to the closure of a "Paleotethyan" oceanic basin to the north of the Perigondwanan terranes.

Key words: Stratigraphy, paleogeography, Lower Paleozoic, NW Gondwana, Turkey.

Introduction

The Lower Paleozoic depositional history, tectonics and geological evolution of the Eastern Mediterranean region is not yet fully understood, due to the scarcity of detailed biostratigraphical studies. The area discussed in this paper covers mainly the Turkish part of the area and includes not only the northern edge of the Arabian Peninsula and southeastern Turkey, but also the Toros-Zagros Fold Belt but excludes the Balkan-Pontide belt in the north.

The Turkish part of the Eastern Mediterranean is located on the Alpine orogenic collage, between the northern margin of the Arabian and Eurasian plates and consists of numerous terranes (Fig. 1). The terranes of Turkey extend eastwards into Iran and westwards into Greece and Carpathian-Balkan region.

The tectonic elements of the southern part of the Turkish area which can be considered as the main body of the "Greater Arabian Lower Paleozoic Basin", have been recently reviewed by Beydoun (1994) and Millson et al. (1996). It has been generally accepted that the Lower Paleozoic units in northern flank of the Arabian Peninsula were developed in a series of intra-cratonic basins across the Gondwanan realm, whereas those in the Turkish area

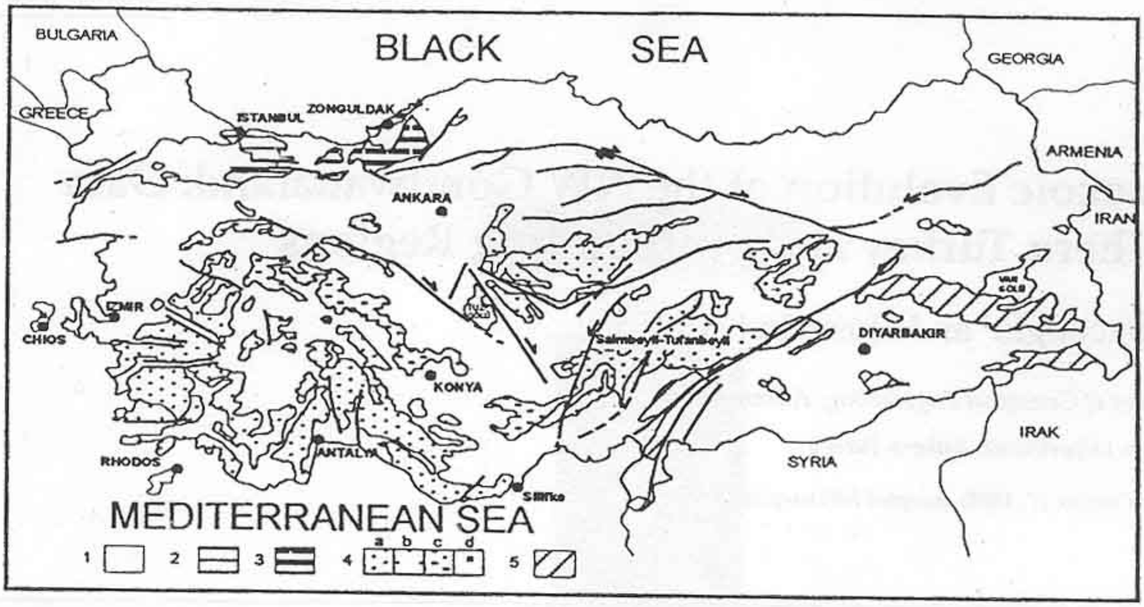

Fig. 1. Main tectonic units (terranes) with studied Lower Paleozoic rocks (simplified after Goncuoglu, 1997). Explanations: 1- Cenozoic cover, Northern Zone: 2- Istanbul Terrane, 3- Zonguldak Terrane, Southern Zone: 4- Tauride- Anatolide Composite Terrane (a: undivided, b: Lycian-Bozkir Nappes, c: Kutahya-Bolkardag Zone, d: Karaburun Zone), 5- Southeast Anatolian Autochthon.

were generated in basins located palinspastically further to the north, facing the Early Paleozoic ocean.

The depositional features and distribution of the Lower Paleozoic rocks in the Turkish part of the Gondwanaland suggest the presence of a "Northern Zone" (Carpathian-Balkan, Istanbul, Zonguldak and Main Range terranes) and a "Southern Zone" (Taurides, SE Anatolian-Arabian, and Central Iranian terranes, Goncuoglu, 1997), separated by an intervening deep (oceanic?) basin.

In this brief review we combine regional literature and unpublished field data to interpret the Early Paleozoic evolution of the Southern Zone in Turkey and N-Arabia.

Tectono-Stratigraphy of the Lower Paleozoic in Turkey

The distribution of the Lower Paleozoic lithostratigraphic units and their stratigraphy are shown in figures 2 and 3, respectively. The stratigraphy and depositional environment of the Lower Paleozoic successions and their basements in the Taurides and SE Anatolia, that represent the "Southern Zone" and hence the actual northern margin of Gondwana-platform will be briefly described. The stratigraphy and evolution of the "Northern Zone", consisting of suspect terranes of probably Perigondwana origin will be discussed somewhere else (Goncuoglu and Kozur, 1999).

Precambrian

Metamorphic rocks of presumably Precambrian age in the Southern Zone in Turkey are reported only from the Alpine crystalline complexes such as the Menderes Massif (Dora et al., 1991) and Bitlis Massif (Goncuoglu and Turhan, 1997). In both cases, the Alpine metamorphism has almost completely overprinted the indications of earlier events and the isotopic age data is too limited to draw a conclusive picture.

In the Menderes Massif (Fig. 2), radiometric data and the presence of some relict phases (Dora et al., 1991) indicate a high grade metamorphism of Pan-African age. Using combined Compston-Jeffery and Nicolaysen diagram, Satir and Friedrichsen (1986) suggest a depositional age of 680Ma for the protoliths of the "core"-gneisses. The first metamorphic event in the migmatitic gneisses, evidenced by a Rb/Sr whole rock isochron of ca. 500Ma is regarded by the same authors as the time of the Pan-African High Grade Metamorphism. Dora et al. (1991) confirm this suggestion by additional Rb/Sr age data. Very recently, Hetzel and Reischmann (1996) have reported from the augen-gneisses Pb/Pb single zircon ages of 546Ma demonstrating a Pan-African igneous activity.

In the Bitlis Massif (Fig. 2), the basement unit comprises para-gneisses, migmatites, amphibolites, micaschists and ortho-gneisses (Goncuoglu and Turhan, 1984). Bands and lenses of kyanite eclogites are found as minor intercalations within the gneisses (Okay et al., 1985). The basement unit is unconformably overlain by a low-grade metamorphic sequence of Early Paleozoic age, which constitutes mainly metaclastics and recrystallized limestones. The pre-Early Paleozoic age of the basement is documented by the presence of HT/HP metamorphic

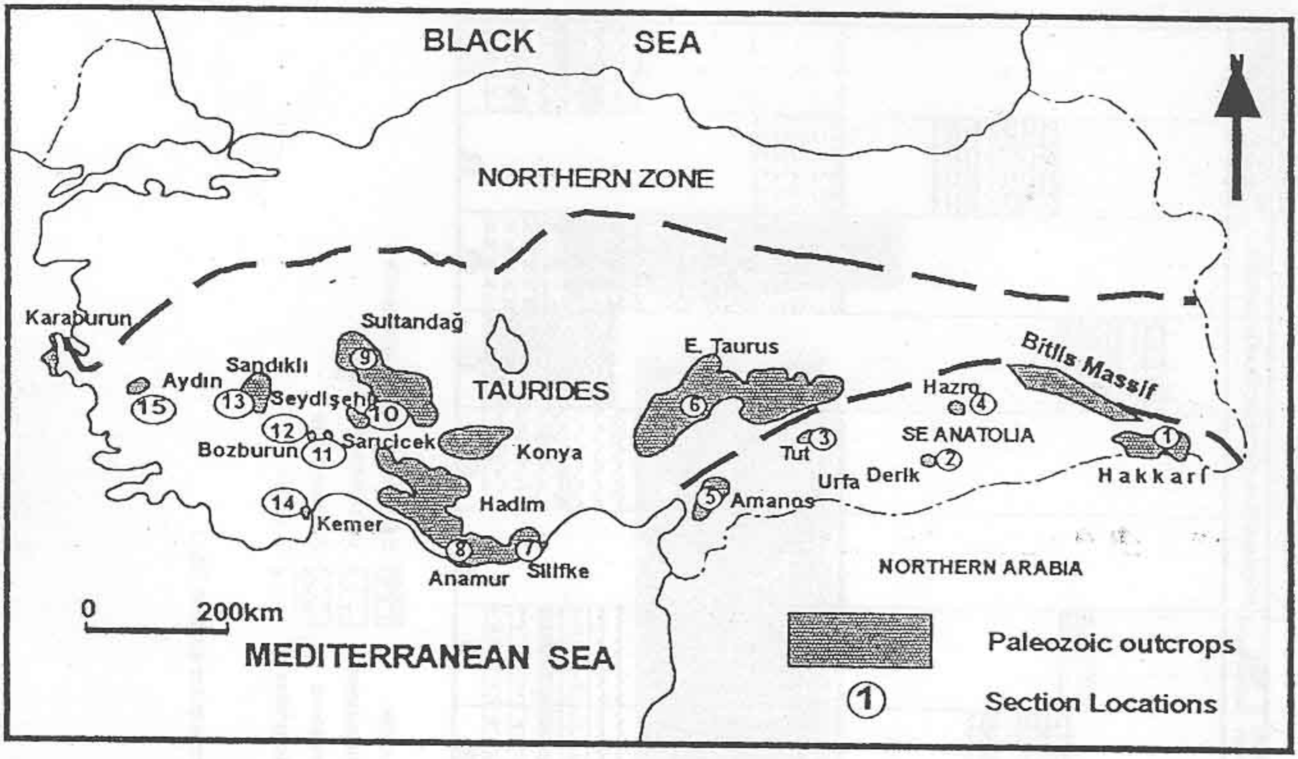

Fig. 2. Locations of the studied Lower Paleozoic outcrops in southern Turkey. The numbers on the map indicate to the generalized columnar sections on Fig. 3.

clasts and pebbles in the basal conglomerates of a clastic sequence to the north of Mutki in Bitlis Massif (Meydan Formation; Goncuoglu and Turhan, 1984) that correlates well to Lower Cambrian clastics of the non-metamorphic sequences in the Arabian autochthon.

In the Northern Arabian platform, on the other hand, the accretion and collision of microcontinents ceased at approximately 620 Ma and the latest Precambrian period is mainly characterized by transpressional events (Husseini, 1989). It is commonly accepted that during Precambrian time the Southern Zone with Menderes and Bitlis Massifs were parts of the peri-Gondwanan craton and separated from the northern continent by the intervening Iapetus Ocean. The only exception to this idea is the interpretation of Kröner and Sengör (1990) suggesting that the Taurides were attached to the Angora craton of Siberia during Vendian. The non-metamorphic to slightly metamorphic pre-Early Paleozoic rock-units of the Southern Zone occur in the Taurides, SE Anatolia and Jordan and mainly consist of terrestrial clastics and volcanics.

In SE Anatolia, in the central part (Derik area, Fig. 3, column 2) the lowermost unit consists of submarine lavas and pyroclastics of intermediate composition, which alternate with red epiclastics and shales of presumably Infracambrian age. This unit comprises red-green colored andesites, agglomerates and tuffs, including pillow-lavas of andesitic-spilitic composition. The volcanic and volcaniclastic rocks reach up to 350 m in thickness and are highly altered. They are followed by alluvial fan and fluviatile-type intracontinental sediments. The presence of some coastal sediments and pillow-lavas indicate a contemporaneous shallow-marine deposition. The red-green sandstone and mudstone interlayers are 2-30 m thick. The amount of volcaniclastic and sedimentary rocks gradually increases towards the top of the formation. The Infracambrian rock-units in western SE Anatolia (Amanos and Adiyaman areas, Fig. 3, columns 3, 4 and 5) slightly differ from those in the central part where volcanic rocks are missing and an alternation of green-dark gray volcanogenic sandstones and shales dominates. The sandstones are thin-medium bedded, rich in mica and silica cemented. Transitions to pure quartzites and a well-developed slaty cleavage in the shales are common features. In the western SE Anatolia the Precambrian/Infracambrian units are deposited completely in intra-cratonic shallow-marine conditions.

In the Taurides, the lowermost part of the Infracambrian sequence is represented by rhyolites and rhyolitic tuffs followed by an alternation of arkoses and shales (Fig.3, columns 11, 12 and 13). Upwards follow varicolored stromatolitic and cherty limestones interlayered with sandstones and shales (Kozlu and Goncuoglu, 1997). The lower and middle part of the succession contain felsic-

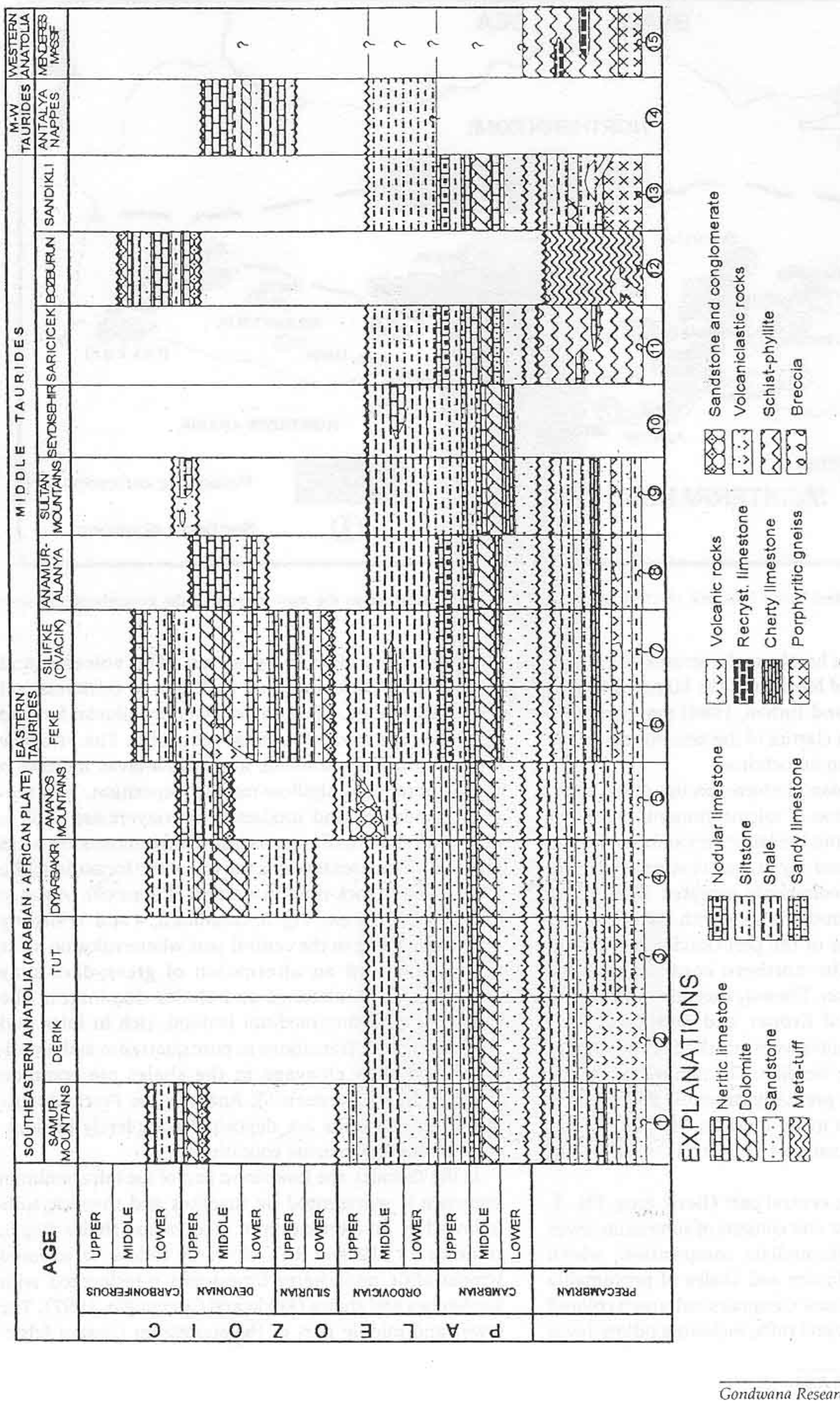

Fig. 3. Generalized columnar sections of the Lower Paleozoic rocks in southern Turkey. Locations of the sections are given in Fig. 2.

intermediate volcanic rocks and highly altered tuffites. The 2000 m thick sequence is slightly metamorphic and unconformably overlain by late Lower to early Middle Cambrian clastics. Sedimentological data suggest that during the latest Precambrian-earliest Cambrian time in the Southern Zone the Pan-African consolidated NW Gondwanan pericratonic margin was rifted by back-arc extension or transtension.

In the northwestern part of the Arabian Peninsula (Jordan and Egypt) the Infracambrian deposits are characterized by syn-rift sequences consisting mainly of terrestrial clastics, whereas in the northeastern part (Iran and NE Arabia) the syn-rift sediments are associated with a transgressive-regressive marine sequence (Husseini, 1990).

Cambrian

Stratigraphy and fauna of the Cambrian formations in the Southern Zone in the Taurides Belt have been recently reviewed by Dean et al. (1991). The lower interval of the Cambrian consists of a thick sequence of cross-bedded quartz-arenites, which are interpreted as beach deposits. It is transgressively overlain by carbonates (Çal Tepe Formation). The carbonates consist of from bottom to top: dolomite, black limestone, light gray limestone and red nodular limestone members. The "light gray limestone" member from the Çal Tepe type-locality (Fig. 3, column 10) contains a small shelly assemblage of late Lower Cambrian - early Middle Cambrian (Sarmiento et al., 1997), whereas trilobite and conodont ages obtained from the overlying "nodular limestone" member indicate a diachronous nature and younging from north to south in the northwest : lowermost Middle Cambrian; in the central part: middle Middle Cambrian; in the further south: middle to late Middle Cambrian (Dean et al., 1991). Recent data (Goncuoglu and Kozur, 1999 a and b) have shown that in the eastern central part and in the south (Eastern Taurides and Anamur-Alanya areas, Fig. 3, columns 6, 7 and 8 respectively) the deposition of the "nodular limestone" member may reach up to the late Cambrian and there is no depositional break during the late Cambrian. The quartzites at the lower interval of the Cambrian successions can be considered as the earliest Paleozoic transgression onto the Gondwanan Platform. The nodular limestones at the top, on the other hand, mark the sudden change from platformal to deeper marine conditions indicating the presence of a deepening basin to the north of the platform. A very thick siliciclastic unit (Seydisehir Formation) that succeeds the Cambrian carbonates is middle Middle Cambrian to Late? Arenig in age. According to Dean et al. (1991) the late Middle Cambrian siliciclastics are mainly restricted to the north whereas bands and lenses of nodular limestones were described in the south. Dean et al. (1991) further suggests a combination of a general regression with weak topographic differentiation at the end of Cambrian in the Turkish part of NW Gondwana.

In SE-Anatolia Cambrian units crop out in five anticlinal structures (Fig. 3, columns 1 to 5). They commonly start with basal clastics, followed by an interval consisting of sandstone, sandy limestone, shale and siltstone alternations. At the top, the unit is represented by coarse grained and hummocky-type cross-bedded sandstones with quartz conglomerates. The deposition of the basal part is characterized by a shallow-marine transgression, transitional to coastal tidal-flat deposits of the middle part. The upper part of the sequence is interpreted as a regressive product of an aeolian environment. The age data is from limestone interlayers in the southeasternmost outcrops in Turkey where *Archaeocyathus* fragments were reported. The succeeding carbonates are composed of sandy-clayey dolomites, followed by thick-bedded dolomites with chert nodules. The upper interval consists of a 20-30m thick nodular limestones. The limestones in the upper part of the sequence are rich in trilobites, brachiopods and acritarchs, yielding a Middle Cambrian age. This formation is interpreted as product of a marine transgression and stable platform deposition. A diachronous younging towards east suggests that the transgression during Middle Cambrian was from west to east. The carbonates are succeeded by an interlayering of nodular limestone and shale and continue with alternating shale, siltstone and sandstone. The micaceous sandstones display ripple-marks and cross-ripple lamination. The basal nodular limestones, alternating with shales are rich in trilobites, brachiopods and crinoids of Middle Cambrian age (Dean et al., 1981). It is implied that the deposition started in a slowly deepening environment followed by basinal deposition. The upper part of the sequence, however, is turbiditic and is interpreted as the product of local regressive delta complexes. In conclusion, late Lower Cambrian-Upper Cambrian period in the Southern Zone is designated by a regional transgression from northwest. The diachronous younging of platform to deep marine carbonates towards southeast suggests a rapid subsidence and hence opening of a relatively deep basin to the northwest of Arabian-Tauride platform that separated the Northern Zone from the Southern one. It is interesting to note that Dean and Monod (1997) claim that the Middle Cambrian trilobite fauna both in western and eastern parts of SE Anatolia are of Mediterranean-European type whereas the Upper Cambrian fauna in the east (NE Irak-Hakkari region) indicates an eastern Asian affinity.

Most data from the southern Arabian Platform are from the central Saudi Arabia, where Lower Cambrian is not reported, whereas the Middle and Upper Cambrian are represented by the fluvial-deltaic sediments of the Risha Formation (Husseini, 1990).

Ordovician

The main bulk of the Ordovician succession in the Taurides is represented by Tremadoc-lower Arenig shales-siltstones alternating with quartzites and rare nodular limestones in its lower part (Seydisehir Formation), and was dated by trilobites, graptolites, conodonts and acritarchs. In its higher parts Seydisehir Formation contains "Cruziana Beds" (e.g. with *Cruziana rugosa* in Kemer area). The uppermost interval of the Ordovician sequence consists of limestones with echinoderm fragments followed by reefal limestones with trilobites and conodonts and shales with acritarchs of early upper Arenig age (Sobova Formation: Dean and Monod, 1985). In a recent work, Sarmiento et al. (1999) found late Darriwilian conodonts in the upper part of the Seydisehir Formation in the Silifke (Ovacik) area (Fig. 3, column 7), indicating that the deposition has continued in the middle Ordovician. The succession is interpreted as a deep-water siliciclastic deposition in a north-facing basin. Towards the end of Arenig and locally during the early Middle Ordovician the deposition of shallow-marine to reefal limestones may suggest a regression. The monotonous deposition during Early Ordovician indicates that there were no important changes in the depositional environment between Late Cambrian and Early Ordovician. In the Taurides, an important hiatus separates the Early/Middle Ordovician from Late Ordovician. Upper Ordovician is totally missing in the Hadim area (Fig. 2) (Ozgul, 1997). It has only been described from the Kemer (Dean et al., 1999; southwestern Taurides, Fig. 3, column 14) and Saimbeyli (eastern Taurides, Fig. 3, column 6) where coarse-grained sandstones, siltstones and silty shales unconformably overlie the Lower Ordovician units. Dean et al. (1991, 1999) reported trilobites of southern-central European affinity together with poorly preserved acritarchs and sporomorphs of Ashgill age from this unit.

The Lower Ordovician succession in SE Anatolia contains in its lower interval shales and siltstones interlayered with quartz-arenites. The upper interval is represented by an alternation of quartz-sandstones with ripple-marks and worm-tubes and thin-bedded dark shales. Fossil data from the surface and subsurface show a Tremadoc-Arenig depositional age (Bozdogan et al., 1996). The deposition of this period started in shallow-marine and continued in deep-marine environment. In the central part of SE Anatolia the Tremadoc-Arenig deposits are not represented. In the southwest (Urfa region) the subsurface data indicate a reduction of the thickness. It is assumed that the variations in the thickness are mainly controlled by erosion and formation of paleotopographic highs. Lower Ordovician deposits are followed by an alternation of dark shales and siltstones in the lower interval, sandstones and shales with local submarine lavas in the middle and upper intervals. The lowermost layers of this unit are Karadoc in age (Dean and Monod, 1985), which would indicate a non-depositional period during Middle Ordovician. In the southeasternmost part of Turkey, however Tremadoc-Arenig shales are unconformably covered by Ashgil sandstones and shales. The topmost interval of the Ordovician in Amanos area constitutes poorly sorted glacial conglomerates with siltstone and mudstone interlayers (Bozdogan et al., 1996). It is assumed that the deposition started with platform-type shallow-marine conditions followed by regressive sequences representing deltaic environments (Bozdogan and Ertug, 1997). The upper part of the sequence is characterized by shallow-marine deposits.

In Jordan and northwestern Syria, Lower Ordovician is mainly characterized by coarse grained sandstones of more proximal facies, whereas during Late Ordovician at least two regressive cycles are recorded (Husseini, 1990). The stratigraphic hiatuses, unconformities and irregular distribution of the Ordovician units in the Southern Zone may be ascribed to glacio-eustatic sea-level changes of Late Ordovician age in the NW Gondwana-margin. An alternative interpretation is proposed by Bozdogan and Ertug (1997) suggesting that the facial differences in the east and west are due to the formation of a local uplift (Mardin-Kahta High) during this period in the central SE Anatolia.

Silurian

Both in the northern and southern areas the Ordovician units are unconformably overlain by Lower Silurian coarse clastics. Early Silurian period in the Southern Zone in Tauride unit is characterized by a transgression on the Lower Ordovician units, represented by clastics followed successively by the development of graptolitic black shales. Local volcanic activity is recorded in the southwestern and eastern Taurides. In the central and eastern Taurides (Ovacik and Feke- E. Taurus areas, Fig. 3, columns 7 and 6 respectively) Silurian successions start with red colored, cross-bedded conglomerates and coarse-grained sandstones. The coarse-grained lower interval contains well-rounded granitic and metamorphic pebbles indicating a source area made up of crystalline basement rocks. This finding is of critical importance, as it clearly indicates a crystalline source area, which does not outcrop the

Taurides. The clastic-dominated lower formation (Halityayla Fm.) grades upward into a gray shale-sandstone interbedding, followed by laminated Graptolite-bearing black shales (Puscutepe Shale Fm.) with rare Orthoceras-bearing limestone interlayers (Yukariyayla Fm.). The upper interval of the unit comprises bioturbated shales alternating with siltstones (Gul, 1995). The heterometric sandstones of the Halityayla Fm. contain few acritarchs of post-Rhuddonian age, whereas the black shales in the upper interval of the Puscutepe Shale Fm. show Aeronian ages, based on graptolites and acritarchs (Ozgul et al., 1973). Ages based on *Monograptus convolutus*: middle Aeronian; Dean et al. (1991). The lower part of the Yukariyayla Fm., where "Orthoceras Limestones" dominate, Dean and Monod (1990) suggest a late Aeronian age, however Goncuoglu and Kozur (1999a) found conodonts of *Pterognathodus amorphognathoides* Zone indicating a latest Llandovery-earliest Wenlock age.

In the western Taurides (Antalya Nappes, Kemer area, Fig. 3, column 14), Goncuoglu and Kozur (in press) confirm the Telychian age proposed by Marcoux (1987) by new conodont findings (*Pterospathodus eopennatus* Zone: lower Telychian). This is further confirmed by the recent work of Dean et al. (1999).

In the Taurides, fossiliferous Middle and Late Silurian is reported only from the more or less metamorphic units in the northern areas (e.g. Fig. 2, Karaburun Area, Kozur, 1997; Konya area, Goncuoglu and Kozur, 1998), where basinal, slope and arid reef limestones were reported. The Ludlow and Pridoli in these northern areas are represented by siliciclastic deep-sea turbidites-olistostromes associated with distal turbiditic dark radiolarites and MORB to OIB-type volcanics. This data clearly indicate the presence of a subduction zone to the north of the Taurides during Late Silurian.

In SE Anatolia, early Lower Silurian is a period of non-deposition or erosion. Thick sandstone-shale alternations of middle Lower Silurian were only penetrated by wells in northern Syria (Bozdogan et al., 1996) and Hakkari area in SE Turkey (Fig. 3, column 1). In a small inlayer in Diyarbakir-Hazro area (Fig. 3, column 4) blue-grey shales and marls with sandy limestones of upper Wenlock-Pridoli age were reported (Fontaine et al., 1980; Fontaine, 1981).

The Early Silurian deepening in the area is very probably related to the relatively rapid global sea-level change, which is reported from different parts of NW Gondwana (Rutherford et al., 1997). The regional depositional break during Early Silurian is followed by the mid Vendlockian - early Frasnian deposition (subsurface data from Bozdogan and Ertug, 1997) which is restricted to the central part of SE Anatolia. Mid Vendlockian - lower Gedinian dark shales of restricted marine environment are followed by tidal-dominated clastics of lower Gedinian-Emsian age and the deposition is terminated with Upper Devonian evaporite bearing dolomites representing a regressive (fluvial) cycle.

Husseini (1991) claims that during the Late Ordovician-Early Silurian the northwestern part of Arabia was covered by polar glaciers, while marginal marine conditions prevailed in the northern and eastern parts. Early-middle Llandoverian transgression in N Arabia and deposition of thick, organic-rich shales over the glacial and periglacial deposits is ascribed to the melting of the polar ice-cap. The upper part of the succession in N Arabia is represented by an upward coarsening sequence. During Wenlockian and Ludlowian stages of Silurian a hiatus associated with a global sea-level drop occurred. The hiatus is terminated by the deposition of braided stream-type coarse clastics of Pridoli age and grades into Lower Devonian fluvial deposits.

The formation of the accretionary prism-type rocks in the northern Taurides and this regression in the southern Taurides and SE Anatolia at the Silurian-Devonian boundary is very probably related to the closure of a basin in the north which will be discussed in the following chapter.

A Possible Geodynamic Outline

Repeated rifting and re-assemblage of continental microplates during the Alpine and pre-Alpine events have greatly overprinted the original signatures of the Early Paleozoic events in Anatolia. The paucity of detailed paleomagnetic, biostratigraphic and paleo-biogeographic work on Lower Paleozoic rocks in this structurally very complex area further limits paleogeographic reconstructions.

The distribution of the Precambrian rock-units suggests a Northern Zone (Carpathian-Balkan, Istanbul, Zonguldak and Main Range terranes) and a Southern Zone (Taurides, SE Anatolian-Arabian, and Central Iranian terranes) representing remnants of a Precambrian orogenic assemblage with oceanic, arc-type and continental elements. They were very probably formed during the early southward subduction of the Eastern Iapetus Ocean (Fig. 4a).

During the Infracambrian-Early Cambrian time (Fig. 4b) in the Southern Zone the Pan-African consolidated NW Gondwanan pericratonic margin was rifted by back-arc extension or transtension. In the Northern Zone the intra-oceanic subduction and formation of an ensimatic arc (Goncuoglu, 1997) lasted at least until ?Middle Cambrian according to the recent radiometric age data of Ustaomer and Kipman (1997).

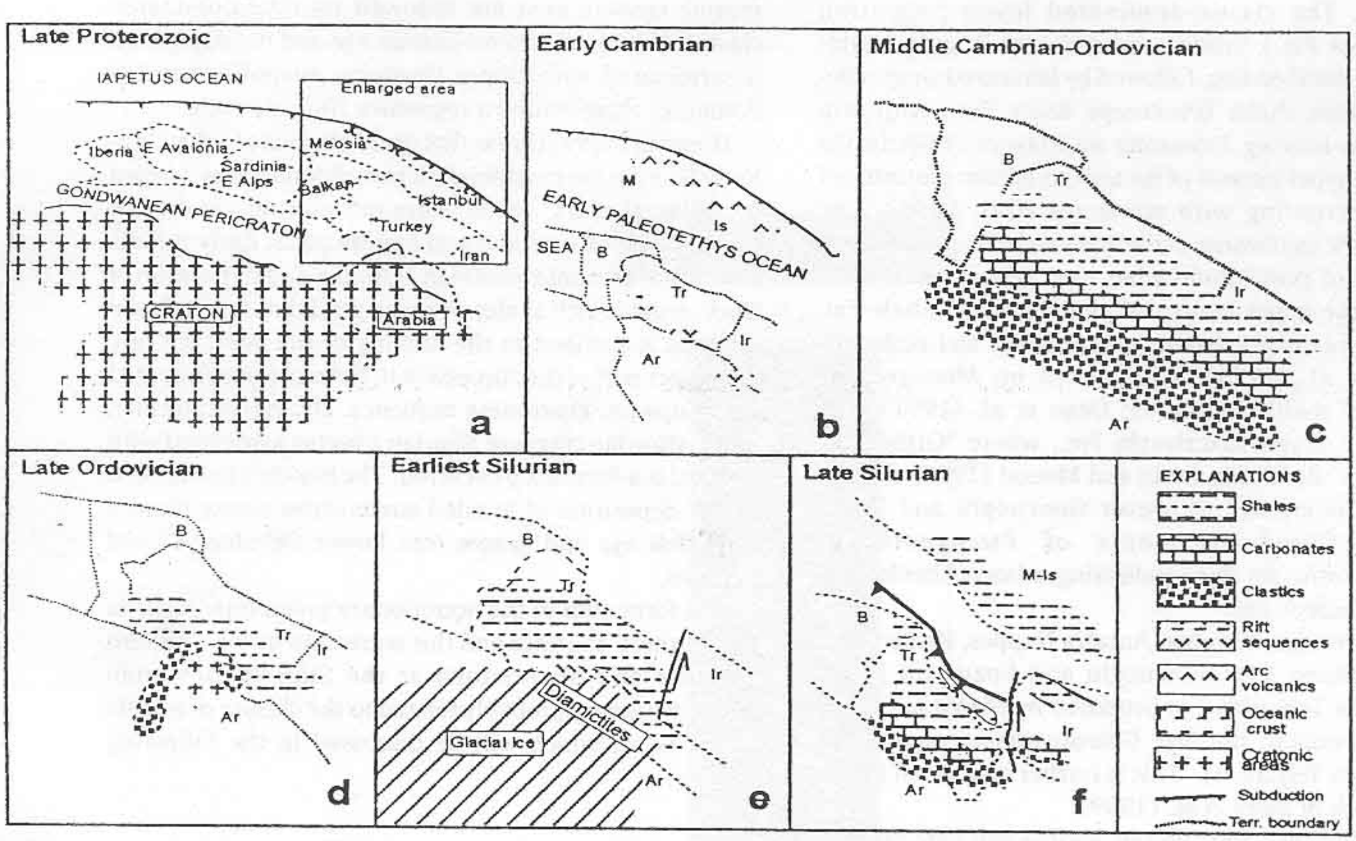

Fig. 4. Lower Paleozoic geodynamic evolution of the Eastern Mediterranean part of NW Gondwana. a- Late Proterozoic, b- Early Cambrian, c- Middle Cambrian-Ordovician, d- Late Ordovician, e- Earliest Silurian, f- Late Silurian. Abbreviations: Ar: Arabia, B: Balkan, Ir: Iran, Is: Istanbul, M: Meosia, SAE: Sardinia-Eastern Alps.

Late Lower Cambrian- late Middle Cambrian period in the Southern Zone is designated by a regional transgression from northeast suggesting a rapid subsidence in the area to the northwest of Arabian-Tauride platform and hence opening of a relatively deep basin in the north (Fig. 4c).

Late-Cambrian-Early Ordovician in the Southern Zone is characterized by a monotonous deposition. Towards the end of Early Ordovician shallowing upward sequences and formation of NW-SE trending highs were noticed (Fig. 4d). The stratigraphic hiatuses, unconformities and irregular distribution of the Ordovician units in the Southern Zone may be ascribed to glacio-eustatic sea-level changes during the Late Ordovician-Early Silurian (Fig. 4e) in the NW Gondwana-margin that may be further complicated by rifting of additional microplates (e.g. Iran microplate) from the pericratonic NW Gondwanan margin. In the Northern Zone during the Early Ordovician the peneplained island-arc was subsided, transgressed from south and covered by deep marine sediments.

The Early Silurian deposition in both zones is very probably controlled by the relatively rapid global sea-level change, which is further known in different parts of NW Gondwanan pericraton (McKerrow and Scotese, 1990).

The regression in the southern Taurides and SE Anatolia and the presence of an accretionary complex with blocks of oceanic sediments, olistostromes and volcanic rocks of oceanic crust and island arc affinity in the Northern Zone at the Upper Silurian-Lower Devonian transition is very probably related to the closure of the small oceanic branch between the Taurides and the northern terranes (Fig. 4f). The subduction during this event was very probably towards south and the basin between the Northern and Southern Zones in the Turkish area has probably narrowed, but remained open until the Early Carboniferous when it closed by southward subduction giving way to the Variscan events in Anatolia (Goncuoglu, 1993). This narrowing is further demonstrated by deposition of similar carbonates in the Northern and Southern zones.

Conclusions

Based on dissimilarities in magmatism and stratigraphic records, two distinct terranes of Early Paleozoic age can be differentiated in the Anatolian-northern Arabian part of the Eastern Mediterranean: a northern super-terrane (Carpathian-Balkan, Istanbul, Zonguldak and Main Range terranes) and a southern one (Taurides, SE Anatolian-Arabian, and Central Iranian terranes) which were separated by an intervening "Paleotethyan" oceanic basin. The palinspastic reconstruction reveals that the southern super-terrane representing the NW margin of Gondwana has very probably experienced an evolution very similar to some terranes in SW Europe:

1- The rifting phase on the Pan-African consolidated pericratonic margin during Late Precambrian and Infracambrian followed by a transgression from W-NW during late Lower Cambrian.

2- Formation of a northward facing margin/slope during the Middle Cambrian-Ordovician.

3- Glacio-eustatic sea-level changes and formation of periglacial deposits during Late Ordovician/Early Silurian at the southern part of the Taurides.

4- Rapid subsidence due to global sea-level rise and deposition of mixed clastics and carbonates during Mid-Late Silurian in the southern Taurides but formation of slope and oceanic basin-type sediments together with MORB-type volcanics in the northern Taurides.

5- Generation of a southward dipping subduction to the north of the northern Taurides associated with the formation of an accretionary prism at the northern margin of the Taurides and the regional unconformity in the southern Taurides indicating an important tectonic event at the Silurian-Devonian boundary in the area to the north of the southern super-terrane.

Even if this reconstruction is based only on fragmentary data derived from different tectonostratigraphic units (terranes) and is highly hypothetical especially for the northern part, it may help to have a general basis for further discussions and correlations.

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