

PRE-VARISCAN TERRANE ANALYSIS OF

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Remarks to the Pre-Variscan Development in Turkey

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The early Paleozoic history of Turkey is known from the "Palaeozoic of Istanbul" in NW Turkey (summarized in Görür et al., 1997), from the Taurides, and from the margin of the Arabian Platform in SE Turkey (summarized by Göncüoğlu, 1997). In the contrast to previous views, we assign the "Paleozoic of Istanbul" to two different terranes, the Istanbul Terrane (Paleozoic-Mesozoic sequence around Istanbul) and the Zonguldak Terrane (Çamdağ, Zonguldak, Amasra and Safranbolu regions). These terranes have a very different Paleozoic-Mesozoic history, but were both north of Perigondwana during the Early Paleozoic. In the Zonguldak Terrane, Precambrian gneisses are overlain by Tremadocian siliciclastic rocks with cosmopolitan acritarchs (Dean et al., 1997) without Perigondwana cold-water forms. Subsequently, dark-grey Arenig-lower Llanvirn mudstones and siltstones with graptolites and trilobites of Welsh-European affinities indicate a rapid deepening of the basin. Overlying limestones and mudstones yielded Caradoc (to Ashgill?) conodonts with a Conodont Alteration Index (CAI) of 5-6, and cosmopolitan acritarchs. The Silurian consists mainly of black and grey graptolitic shales and mudstones. Different Wenlock to Prídoli horizons (CAI = 5) are unconformably overlain by Devonian siliciclastics, followed by shallow-water dolomites and limestones with late Lower Devonian to Upper Devonian conodonts (CAI=2-2.5). Shallow-water, partly dolomitic limestones continued in the Lower Carboniferous, and the youngest marine Paleozoic beds that we found, are lower Namurian conodont-bearing limestones (CAI=1.5). Upper Carboniferous, uppermost Permian, and Triassic are represented by continental beds. The Middle Ordovician to latest Silurian deep-water development, the distinct thermal alteration of the Ordovician to uppermost Silurian beds (CAI = 5-6), the disconformity between the Silurian and the higher Lower Devonian, and the thermally unaltered shallow-water Devonian and Lower Carboniferous beds indicate the following: (1) The Zonguldak Terrane does not belong to the Hercynian chain, but was in Hercynian time a stable shallow-water shelf attached to the southern margin of Eurasia. (2) There were distinct Caledonian movements and thermal alteration. (3) The Zonguldak Terrane may be during the Ordovician and Silurian part of a non-oceanic Tornquist Sea. Its Paleozoic development is very similar to that of the Moesian Platform.

The Istanbul Terrane shows a Lower Triassic transgression on Bashkirian or older beds, Middle Triassic condensed deep-water deposits and Upper Triassic flyschoid siliciclastic turbidites and olistostromes. This Triassic development is very similar to the adjacent northern part of the Karakaya Ocean, but also to the northern Dobrogea, where, however, the Paleozoic development is distinctly different. The oldest rocks in the Istanbul Terrane are Ordovician siliciclastic deposits. Upper Caradoc-Ashgill ostracod and brachiopod faunas (Sayar & Schallreuter, 1989) contain *Piretella*, a typical Baltoscandian genus, *Klimphores* (very common in that region, but occurs also in Perigondwana Europe and Saudi Arabia) and *Eochilina* (outside Turkey only known from Siberia and Michigan). The brachiopods show connections to Baltica, Bohemia and the Appalachians. The Ordovician had apparently a warm-temperate fauna with connections to North Europe and Siberia/North America (warm-water), and with some connections to Perigondwana. (cold-water) The clastic shallow-water deposits continued in the Llandovery, whereas during the Wenlock and Ludlow shallow-water limestones were deposited. Despite of a slight deepening during the Prídoli, shallow-water limestones (in the Lower Devonian partly also clastics) were deposited until the Emsian. The upper Emsian to Upper Devonian consist of pelagic rocks, predominantly limestones. In the Tournaisian lydites are common, and in the Viséan Culm flysch was deposited. The youngest marine Paleozoic deposits yielded lower Bashkirian fossils. Lower Carboniferous flysch and Hercynian thermal alteration (Devonian CAI = 4, Gedik, 1988) indicate that the Istanbul Terrane belongs to the Hercynian Belt. Shallow-water Ordovician to Lower Devonian deposition without hiatus between the Silurian and Devonian indicates that there were no Caledonian movements.

Early Paleozoic rocks are widely distributed south of the Izmir-Ankara Belt, the Neotethyan suture zone. They occur in the Taurides, in the Alanya and Antalya nappes of the southern Tethyan branch, and in SE Turkey (SE Anatolia) on the margin of the Arabian Platform (Border Fold Belt). The Taurides consists of the Geyik Dağı Autochthonous, tectonically overlain in the western Taurides by the Lycian nappes, in the central Taurides by the Aladağ, Bolkardağ and Bozkir units. The tectonically highest units (Lycian nappes and Bozkir Unit) are originally situated in the northernmost position adjacent to the Neotethyan suture. In a tectonic position between the Bolkardağ Unit and the Bozkir Unit lies the Karaburun Unit of Karaburun Peninsula and Chios.

The Geyik Dağı Autochthonous has a very similar development throughout the Taurides, and also in SE Turkey a similar lithologic succession is present. The low-grade metamorphic Infra-Cambrian of the Taurides (Emirgazi Fm. and equivalents), SE Turkey (Meryemuşağı Fm.) and of the lower Mahmutlar Nappe (Alanya Unit) consists of shallow-

water siliciclastics, in the middle part also stromatolitic and cherty limestones. In the lower and middle part often mafic to intermediate volcanics and tuffs are present. The slight metamorphic overprint and the discordance against the overlying unmetamorphic Lower Cambrian speaks for youngest Pan-African movements in the entire area. The Cambrian begins with Lower Cambrian quartzites (Feke or Hüdai Fms., in SE Turkey Zabuk Fm.). They are overlain in ascending order by dolomites, black and light-grey limestones, and red nodular limestones (Çaltepe Fm., in SE Turkey Koruk Fm.). In the Sultandağ, the lower part of the Çaltepe Fm. contains numerous Lower Cambrian archaeocyathids. The Lower-Middle Cambrian boundary lies within the Çaltepe Fm. The nodular limestone indicates a Middle Cambrian deepening that begins generally later towards the SE. Further deepening is indicated by the deposition of upper Middle Cambrian to Arenig basinal fine-grained siliciclastic rocks (Sedişçir Fm.). In the upper Arenig a shallowing occurred and limestone intercalations appeared. The Sedişçir Fm. is also known from the Antalya Unit. After a long Middle Ordovician gap in few places of the Taurides and in SE Turkey upper Caradoc to Asgill clastics were deposited. The Ordovician acritarchs of the Taurides show clear Perigondwana cold-water character (*Arbusculidium filamentosum*, *Arkonia*, *Aureotesta clathrata*, *Coriphidium bohemicum*, *C. elegans*, *Stelliferidium trifidum*, *Striatotheca principalis parva*, *Vavrdovella*, Dean & Martin, 1992, Martin, 1996). Trilobites consists both of European Perigondwana species and of Asian species, in the Arenig also trilobites and conodonts with Baltoscandian affinities are present. In SE Turkey, situated on the same Perigondwana shelf, the faunistic connections to the Perigondwana cold-water associations are less pronounced and mainly indicated by the acritarch *Vavrdovella-Coryphidium* group. Tremadoc trilobites indicate affinities to warm-temperate and warm-water faunas of Iran, Afghanistan, China and Australia (Dean & Martin, 1992). Caradoc trilobites have distinct Perigondwana affinities, whereas Asgill trilobites have again Asian and Baltoscandian affinities. The irregularly distributed Silurian of the Geyik Dağı Autochthonous and of the Antalya Unit follows discordantly mainly on Lower Ordovician beds. It begins with coarse clastics followed by graptolitic shales and nautiloid limestones, indicating a deepening. Some volcanic activities are also known. A general uplift can be observed in the Upper Silurian and Lower Devonian, causing shallowing upwards sequences. Shallow-water, mainly carbonatic Devonian shelf deposits lie unconformably on Silurian-Lochkovian or older sediments. In SE Turkey, the Middle and (?) Upper Devonian dolomites contain evaporites.

A Caledonian ocean separated the Perigondwana Tauride shelf (with Ordovician cold-water faunas) from the Istanbul and Zonguldak Terranes (with faunistic relations to Baltica and Siberia, and only a few relations to Perigondwana). Remnants of this ocean were found in the Bolkardağ Unit (Göncüoğlu & Kozur, in prep.) and above all in the Karaburun Unit (Kozur, 1997, in press), where they were so far included in the "Scythian-Anisian Karais Fm." In the Karaburun Unit, more than 2000 m thick very low-grade metamorphic pre-Silurian siliciclastic deposits are overlain by a dated Silurian oceanic sequence with shales, lydites and basic volcanics. Upper Silurian to lower Pragian siliciclastic turbidites and olistostromes are rich in distal turbiditic lydites with radiolarians, muellerisphaerids and conodonts. Olistoliths consist mostly of Silurian lydites and sandstones, rarely of Silurian pelagic limestones, partly with basic tuffs. The contemporaneous shelf and slope is represented by the Kalecik Limestone (known from large blocks within the Bornova Melange of the Izmir-Ankara Belt). In the Bolkardağ Unit an identical Silurian to Lower Devonian oceanic sequence, and the adjacent carbonate platform and slope (Bozdağ Limestone) are known. In the Upper Silurian to lower Pragian turbidite-olistostrome unit many felsic to intermediate volcanics are present, probably related to a southwards-directed subduction of the ocean north of Perigondwana. By this Caledonian subduction, the Bolkardağ Unit was attached to the Perigondwana shelf, and the Devonian to Permian is characterized by shallow-water, largely carbonatic shelf sediments with sedimentary gaps. North of this Caledonian accreted part of the Perigondwana shelf, an ocean remained open or new oceanic basins opened on the adjacent shelves. In these areas pelagic Upper Devonian is followed by uppermost Devonian and Lower Carboniferous turbidites and olistostromes, often with felsic and intermediate volcanics. These Hercynian units are known from the Karaburun Unit, where the Hercynian flysch and transition series (with felsic tuffs) to the overlying Serpukhovian-Bashkirian shallow-water carbonates and clastics was previously also assigned to the "Scythian-Anisian Karais Fm." (Devonian-Carboniferous age determined by Kozur, 1997), Tavaz Nappe of the Lycian nappes (Lower Carboniferous lydites, shales, turbidites and olistostromes, formerly assigned to the Permian, Kozur et al., in press), Çataloturan Nappe of the Aladağ (Nohutluk Fm.: Lower Carboniferous turbidites, lydites, cherty limestones, felsic to intermediate tuffs, overlain, as in the Karaburun Unit, by Serpukhovian to Bashkirian shallow-water carbonates and clastics, Tekeli et al., 1984), and at the northern margin of the ocean the Hercynian flysch of the Istanbul Terrane.