

## Stratigraphy of the Ordovician rock–units in Turkey: new age data and a paleogeographic review

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In Anatolia, Ordovician successions occur within the basement of a complex mosaic of Alpine terranes (Göncüoğlu and Kozlu, 2000).

In the Safranbolu zone of the alpine Istanbul–Zonguldak Terrane in NW Anatolia, the pre–Ordovician basement is represented by island arc volcanics, disconformably overlain by Tremadoc red siltstones and sandstones. The overlying sequence is mainly made up of massively bedded gray quartzites, and dark gray mudstones with quartzitic beds including Arenig–Lower Llanwrin graptolites, chitinozoans, and trilobites of Welsh affinity (Dean *et al.*, 1997). The succeeding green–gray mudstones contain dark micrites and calcarenites with Caradoc acritarchs, conodonts and trilobites. Yet, no definite fossil evidence for the presence of Ashgill strata are reported and the Ordovician succession in Safranbolu area is overlain by graptolite–bearing Lower Silurian (Aeronian) black shales. In the Istanbul area to the west, Ordovician is mainly represented by arkoic sandstones and conglomerates, followed by quartzites and variegated quartz–siltstones. To date, no significant fossil evidence is reported from the Istanbul area, except a single “Middle Ordovician” conularia finding from the upper part of the arkoic sandstones.

In the Western, Central and Eastern Taurides, the Lower Ordovician succession comprising the Tremadoc and Arenig Series (Seydisehir Formation) is mainly characterized by a monotonous siliciclastic deposition represented by tempestites. Within the basal part of the Seydisehir Formation, the dark green to gray anchimetamorphic slates and siltstones include pink to greenish coloured nodular limestone beds, which yielded Tremadoc conodonts and trilobites. The clastic rocks display well–developed flute casts, cone–in–cone textures and include trace fossils in the lower part of the succession (Özgül and Kozlu, 2002). The main body of the formation includes a large number of coarsening–upwards sequences. In the upper parts of the formation in the Eastern Taurides trilobites closely resembling Early Arenig species from southern France have been reported (Dean and Monod 1990). Towards the top of the formation shallowing–upward sequences with carbonate bands and lenses (Sobova Limestone) are developed. The Sobova Limestone in its type–locality in western Taurides is assigned to late Arenig. Corresponding limestones in the Central and Eastern Taurides yielded Early Darrivillian conodonts. In the southern Taurides, on the other hand, the carbonate tempestites in the uppermost part of the Seydisehir Formation include Baltoscandian–type Late Darrivillian conodonts (Sarmiento *et al.*, 1999). The Seydisehir Formation is overlain with an erosional contact by dark green siltstones and mudstones that resemble in its lower part the Caradoc Bedinan Formation in Southeast Anatolia. The basal part of this succession includes red, sandy conglomerates and sandstones. The upper part of this unit is assigned to the Sort Tepe Formation, consisting of brown to grey siltstones and sandstones and reddish silty shales with Early Ashgill trilobites (Dean and Monod, 1990). Comparative mineralogical data (illite crystallinity,  $b_0$  values of white micas, polytypes of K–micas and chlorites) between the argillaceous sediments of Seydisehir and ?Bedinan/Sort

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Tepe formations suggests the presence of a thermal event between the Late Darriwilian and Early Ashgillian times (Bozkaya *et al.*, 2002). Sandy diamictites with isolated quartz pebbles overly the shallow-marine Sort Tepe Formation with an erosional contact and grade into glacial deposits of the Halevikdere Formation (Ghienne *et al.*, 2002). Chitinozoans and poorly diversified acritarch assemblages from the upper part of this unit indicate a Hirnantian depositional age (Monod *et al.*, in print). The ice-related sediments are transitional to graptolite-bearing black shales with Rhuddanian graptolites (Kozlu *et al.*, 2002).

In SE Anatolian Autochthon, the distribution of the Ordovician units is mainly controlled by important tectonic events. To the N of the “Mardin–Kahta Paleohigh” the Arenig Seydischir Formation rests unconformably on Middle Cambrian sediments. In this area, dark shales and siltstones (Bedinan Formation) of Middle–Late Caradoc age are followed by glacio-marine sediments (Monod *et al.*, in print), resembling the Halevikdere Formation in the Taurides. To the S of the paleohigh, a continuous succession from Cambrian Derik Group to Lower Ordovician Seydischir Formation is observed. Here, the Bedinan Formation is not observed and Sort Tepe Formation (Ashgill) unconformably covers the Seydischir Formation.

Considering the fossil data and the stratigraphic successions, it is suggested that the Early Paleozoic rock units in northern, central and southern Anatolia belong to Gondwana or Gondwana-derived (Perigondwanan) terranes. The northernmost unit, the Istanbul–Zonguldak Terrane was already separated from Gondwana by an intervening basin during the Early Ordovician. The Darriwilian carbonate deposition in the Taurides is indicative for a temperate paleogeographic position. The pre-Tremadoc unconformities and the thermal event in the Taurides and SE Anatolia is recorded in many other places in Europe and probably mark the opening of PalaeoTethys in the northern margin of Gondwana. The latest Ordovician glacial deposition in the Taurides and SE Anatolia indicate that both units were still in close vicinity of the northern Gondwana margin, somewhere between Sardinia and N Africa.

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