Tectonostratigraphic terranes in the pre-Neogene basement of the Hungarian part of the Pannonian area

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Abstract

The greatest part of the Pre-Neogene basement of the Pannonian Basin is built up by two Alpine megatectonic units, the Pelsonia Composite Terrane in the N, forming the southern part of the ALCAPA Composite Terrane, and the microcontinent-sized Tisia Terrane in the S. They are separated by the Zagreb–Zemplín or Mid-Hungarian Lineament, which likely merges E of the Danube River with the ENE-ward continuation of the Periadriatic-Balaton Lineament. The crustal blocks/terranes of the basement and of the rest of the ALCAPA C.T. form a true orogenic or terrane collage, framed on the E–SE, resp. SW by two deformed, but unbroken Neotethyan continental margin domains: the Median Dacidic (or Bucovino–Getic) – Serbo-Macedonian (i.e. Carpatho–Balkanide) margin on the E and SE and by the South Alpine – Outer Dinaridic (i.e. Adriatic or Apulian) margin on the SW (although the former was partly separated from the European foreland in course of the Late Jurassic – Early Cretaceous by the narrow Outer Dacidic or Civcin–Severin Rift Zone). These domains enclose the main Neotethyan suture zones of the Axios/Vardar and Maliak–Mirdita–Dinaridic Ophiolite Belt zones, bifurcating in the present setting at the southern margin of the Tisia Terrane.

In the first chapter of the present review a short history of the terrane concept and of the recognition of the heterogeneous block structure of the Pannonian basement is given, followed by some methodology. In the main chapter the major terranes of Hungary (Pelsonia and Tisia, i.e. their Hungarian part) are described, concerning their Variscan and Alpine sedimentary, magmatic, metamorphic and (up to a certain extent) tectonic evolution. Palaeomagnetism is analysed in a separate contribution (Márton, present volume), whereas for a latest review of Mesozoic (especially Jurassic) palaeobiogeography we refer to Vörös (1993). Terranes of the Eastern Alps (Austroalpinia, Penninia) and of the West Carpathians (Veporia, Zemplenia), extending only a small amount into the territory of Hungary, are only briefly characterised, not described in detail.
The Pelsonia Composite Terrane bounded on the NW and N by the Rába, Hurbanovo–Diósjeno and Lubeník–Margecany Lines, of varying ages and character, includes the following terranes:

- **Bakonyia Terrane**, built up by continental margin-type, mostly very low-grade metamorphosed Variscan and non-metamorphosed Alpine successions. Characteristic are: a thick, Lower Palaeozoic phyllite group, Devonian carbonates (both pelagic and platform-type), mostly platform-type Triassic, with basinal Buchenstein Fm. (containing tuffs) in the Middle Triassic, pelagic Jurassic of mostly Ammonitico Rosso facies. It forms a large, WSW–ENE striking synclinorium, with imbrications on its both flanks. The terrane constituted the floor of the major part of the Hungarian Palaeogene Basin.

- **Zagorje–Mid-Transdanubia Composite Terrane**, bounded on the N by the Periadriatic–Balaton and on the S by the Zagreb–Zemplín Lineaments. It comprises, in a strongly sheared zone, several units in the continuation of the Slovenian and Croatian area (Julian Alps – South Karavanks as well as ophiolite and metamorphosed units of the Dinarides–Vardar Zone).

- **Bükkia Composite Terrane**: it comprises the non- to low-grade metamorphosed, S-vergent folded Bükk Parautochthon Unit with a marine, predominantly carbonate Late Palaeozoic-Early Mesozoic succession, embraced between a Middle Carboniferous Variscan flysch and an Upper Jurassic Eohellenic flysch formation, and the Neotethyan Szarvaskő and Darnó ophiolite complexes, emplaced over the former from the NW (according to present co-ordinates). Up to recent times the marine Palaeozoic Szendro and Uppony units (in the former also with Middle Carboniferous flysch) had been considered as parts of the "Bükkium" Unit; however, they show an opposite, northerly vergency.

- **Aggtelekia Composite Terrane**: it comprises the non-metamorphosed Aggtelek–Bódva couplet, with a southward thrust and partly folded structure, the former being a predominantly carbonate platform type, whereas the latter a deep-water Triassic succession. In the sole thrust of the former, slices of ophiolites can be found as tectonic inclusions in Upper Permian evaporites (Tornakápolna Unit or Bódva Valley Ophiolite Complex). The very low to low-grade metamorphosed Martonyi (or Torna s.s.) Unit is characterised by Triassic basinal carbonates.

The Alpine Tisia Terrane in its Hungarian part comprises three Variscan terranes, which form the Pre-Alpine basement of different Alpine zones/nappe systems. They are terminologically separated from the Alpine tectonostratigraphic units. The Kunságia Terrane consists of two units. The Mórágy Unit forms the basement of the Alpine Mecsek Zone and is characterised by a Variscan syncollisional granitoid complex, related to the Moldanubian Zone of the Central European Variscides. The Körös Unit forms the Pre-Alpine basement of the Alpine Villány (–Bihor) Zone, and contains both medium-grade metamorphosed rocks and granitoids. The Békésia Terrane constitutes the Pre-Alpine basement of the Alpine (Szeged–) Békés–Codru Zone. It also contains medium-grade metamorphosed rocks and in its Battonya Subunit granitoids of different type (West Carpathian or Tatro–Veporic-type). The (Slavonia–) Dravia Terrane is also built up by Variscan medium-grade metamorphosed rocks and represents the northern subsurface extension of the of the Papuk–Psunj complexes, occurring at the surface in Croatia. A few occurrences of very low to low grade metamorphosed rocks may be regarded as Pre-Alpine nappe outliers or relics of wrenching zones. During the Late Carboniferous to Late Permian a fault-controlled basin formed above the junction area of the (Slavonia–) Dravia and Kunságia Terranes, in which up to 3,500 m of continental molasse sediments accumulated. Other areas of the Hungarian part of Tisia were exposed to denudation during most of the Late Variscan times. The base of the Alpine overstep sequence in the Hungarian part of Tisia is constituted by Scythian continental redbeds. However, in its southern zones, outside of the territory of Hungary, marine sedimentation already began in the Scythian. After a marine incursion in the Middle Triassic, separation of the Mecsek and Villány (–Bihor) zones began in the early Late Triassic. The former zone became a rapidly sinking half-graben area, in which up to 4,300 m thick, partly continental, partly marine siliciclastic, resp mixed siliciclastic-carbonate sediments were deposited until the end of Bajocian. On the other hand, the latter area became a swell zone with 0–30 m contemporaneous sedimentation. In the former zone pelagic sedimentation commenced from the Bathonian onward, followed by intense alkaline rift volcanism in the Early Cretaceous. On the other hand, in the latter...
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zone Urgon-type shallow marine deposition prevailed, in the Early Cretaceous, which was overlain by flysch-type deposits in the Albain-Cenomanian.

The comparative analysis of the terranes of the Pelsonia C. T. and of the Tisia T. with the surrounding Alpine (and Fore-Alpine), Carpathian and Dinaridic units/terranes, in terms of both their Variscan and Alpine evolution, reveals the close relationship of the Bakonyia Terrane to the Southern Alps and of the Zagorje-Mid-Transdanubia and Bükkia composite terranes to the Dinarides. Units of the Aggtelekia Composite Terrane show analogies partly to the Juvavicum of the Northern Limestone Alps, but also to the Internal Dinarides and to the Internal Hellenides.

The Variscan basement of the northern part of the Tisia Terrane (Mórágy Unit of the Mecsek Zone) show close relationship to the Moldanubian Zone of the European Variscides, whereas that of the more southern parts to the "Median Crystalline Zone" in sense of NeuBauer and von Raumer (1993). In the earlier Mesozoic the (future) terrane was part of the North Tethyan margin, which is also indicated by its anomalously high paleomagnetic latitudes. Cessation of terrigenous input in the Bathonian indicates the separation of the future Tisia Terrane from the European hinterland. Contemporaneously, the character of the fauna also changed from European types to Mediterranean ones. However, a major change in the palaeomagnetic record appears only in the Berriasian (Márton, in the present volume), just before the paroxysm of alkaline rift volcanism in the Mecsek Zone, which shows analogies to that of the Outer West Carpathian Beskides in Poland. From this time on until the end of Early Miocene Tisia moved as an independent terrane.

The most prominent feature of the Pannonian basement for Alpine geology is the Zagreb-Zemplín Lineament (or Zone: Csontos and Nagymarosy 1998), along which the transition from the Dinarides into the Alps has been displaced about 500 km from the NW Dinarides to NE Hungary.

Late Variscan and Neotethyan (P3-J3) facies zones of the Pelsonia C. T. reveal its 400–500 km sinistral offset relative to the northerly adjacent main units of the ALCAPA C. T. (Austroalpinia, Tatro-Veporia) and the same dextral offset along the Periadriatic-Balaton, resp. Zagreb-Zemplín lineaments. The sinistral offset must have preceded the Middle-Late Cretaceous nappe stacking, and probably took place synchronously with Neotethyan closure during the Late Jurassic-Early Cretaceous, whereas the dextral offset was the result of the Late Oligocene – Early Miocene eastward escape of the entire ALCAPA C. T. The whole displacement of the composite terrane was the sum of the displacements of its constituent blocks/terranes, moving relative to each other, as well.

The offsets of the Late Variscan and Neotethyan facies zones of the Pelsonia C. T. within the ALCAPA C. T. of higher rank also imply that no Mesozoic (and also no Palaeozoic) palaeotectonic and palaeogeographic reconstruction can be performed in an orthogonal N–S modelling for the North Pannonian-West Carpathian area, as already emphasised by Balla (1988a).

Key words: tectonostratigraphic terranes, Variscan evolution, Alpine evolution, sedimentary evolution, magmatic evolution, tectonometamorphic evolution, terrane analysis, paleogeography, Pannonian basement, Hungary

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