



## Alpine thermotectonic evolution of the Apuseni Mountains (Romania)

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The Apuseni Mountains represent an enigmatic and isolated massif within the inner Carpathian belt. They constitute the largest outcropping part of the Tisza block, bounded by the Pannonian and Transylvanian Tertiary basins to the west and east, respectively. The area exposes a nappe stack that formed in response to continental collision, following the closure of the Neotethys Ocean. The northwestern part of the Apuseni Mountains is made up of a W to NW-facing, Turonian-age, coherent nappe sequence, represented by, from bottom to top, the Bihor, Codru and Biharia nappe systems. The tectonically highest Biharia nappe system was previously considered as part of Tisza plate (Csontos and Vörös 2004), but has recently been attributed to the Dacia Mega-Unit since it was involved in the Early Cretaceous E-facing nappe stacking typical for the external Carpathians that constitute Dacia (Schmid et al., 2008).

The first Alpine tectonic event in the area was probably related to the obduction of the Eastern Vardar Ophiolitic unit (Transylvanides) onto parts of the Dacia Mega-Unit (Biharia) during the latest Jurassic. This was followed by the late Early Cretaceous final closure of Neotethys remnants between Tisza and Dacia associated with the top-E nappe stacking that affected mainly the Dacia unit. Turonian-age shortening led to top-W to NW superposition of the Dacia over the Tisza Mega-Unit. Subsequent compressional deformations occurred during the end of the Cretaceous and the Eocene.

The Jurassic-age volcanics of the Transylvanides, their sedimentary cover and the underlying Baia de Aries nappe (the highest structural unit of the Biharia nappe system) exhibit late Early Cretaceous zircon fission-track (FT) ages (Aptian and Albian, 120 – 103 Ma). The more westerly and structurally lower units (Biharia nappe of the Biharia nappe system, Codru and Bihor nappe systems), however, exhibit Late Cretaceous (Turonian to Campanian, 95 – 71 Ma) zircon FT ages. The late Early Cretaceous zircon FT ages found in the Baia de Aries nappe and the Jurassic ophiolites and their sedimentary cover, suggest that this nappe and formerly obducted Transylvanides must have been buried to a minimum of 8 km before cooling through the zircon annealing window in spite of the fact that they presently represent the highest tectonic units. Such burial supports the idea of an Early Cretaceous phase of underthrusting of these units (i.e. Dacia) below the Tisza Mega-Unit that formed the upper plate during top-east orogeny. The cooling ages obtained from the Tisza Mega-Unit (Bihor, Codru) and structurally lower part of the Dacia unit - Biharia nappe (Turonian to Campanian, 95 – 71 Ma), on the other hand, record erosional denudation that immediately followed the late Cretaceous top-NW event that led to the present-day nappe stack in the Apuseni Mountains. The internal parts of the Baia de Aries nappe and the overlying Transylvanides escaped reheating during this second event since they occupied the highest tectonic position. Zircon FT ages, combined with thermal modelling of the apatite FT data, show that relatively rapid post-tectonic cooling of the area during the late Cretaceous was followed by slower cooling during the early Paleogene (65 – 55 Ma). Some areas have experienced cooling through the temperature interval 120° – 60°C between 55 and 40 Ma, probably related to the active tectonic during this time.

### References:

- Csontos, L., and Vörös, A. 2004. Mesozoic plate tectonic reconstruction of the Carpathian region, *Paleogeography Paleoclimatology Paleoecology*, 210, 1–56.
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