Structural evolution of the East Alpine-Pannonian junction area: from nappe stacking to extension

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The western part of the Miocene Pannonian Basin covers the transition from the Eastern Alps to the Pre-Miocene basement units of the Pannonian Basin. Structural evolution of this area was reconstructed from surface observations, borehole data, seismic reflection profiles and 3D seismic data sets. Fault-slip and geochronological data were collected at the Miocene basin margins, in the Pohorje-Kozjak Mts. (Slovenia) and in the Transdanubian Range (TR) in Hungary.

The area is characterized by NW or W-verging Cretaceous nappe stacking and internal folding and thrusting (Tari 1994, Héja et al. 2015) while SE-vergent thrusts in the TR are considered as back-thrusts. Detachment levels are postulated in the Carnian and Silurian levels. In the highest TR unit this deformation occurred before the Mid-Albian (before 108 Ma). In the underlying low-grade units the youngest K-Ar age is around 116 Ma, while in the lower medium-grade Koralpe-Wölz unit geochronological data scatter from 95 to 87 Ma (Árkai & Balogh, 1989; Thöni, 2002). The mid-Cretaceous thrust contact was reactivated or deformed by two phases of extensional deformation: few cooling ages indicate late Cretaceous exhumation of the medium-grade Koralpe-Wölz metamorphism in the Kozjak Mts. (Fodor et al. 2003, 2008). Major structures are a wide mylonitic belt, shear bands, folds related to low-angle normal shearing, and in map-scale, extensional allochtons: they are composed of Palaeozoic rocks and the non-metamorphic Permo-triassic sequence of the TR. This extensional deformation might have been connected to Senonian (Santonian to Campanian) basin formation in the hanging wall units (TR); such synsedimentary normal faults were in fact observed on seismic profiles.

Good parts of the geochronological data set indicate Miocene cooling of the Koralpe-Wölz rocks and the Miocene Pohorje pluton. The Miocene exhumation resulted in low-angle detachment faults and mylonitic shear zones in deeper structural level. Above these first-order structures, a series of half grabens and few strike-slip faults formed; the latter ones played as transfer faults and part of them presumably reactivated former strike-slip faults (e.g. Mid-Hungarian Shear Zone). Extension was oblique within these shear zones. Tectonic exhumation resulted in the formation of metamorphic core complexes.

Exhumation exposed different structural levels from the Cretaceous nappe pile: Koralpe-Wölz in the Pohorje Mts., Murska Sobota high and the Penninnic unit in the Rechnitz windows (Tari 1994, Dunkl & Demény 1997, Fodor et al. 2003). Extension affected the 18.6 Ma old Pohorje intrusion during its cooling through greenschist facies conditions between 18–15 Ma. Extension in the pluton was recorded by AMS data, crystal plastic and brittle deformation structures which have been observed in the pluton and related Miocene magmatic dykes of variable composition. This extensional deformation was connected to the opening of the Pannonian Basin from ca 18.5 Ma to ca. 15 Ma.

During the middle Badenian the extension direction gradually changed to ESE-WNW. However, few map-scale grabens were associated to this deformation, which could be much more important further to the north, in the Danube basin.

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