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Detachment control of core complex exhumation and back-arc extension in the East Slovakian Basin

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Abstract. The East Slovakian Neogene Basin is floored by the metamorphic series of the Iňačovce-Krichevo Unit. This unit appears to be the Lower Miocene core complex, exhumed jointly due to back-arc extension of the East Slovakian Basin. Petrological, structural and geochronological data allow to interpret the processes of core complex updoming and basin downfaulting.
Key words: East Slovakian Basin, metamorphic core complex, exhumation, low-angle detachment, basin subsidence

Pre-Neogene basement of the East Slovakian Basin is formed mainly by the Iňačovce – Krichevo Unit (IKU). This subsurface unit comprises mostly of metasedimentary formations showing a similarities to the Penninic Zone. At the base of the complexes there are variegated phyllites, calcschists and marbles, which can be correlated with the red-bed formations, in Alpine region known as „Quartenschiefer“. Their Upper Trassic age has been determined biostratigraphically. Above them a thick „Bündnerschiefer“-like formation follows, containing green or dark phyllites, metasandstones and metasiltstones. Oceanic lithology of these metasediments is indicated by the presence of metaultramafic rocks, metabasalts and metatuffites. In the upper part, „Bündnerschiefer“ formations pass into the more arenaceous sequences. The Upper Cretaceous formations are probably represented by turbiditic sequences of dark schists and metasandstones. The youngest formations (Middle Eocene) are formed by dark phyllitic schists intercalated by Nummulites-bearing metasandstones. Considering that, the latest phase of syntectonic low-temperature metamorphism, were taking place probably after the Middle Eocene.

The estimation of the physical conditions of metamorphism in the IKU is based on the study of mineral assemblages. The peak metamorphic conditions are documented by assemblages: (1) biotite + actinolite and/or magnesioriebeckite + chlorite + titanite + epidote (metabasalts), (2) muscovite + quartz + pyrophyllite + paragonite + intermediate Na-K micas + chloritoid (Al-metapelites), which are indicative of metamorphic temperatures between 350 and 400°C. Co-existence of Na and Ca amphibols is considered here as a relic of earlier, higher pressure metamorphic event (greenschist to blueschist transition zone, $p \approx 7\text{-}8$ kbar). During decompressional phase of metamorphism normal greenschist assemblages occurred (chloritoid in metapelites and biotite in metabasalts) at a pressures <5 kbar. The youngest sediments of the IKU are represented by the Middle Eocene formations composed of black phyllites and metasandstones. Using phyllosilicate „crystallinity„ and coal rank data, their degree of metamorphism corresponds to the higher anchizone or lower epizone, respectively ($IC = 0.31°\Delta 2\Theta$, $ChC_{(002)} = 0.26°\Delta 2\Theta$, $R_{o\,max} = 5.75\%$).

The IKU reveals a complex polydeformational history. Progressive deformation proceeded from (1) underthrusting - soft sediment deformation, stratal disruption and boudinage of high-competent layers, overpressured conditions, (2) underplating and deep tectonic burial - high flattening strain, F_1 foliation, synkinematic crystallization, intrafolial folding, diffusional mass transfer, crystalplastic deformation, (3) subcretion and intrawedge shortening - crenulation cleavage as F_2, transpositional foliation, high-strain zones, ultramylonites, δ - type porphyroclasts, open to tight F_2 folds, dynamic recrystallization, etc., and (4) updoming and extensional unroofing - shear bands, SC foliation fabric, kink-bands, en-echelon structures, extensive veining, cataclastic deformation, brecciation, normal faulting, etc.

The FT dating of the IKU gave significantly younger ages, than the sedimentation ages. This rather narrow range (with a mean of 20.1 ± 0.9 Ma) can be considered as cooling age after the Neogene metamorphic event, which caused the total resetting of the zircon FT ages. The similarity of the white mica K/Ar ages and the range of zircon FT ages indicates a rapid cooling period in Early Miocene. The Neogene syn-rift sediments from above the metamorphic basement suffered no significant post-depositional overprint and their zircon FT ages can be interpreted as a typical cooling ages of the source regions, but not the IKU.

The East Slovakian core complex occurs in the area of strike-parallel wrench zone. Therefore, the exumation of the IKU could be iniciated by buoyancy and ductility

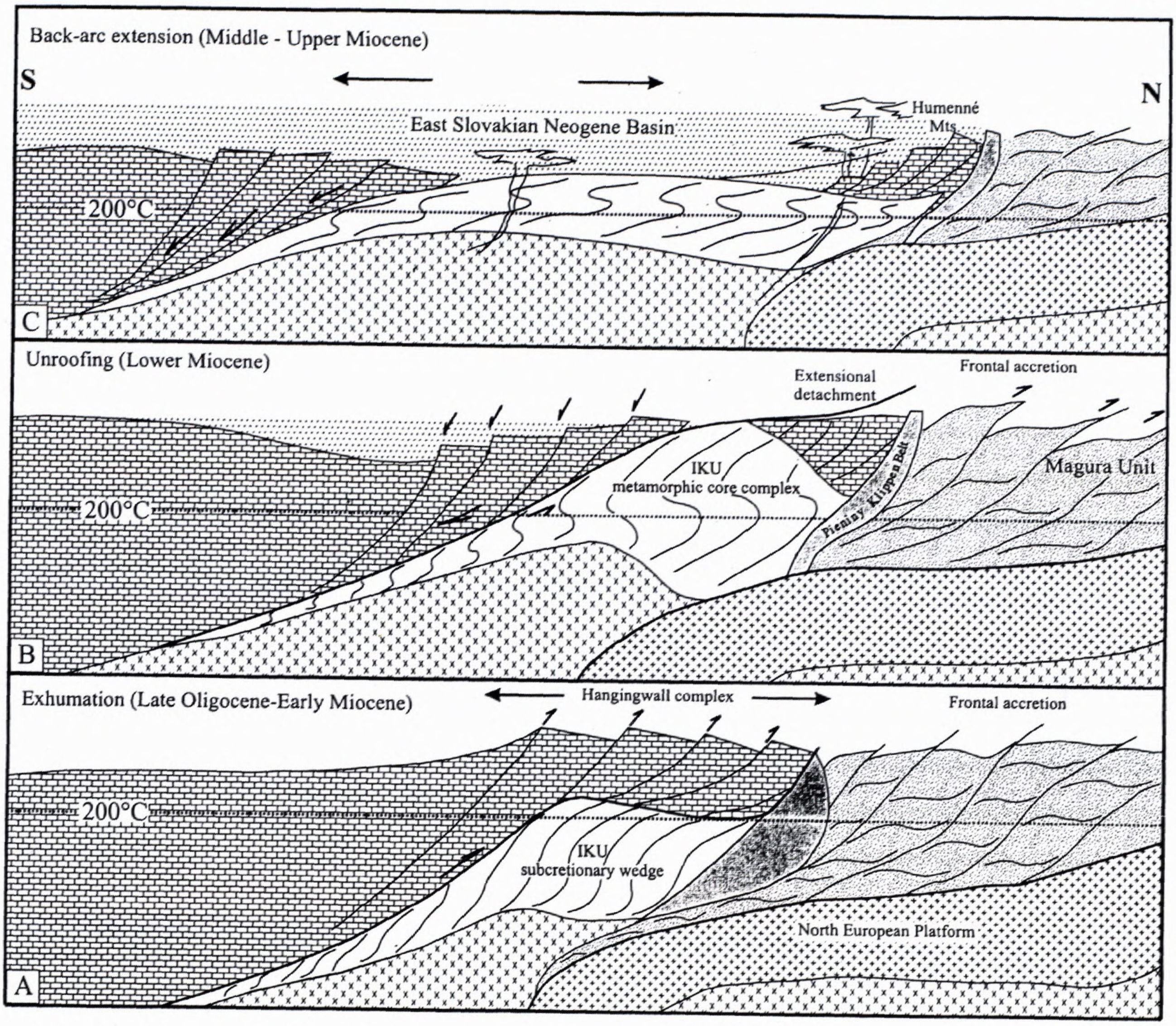

Fig. 1 Exhumational history of the Iňačovce-Krichevo Unit (IKU). Exhumation started with updoming and intrawedge shortening of the IKU (A), subsequently reached a depth appropriate for zircon FT annealing (izotherm near 200°C) and finally its emplacement on the bottom of the East Slovakian Basin (C). Exhumation process was accomplished by destabilization and collapse of orogenic wedge (A), detachment faulting and extensional unroofing (B) and back-arc extension and basin subsidence (C).

of underplate rocks, updomed within the wrench zone. Since the Early Miocene, the main controlling factor of the exhumation was an extensional unroofing (Fig. 1). The extensional formation of the core complex structure is evidenced by the cataclasites developed on detachment faults. Youngest extensional detachment with cataclasites overprinted the contact of basement core complex with the Neogene sediments (cataclastic breccias were misinterpreted sometimes as a basal clastic sediments). Therefore, the Neogene sediments appear to be detached during the core complex exhumation. This assumption is also supported by FT results, which provide a different type of zircon grains in Neogene syn-rift sediments having no the young FT annealing typical for the core complex associations. In the seismic profiles, this detachment is expressed as a basin/basement reflector, which corresponds to the low-angle normal fault with roll-over growth of elevations in the Ptrukša Zone and Zemplín Unit (see profile 598/84 in Vozár & Šantavý 1999). In this case, the East Slovakian Basin was formed above extensional detachment (master fault), which gave rise as a consequence of core complex updoming accomplished by hangingwall normal faulting and basin subsidence.

Stratigraphic evidences and geochronological data on the IKU allow to interpret the time-temperature path. The cored rocks of the IKU were brought from the metamorphic depth (cca 15 km) to shallow crustal level, or even to the near-surface position (their material was recycled to the Merník conglomerates – Soták et al. 1990). Thus, the complexes of the IKU appear to have been cooled and exhumed rapidly. The vertical displacement of the core complex started in the Upper Oligocene, with a high uplift rate and approached the zircon FT blocking temperature during the Early Miocene (~20 Ma). If the time of 30 - 20 Ma is assumed for the exhumation, the core complex reached the uplift rate of about 1.5 km/Ma. Such uplift rate is high, but obvious in the core complexes exhumed in the continent-continent collisional orogens.

The cooling age of the IKU is most consistent with zircon FT ages of the Rechnitz window. From this Penninic window, Dunkl & Demény (1991) reported the zircon FT data ranging from 15.1 to 18.5 Ma. Although that window is situated at the western margin of the Pannonian Basin System, the formation of both core complex structures was related to the same Early Miocene extensional period (Royden et al., 1983). The minor difference between the means of zircon FT ages in these windows could indicate some temporal shift of the main extension. The paper is a contrubution to the VEGA grant N_O 7068.

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