Succession of tectonometamorphic processes in the Veporic–Gemeric contact zone revealed by monazite age data (Western Carpathians, Slovakia)

TOMÁŠ POTOČNÝ[1], ŠTEFAN MÉRES[2] and DUŠAN PLAŠIENKA[1]

[1]Department of Geology and Palaeontology, Faculty of Natural Sciences, Comenius University, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava, Slovakia; potocny9@uniba.sk, dusan.plasienka@uniba.sk
[2]Department of Geochemistry, Faculty of Natural Sciences, Comenius University, Mlynská dolina, Ilkovičova 6, 842 15 Bratislava, Slovakia; stefan.meres@uniba.sk

Abstract: The Veporic–Gemeric contiguous zone is characterized by the presence of several major tectonic units exhibiting differing structural–metamorphic histories. Relying on the detailed structural, petrologic and geochronologic (EMPA dating of monazites) investigations, three main metamorphic stages have been distinguished. The first event (ca 360–355 Ma) is restricted to the Veporic basement and relates to the Variscan regional metamorphism and granitoid intrusions, the others two are Alpine in age. Ages around 145–140 Ma occur in the Meliatic HP Bôrka Nappe only and associate with its exhumation and thrust emplacement; while the mid-Cretaceous data (100–90 Ma) are found in all units and are likely connected with the main phase of the Western Carpathian nappe stacking and onset of the extension-related exhumation of the Veporic metamorphic dome.

Introduction

The contact zone of the Veporic and Gemeric basement-involved superunits in central Slovakia follows the Lubeník fault zone, which was the thrust plane of the latter over the former originally, later affected by significant transpressional and extensional reactivation. The deformation processes in this structurally complicated area resulted in a superposition and/or juxtaposition of several units that exhibit complex tectonic and metamorphic relationships. We present the structural, metamorphic and geochronologic data which constrain their tectonothermal evolution into three distinct stages.

Geological setting

Three superposed major Western Carpathian tectonic units in the investigated area between Čierna Lehota and Štítnik villages in central Slovakia occur (Fig. 1). The Veporic Superunit in the lowermost structural position includes the pre-Alpine crystalline basement and the post-Variscan Upper Paleozoic–Triassic sedimentary cover (Foederata Unit). The Veporic basement is composed of polymetamorphic (Variscan and Alpine) metasediments and scarce metavolcanics (Hladomorná dolina Complex; HDC) intruded by Variscan granitoids (Kráľova hoľa Complex; KHC — Klinec 1966, 1971). The HDC is discordantly overlain by clastic deposits of the Permian Rimava Formation as a part of the South Veporic sedimentary cover. In addition to the polyphase regional metamorphism, the HDC bears also superimposed contact metamorphic associations related to the hidden Upper Cretaceous granitic intrusion (Rochovce granite; Korikovsky et al. 1986; Poller et al. 2001; Kohút et al. 2013) which was drilled in its underlier (e.g., Klinec 1980).

Along the SW–NE trending Lubeník fault zone, which turns to the N–S direction in the investigated area, rocks of Veporic Rimava Fm. are juxtaposed to the Paleozoic complexes of the Gemeric Superunit. In the direct contact with the Veporic units, the Mississippian rocks of the Gemericum are represented by the Ochtiná Group overlain by the Pennsylvanian clastics of the Hámor Fm. (e.g., Vozárová 1996). The Ochtiná Unit is overthrust by the main Gemeric basement and cover thrust sheet represented by the Lower Paleozoic low-grade polymetamorphic volcano-sedimentary formations (Gelnica Group) and the Pennsylvanian–Permian cover clastics (Permian Gočaltovo Group in the area concerned).

The Gemeric rock complexes are overridden by the Meliatic Superunit. The Meliaticum is formed by the Bôrka Nappe (Mello et al. 1998) composed of the Permian to Jurassic HP/LT metamorphosed sedimentary and volcanic rocks, and very low-grade Jurassic syn-orogenic sedimentary formations with huge olistostrome bodies (Meliata Unit s.s.; Mock et al. 1998). Rocks of the Bôrka Nappe underwent Upper Jurassic blueschist-facies metamorphism and were subsequently affected by the Early Cretaceous greenschist-facies

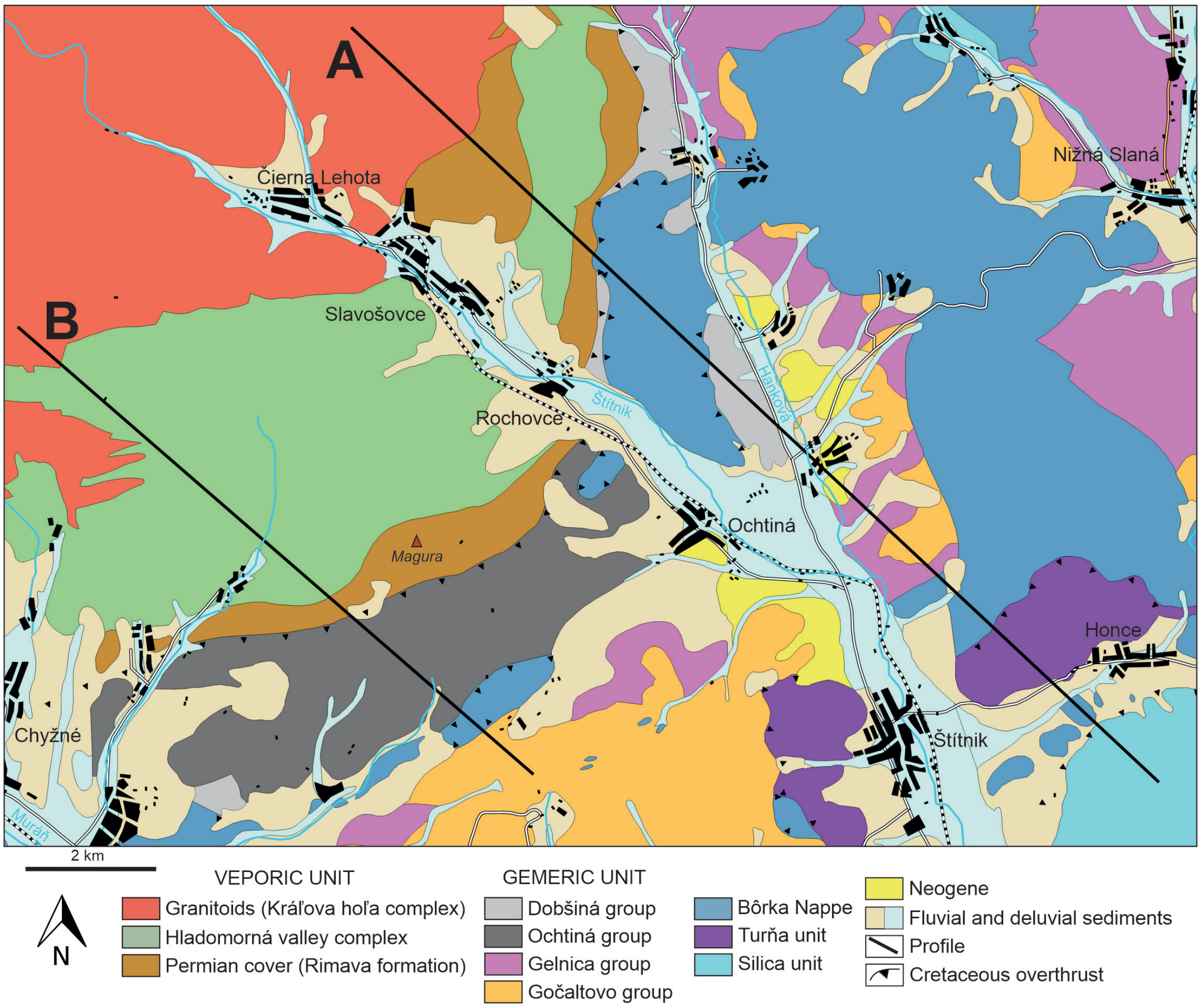

Fig. 1. Geological sketch map of the investigated area with indicated profile lines.

retrogression (e.g., Plašienka et al. 2019 and references therein). Meliaticum is tightly imbricated and forms a combined accretionary complex with the overlying Turňa Unit represented by a system of partial nappes and duplexes consisting of low-grade Carboniferous to Triassic metasediments (Lačný et al. 2016). The structurally highest unit is the Silica Nappe, which overlies the Meliatic-Turnaic accretionary complex with a pronounced structural and metamorphic discordance (Reichwalder 1982).

The structural relationships of the Veporic–Gemeric–Turnaic–Meliatic thrust stack are described along two subparallel, NW–SE trending profile lines in the studied area (Fig. 1). The first profile A is located between the mountain ridges NW and SE of the Štítnik River valley. It crosses units of the Veporicum (KHC, HDC, Rimava Fm.), Gemericum (Ochtiná, Gelnica and Gočaltovo groups), Meliaticum (Bôrka Nappe), Turnaicum and Silicicum. The second profile (B in Fig. 1) follows the mountain ridge between valleys of the Štítnik and Muráň rivers and includes from NW to SE the Veporic (KHC, HDC, Rimava Formation), Gemeric (Ochtiná and Gočaltovo groups) and Meliatic units (Bôrka Nappe).

We investigated a number of samples, in part oriented, from all these units. Thin-sections were subjected to petrological study under the polarized microscope and electronic microanalyzer to obtain data about the lithology, metamorphism and microstructures. Several samples that contain metamorphic monazites were dated by the EMPA method providing ages that can be grouped into three main stages — one Variscan and two Alpine.

Petrology, metamorphism and structures

First representative of the Veporic basement is a skarnoid body occurring within the Variscan granitoids near

Čierna Lehota village. The mineral composition of the skarnoid is dominated by garnet, biotite and ore minerals. The HDC includes different types of metasediments (phyllites and gneisses) and metavolcanic rocks in the study area. Characteristic feature of metasediments is very fine-grained matrix composed of chlorite, biotite, muscovite, quartz and plagioclase. Contact metamorphism related to the underlying Rochovce granite intrusion produced porphyroblasts of garnet, biotite, cordierite and andalusite. Metabasites from HDC consist of amphibole, epidote, chlorite and plagioclase with biotitization due to the mentioned Alpine contact metamorphism. The cover Rimava Fm. involves metasandstones, metavolcanics and metavolcanoclastics with mainly fine-grained matrix formed by sericite, quartz, albite and biotite. The Ochtiná group is represented by metaconglomerates, different types of phyllites and metabasalts. The mineral composition of phyllites includes chlorite, sericite, albite, quartz and organic matter. The main minerals of metabasalts are amphibole, chlorite and epidote. Occurrence of two types of amphibole is characteristic for these metavolcanic rocks. Rock composition of the Bôrka Nappe comprises different types of metabasalts in association with metacarbonates, phyllites and radiolarites. Chlorite, amphibole and epidote dominate in metavolcanics. Sericite, chlorite, albite and quartz are the main components of phyllites. Besides the contact metamorphism, we observed mineral associations characteristic for the greenschist facies conditions in all rock complexes.

Majority of the measured metamorphic foliation planes show moderate dips to SE, which is correlated with the main Alpine tectonic stages. The HDC is an exception, showing dip direction to the SW or S. These different attitudes are considered to be inherited from the pre-Alpine period, as it is indicated by the same orientation the Variscan granitoid sills near Chyžné village.

Monazite ages

The first set of monazite age data come from rock complexes occurring along the A profile line (Fig. 1). Two generations of monazites were encountered in skarnoid body occurring within the Variscan granitoids. The older monazites Mnz1 show a rounded habitus, dimensions from 10 μm to 30 μm and always as inclusions in garnets occur. EMPA dating of Mnz1 revealed the Devonian/Carboniferous boundary ages (359±4.2 Ma). The younger monazite generation (Mnz2) always occurs out of the garnets, most commonly in biotite or quartz. Mnz2 has a dendritic, strongly irregular habitus and is present in layers 30 μm to 100 μm thick along with older allanite. Mnz2 has the early Late Cretaceous age 92±7.2 Ma.

Two generations of monazites were identified in a mylonitic granite (Zlatná valley, NE of Slavošovce) located between the Variscan granitoids and Permian Rimava Fm. The older monazites (age around 355 Ma) are located in a massive fabric and they have dimensions from 100 μm to 50 μm. The younger monazites (ages around 100 Ma) are restricted to the Alpine foliation planes.

Numerous post-kinematic idiomorphic porphyroblasts of monazites (30–500 μm in size) were observed in the sericite-chlorite phyllites of the Bôrka Nappe (locality Honce, 10 km SE of Slavošovce). Monazites show a typical oscillation zonation which is reflected in their chemical composition. The EMPA dating of these monazites provided again two age groups: (1) 147±17 Ma and (2) 89±18 Ma.

We obtained other two distinct monazite age groups from the mylonitic granite and from garnet–biotite gneiss (NE of Chyžné village) located between the Variscan granitoid and HDC (profile line B in Fig. 1). Older monazite ages (around 355 Ma) were obtained from the mylonitic granite, while younger monazite ages (around 88 Ma) were identified from the garnet–biotite gneiss. Analogous monazite age 88 Ma was provided on the contact of the metamorphosed cordierite–biotite gneiss from the HDC near the contact with the Permian Rimava Fm. (NE of Magura Hill).

Further on, two monazite ages were acquired from sericite–chlorite phyllites of the Bôrka Nappe (locality Hrádok, 5 km S of Slavošovce). These monazites are very fine-grained (below 30 μm, frequently below 15 μm). Dating provided two different age groups: older (1) monazites 139±13 Ma, and younger (2) monazites 97±5 Ma. Older monazites occur in the coarser-grained domains and younger monazites are always present as elongated grains aligned within the very fine-grained foliation domains. Microscopic observations indicate shearing along the foliation planes.

Conclusions

Three principal tectono-metamorphic events can be discerned based on our petrologic and structural investigations and monazite age data: (1) the oldest monazite ages from the skarnoid body and from the mylonitic granites indicate the Variscan regional metamorphosis tacking from intrusion of granitoids into the Lower Paleozoic pelitic protolith of HDC; (2) the monazites age group around 145–140 Ma from sericite–chlorite phyllites of the Bôrka Nappe likely indicates exhumation related to thrusting of the Meliatic accretionary wedge over the lower-plate Veporic and Gemeric units, following subduction of the Meliata Ocean; (3) the youngest monazite age group from all analysed rocks records the Alpine overprint of the Veporic basement simultaneously with recrystallization of the Meliatic complexes during the main phase of the Western Carpathian nappe stacking and commencement of the extension-related exhumation of the Veporic metamorphic dome.

Acknowledgements: Financial support from the Grant Agency for Science, Slovakia (project VEGA 1/0085/17) and from the Slovak Research and Development Agency (project APVV-17-0170) is gratefully appreciated.

References

Klinec A. 1966: Zum Bau und Bildung des Veporiden-Kristallin. *Sbor. Geol. vied, rad ZK* 6, 7–28 (in Slovak with German summary).

Klinec A. 1971: The main tectonic elements in the eastern Veporides. *Geol. práce, Správy* 57, 105–109 (in Slovak with English summary).

Klinec A. 1980: Contiguous zone of Gemerides and Veporides enlightened by well near Rochovce. *Geol. Zbor. — Geol. Carpath.* 31, 537–540.

Kohút M., Stein H., Uher P., Zimmerman A. & Hraško Ľ. 2013: Re–Os and U–Th–Pb dating of the Rochovce granite and its mineralization (Western Carpathians, Slovakia). *Geol. Carpath.* 64, 71–79.

Korikovsky S.P., Janák M. & Boronichin V.A. 1986: Geothermometry and mineral equilibria during recrystallization of garnet mica schists and cordierite-bearing hornfelses in the Rochovce granite aureole (Slovak Ore Mts., Rochovce–Chyžné district). *Geol. zbor. — Geol. Carpath.* 37, 607–633.

Lačný A., Plašienka D. & Vojtko R. 2016: Structural evolution of the Turňa Unit constrained by fold and cleavage analyses and its consequences for the regional tectonic models of the Western Carpathians. *Geol. Carpath.* 67, 177–193.

Mello J., Reichwalder P. & Vozárová A. 1998: Bôrka nappe: high-pressure relic from the subduction-accretion prism of the Meliata ocean (Inner Western Carpathians, Slovakia). *Slovak Geol. Mag.* 4, 261–273.

Mock R., Sýkora M., Aubrecht R., Ožvoldová L., Kronome B., Reichwalder P. & Jablonský J. 1998: Petrology and stratigraphy of the Meliaticum near the Meliata and Jaklovce Villages, Slovakia. *Slovak Geol. Mag.* 4, 223–260.

Plašienka D., Méres Š., Ivan P., Sýkora M., Soták J., Lačný A., Aubrecht R., Bellová S. & Potočný T. 2019: Meliatic blueschists and their detritus in Cretaceous sediments: New data constraining tectonic evolution of the West Carpathians. *Swiss J. Geosci.* 112, 55–81.

Poller U., Uher P., Janák M., Plašienka D. & Kohút M. 2001: Late Cretaceous age of the Rochovce granite, Western Carpathians, constrained by U–Pb single-zircon dating in combination with cathodoluminiscence imaging. *Geol. Carpath.* 52, 41–47.

Reichwalder P. 1982: Structural characteristic of root zones of some nappes in innermost parts of West Carpathians. In: Maheľ M. (Ed.): Alpine structural elements: Carpathian–Balkan–Caucasus–Pamir orogene zone. *Veda Publ.*, Bratislava, 43–56.

Vozárová A. 1996: Tectono-sedimentary evolution of late Paleozoic basins based on interpretation of lithostratigraphic data (Western Carpathians, Slovakia). *Slovak Geol. Mag.* 3–4, 251–271.