Original paper

Zircon fission-track dating of granites from the Vepor–Gemer Belt (Western Carpathians): constraints for the Early Alpine exhumation history

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We present new zircon fission-track (ZFT) data from Variscan granitoid bodies in the Veporic (footwall unit) and Gemeric (hangingwall unit) thick-skinned nappe sheets of the Central Western Carpathians. All samples show Late Cretaceous to earliest Paleogene cooling ZFT ages, which contribute to constraining the low-temperature exhumation history of the Vepor–Gemer Belt. Four granite samples from the western part of the Gemericum near the contact with the underlying Veporicum provided central ZFT ages between 70.4 ± 5.4 and 74.7 ± 5.6 Ma. One sample from this area shows an older age of 87.7 ± 5.9 Ma, possibly owing to its higher structural position. One remoter sample from the SE part of the Gemeric Unit has 61.7 ± 3.4 Ma central ZFT age, which probably reflects exhumation associated with a younger compressional tectonic event in that area. One sample from the centre of the Veporic metamorphic core complex yielded a cooling age 64.9 ± 4.8 Ma. However, most of these samples exhibit an internal age scatter pointing to complex cooling and exhumation history influenced by a slow passage through the zircon partial annealing zone and/or reheating brought about by the Cretaceous Rochovce granite intrusion. In spite of this, the acquired ages generally match the exhumation trend of the Veporic metamorphic core complex.

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1. Introduction

Zircon and apatite fission-track analyses (ZFT and AFT, respectively) are widely applied in various geological settings because they represent a tool for constraining the time elapsed after these minerals crossed annealing or "closure" temperature, above which the tracks are healed. Although chemical composition, crystal structure and pressure show influence to annealing of tracks (Carlson 1990; Barbarand et al. 2003), the fission tracks are often interpreted more simplistically. In comparison to apatite, the mechanism of zircon annealing is not yet fully understood and recent studies suggest a wide range of temperatures for the zircon annealing (200–310 °C: Tagami et al. 1998). In this study we adopted a commonly accepted effective closure temperature of 240 ± 50 °C (Hurford and Green 1983; Hurford 1986) corresponding to the upper crustal depths at a normal thermal gradient. The above temperature ranges are widely used to define the zircon partial annealing zone (PAZ). When reheated to PAZ, the existing fission tracks are progressively shortened and above a given temperature they disappear completely.

Existing ZFT and AFT data from the Western Carpathian crystalline basement indicate an earlier exhumation of the Vepor–Gemer domain in comparison to the Tatra–Fatra belt of "core mountains" (Kráľ 1977; Kováč et al. 1994; Danišík et al. 2004). According to these data, the Veporic domain started exhumation already during the Late Cretaceous, following the Palaeo-Alpine compression stage. At that time the Veporic Unit has been buried to the middle crustal depth (see Janák et al. 2001a) but within the period 90–55 Ma its depth decreased to about 5 km (AFT data, Kráľ 1977) at an exhumation rate 0.5–1 mm/a (estimated by Kováč et al. 1994). On the other hand, the Tatric crystalline basement reached this level considerably later, mainly in the period 35–20 Ma (Kováč et al. 1994). The AFT thermochronology used to constrain the burial and exhumation history of basement highs along the NW margin of the Pannonian basin resulted in different timing of exhumation in the Malé Karpaty and Tribeč Mts. on the one hand (44 to 35 Ma), and Považský Inovec (21 to 13 Ma – Danišík et al. 2004) on the other. The oldest to date measured zircon FT ages from the Western Carpathians come from pebbles of granitoids from the Cretaceous "exotic" conglomerates of the Pieniny Klippen Belt (110–90 Ma; Kissová et al. 2005).

In this contribution we present and discuss new ZFT age data obtained from granites occurring mostly in the contact zone between the Gemeric and Veporic units in the southern Central Western Carpathian zones. Our results extend the thermochronological dataset of the area and fill the gap between the published $^{40}Ar/^{39}Ar$ ages (hornblende, muscovite, biotite, generally between 100 and 70 Ma) and AFT measurements (down to 50 Ma). We interpret these data in terms of extensional exhumation of the Veporic domain, by a mechanism similar to exhumation of the metamorphic core complexes. Samples from the hangingwall Gemeric Unit show significant dispersal of individual grain ages, but the calculated central ages follow the exhumation and cooling trend indicated by the other thermochronological data from the area. Consequently, we consider our data applicable for constraining low-temperature exhumation history of the Vepor–Gemer region.

2. Geological setting

The Vepor–Gemer Belt in southern part of the Central Western Carpathians is dominantly composed of basement complexes of the Veporic and Gemeric thick-skinned thrust sheets (e.g. Plašienka et al. 1997). The Veporic basement comprises various, presumably Lower Paleozoic volcano-sedimentary complexes metamorphosed mostly under the amphibolite-facies conditions during the Variscan orogeny (e.g. Krist et al. 1992). These metamorphic complexes were intruded by several suites of Variscan granitoids constituting the extensive composite Vepor Pluton (e.g. Petrík and Kohút 1997; Petrík et al. 1998; Broska and Uher 2001). Permian post-orogenic history was dominated by reheating, rifting, uplift and erosion, as recorded by signs of HT/LP metamorphism (Jeřábek et al. 2007), A-type granitic intrusions and sedimentation of continental red-beds in associated grabens. The Mesozoic cover consists only of Triassic sandstones and carbonates in the southern Veporic Unit. During the Palaeo-Alpine (Cretaceous) orogeny, the Veporic basement and cover were overridden by the Gemeric basement/cover nappe sheet and underwent low- to medium-grade metamorphism and ductile deformation (e.g. Janák et al. 2001a). At the Veporic–Gemeric contact zone, a hidden subsurface Rochovce granitic body was revealed by drilling and proven to be the only known Cretaceous granite intrusion in the Western Carpathians (Hraško et al. 1999; Poller et al. 2001).

The deep burial of the Veporic Unit was for the first time indicated by Vrána (1964), who documented a significant metamorphic overprint at 450 °C during the Palaeo-Alpine orogeny. According to Vrána (1966, 1980), the newly-formed Alpine grossular from metagranitoids of the Veporides corresponds to Alpine garnets from High Tauern and Swiss Alps with a comparable metamorphic grade. Vrána (l. c.) suggested more than 10 km of overburden above the Veporic Unit and explained it by obduction of the Tatric and Gemeric units over the Veporic. Later on the Vrána's estimates of metamorphic grade in the Veporic Unit were fully confirmed and established to *c.* 500–800 MPa at 400–550 °C (Vozárová 1990; Méres and Hovorka 1991a, b) at lower to middle pressure conditions (Kováčik et al. 1996). According to Plašienka et al. (1999) and Janák et al. (2001a) the Alpine metamorphic assemblages in the Veporic crystalline basement indicate conditions from 500 °C and 700–800 MPa to 620 °C and 900–1000 MPa, i.e. a metamorphic gradient from the greenschist to amphibolite facies. The tectonic interpretation of these authors assumes that the Veporic Unit has evolved as a metamorphic core complex during the Cretaceous growth of the Western Carpathian orogenic wedge. In this sense metamorphism was related to collisional crustal shortening and stacking, following closure of the southerly located Meliata Ocean. Subsequent exhumation was accomplished by orogen-parallel extension and unroofing in an overall compressive regime (Plašienka et al. 1999). The master low-angle detachment fault corresponds to the present Veporic/Gemeric contact zone (the so-called Lubeník–Margecany line), which is a reactivated original thrust plane (see Fig. 4).

The Gemeric thrust sheet is composed of mostly low-grade pre-Alpine basement and its Pennsylvanian–Triassic sedimentary cover. The basement includes Lower Palaeozoic volcano-sedimentary formations (Gelnica, Rakovec and high-grade Klátov groups) intruded by fairly small bodies of post-orogenic Permian to Early Triassic granites of two basic types (Uher and Broska 1996; Finger and Broska 1999; Broska et al. 2001; Poller et al. 2002): more widespread specialized (tin-bearing) S-type granites (Betliar, Hnilec, Dlhá dolina and Poproč) as well as the single A-type granitic body near Turčok.

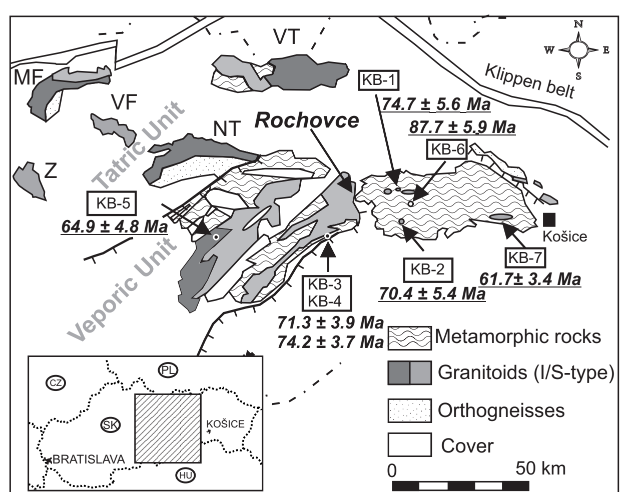

Fig. 1 Geological sketch of the Western Carpathians crystalline basement and positions of the investigated samples.

The northernmost part of the Gemeric Zone is composed of Mississippian rocks (Ochtiná Group). Pennsylvanian to Scythian cover is composed of various clastic sediments dominated by Permian red-beds. Except for strong deformation and penetrative cleavages, the Alpine metamorphic overprint is rather low, reaching the greenschist facies in the Gemeric basement.

The Gemeric Superunit is overridden by nappe outliers of the Meliatic Superunit (Bôrka nappe) and the Silicic cover nappe system. The Bôrka nappe includes Triassic–Jurassic oceanic complexes, including ophiolites, which suffered a Late Jurassic blueschist-facies metamorphic overprint (Maluski et al. 1993; Dallmeyer et al. 1996, 2005; Faryad and Henjes-Kunst 1997).

3. Sample locations and their characteristics

Granites chosen for ZFT dating were taken from the main granite bodies in the Gemeric Unit, and one sample from the Veporic Sihla tonalites. Geographic and geological position of samples is shown in Fig. 1.

The granites from the Gemeric Unit (KB-1, 2, 6, 7) differ from all other granite groups in the Western Carpathians by their Sn–Mo–B–F specialization and additional Nb–Ta–W–rich mineralization. Therefore, they are designated as specialized S-type granitoids represented by biotite–muscovite to muscovite leucogranites, albite-, microcline, ± topaz-bearing granites and/or rare granite porphyries (Uher and Broska 1996; Broska and Uher 2001). They show Permian–Early Triassic intrusion ages, which were obtained by zircon single grain U-Pb isotopic analyses (Poller et al. 2002), by monazite CHIME dating (Finger and Broska 1999), Re-Os molybdenite dating (Kohút et al. 2004; Kohút and Stein 2005) and earlier Rb-Sr WR and mineral isochrons (Cambel et al. 1989). These granites originated from a mature continental metasedimentary feldspar- and muscovite-rich protolith (Petrík and Kohút 1997). The partial melting was probably induced by heating of the lower crust due to rifting processes during the Permian–Early Triassic period (Broska and Uher 2001). Sample KB-1 was taken from the Hnilec body, KB-2 from the Betliar granite porphyry and KB-6 (borehole DD-3 from the Dlhá dolina valley) is an example of the most evolved granite emplaced to the shallowest crustal levels due its high primary contents of volatiles.

The Turčok granite (KB-3, 4) is a representative of the A-type granites, which are Permian in age (Putiš et al. 2006) and were probably generated along a continental strike-slip zone. It is located along the Hrádok Fault Zone near the Veporic–Gemeric contact. The Turčok granite is strongly tectonically deformed biotitic granite with specific A-type chemistry as well as accessory mineral assemblage (Uher and Gregor 1992). This granite is enriched in zircon, apatite, allanite, magnetite, tourmaline and pyrite.

The Sihla tonalite (KB-5), as the most prominent Veporic granitoid rock, belongs to the post-tectonic I-type granite suite, which according to conventional zircon dating shows Late Carboniferous age (Bibikova et al. 1990). Microgranular enclaves, a conspicuous feature of the Sihla granitoids, indicate their origin in the lower crustal conditions above a zone of asthenosphere upwelling, where mixing of silicic and basic magmas was commonplace (Broska and Uher 2001).

4. Analytical procedure

Zircons were obtained by a routine separation method with crushing and sieving of approximately 6 kg of investigated rocks. The concentration of accessory minerals was done on Wilfley shaking table and the resulting heavy fraction was purified using heavy liquid (bromophorm). Finally, after magnetic separation, zircon grains were hand-picked and mounted in Teflon for the cathodoluminescence (CL) analysis and for FT dating.

Formation of fission tracks is described as a decay of an ^{238}U atom into two highly charged particles, which travel through the crystal lattice creating a linear zone of damage called fission track (Fleischer et al. 1975; Wagner and Van den Haute 1992). Chemical etching enlarges these tracks in minerals. Our zircon grains were etched in eutectic melt of KOH and NaOH for 31–54 hours at 200 °C and spontaneous tracks in zircons were counted under the optical microscope. After etching we prepared the sample for the irradiation. Sample preparation for irradiation included mounting of the zircon crystals to the Teflon PFA, polishing and etching. We were using grinding paper (1200 and 2500) for polishing and polishing diamond suspensions of different grain size (9 μm, 3 μm, 1 μm). Every mount was covered with flakes of low-U muscovite from India, packed using foam, polyethylene and parafilm and irradiated at the TRIGA nuclear reactor (Oregon, USA). Standard of known age (Fish Canyon Tuff, Tardree Rhyolite – Hurford 1998) and glass dosimeters with known uranium concentration CN2 were included in the package for irradiation and used for the calculation of a ζ-value (zeta) – Hurford and Green (1983), Hurford (1998). The calculated personal ζ -value is 122.4 ± 3.3. All fission tracks in age standards and in samples were counted using the same microscope setup (Zeiss Axioscope, objective with 1000× magnification, using immersion oil). The ages were calculated using software TrackKey (Dunkl 2002).

5. Results

5.1. Zircon characterization

Zircons are only very slightly metamictized in all investigated samples. Their colour is pink or hyacinth with elongation usually exceeding 2–3.

The Sihla granite zircons (KB-5) show a very fine internal zoning indicating a prolonged crystallization. There are only slight changes in morphology from cores to rims with relatively limited diffusion features inside the crystals (Fig. 2a). However, proportion of inherited cores is rather high. According to the Pupin's classification (1980), the S_{12} zircon subtype prevails.

The Turčok granite (KB-3, KB-4), as a representative of the A-type granites, has high P and D subtypes of zircons reflecting origin from dry and hot magmas (Uher and Gregor 1992). These zircon subtypes strongly prevail over the other (70 vol. %). Although the diffusion or element redistribution within the zircon grains is relatively high, zircons have been dated (Fig. 2b).

Primary zircons from the Gemeric S-type granites (KB-1, KB-2, KB-6, KB-7) are mainly S_8 subtypes, secondary or late magmatic belong to the G_1 subtype. The latter fraction forms about 15–20 vol. % of the total zircon population. These late-stage zircons show also different composition (higher contents of P, Y and Hf). The CL images often show primary oscillatory zoning of zircons, but inherited cores are usually not apparent. Rarely some crystal cores have a morphology close to the higher temperature origin or high-temperature D zircon subtypes (Fig. 2c). Fluid interaction resulting in diffusion texture of zircons is present relatively often, especially in the Dlhá dolina granites (KB-6), where rocks were strongly affected by a fluid activity (Fig. 2d). Zircons from the Betliar granite porphyry (KB-2) are characterized by a complicated growth history. Older zircon cores crystallized relatively rapidly in (highly) alkaline environment (G type), later zircons overgrew cores at higher temperatures to the final S_3 subtype (Fig. 2e). Signs of the alkaline activity indicate possibility of a partial zircon dissolution. This process probably occurred at the late stage of the granite evolution and is recorded by smooth edges of some inner faces on the CL images (Fig. 2f). Dissolution of zircon is observable also on the grain surfaces.

5.2. Zircon fission-track results

Zircon fission-track ages (ZFT) were determined on 7 granite samples and most of them passed the chi-square test. The obtained ZFT were reported as central ages in the range between 61.7 ± 3.4 and 87.7 ± 5.9 Ma (Tab. 1). Radial plots portray the dispersion of data and refer to the mean values of the measured ages (Fig. 3). However, all samples show either a scatter of ages obtained from individual grains, or the number of measured grains is too low for reliable conclusions. Consequently, the geological meaning of the obtained age data might be questionable. Most probably the measured samples represent apparent or mixed ages of rocks that experienced a complex thermal history.

6. Discussion

According to the regional tectonic interpretation of Plašienka et al. (1999) and Janák et al. (2001a), the Vepor–Gemer area represents an Alpine metamorphic terrain that was exhumed as a core complex during the Late Cretaceous. The Veporic basement/cover Superunit occurs in the footwall of a low-angle detachment fault and suffered a greenschist- to lower amphibolite-facies metamorphic overprint. In contrast, the hangingwall Gemeric basement/cover Superunit experienced only greenschist to very low-grade Alpine metamorphism. Nevertheless, P-T metamorphic conditions in both units were well above the ZFT closure temperature, especially

Tab. 1 Zircon fission-track results measured on granitoid samples from the Gemeric and Veporic superunits.

Localities	Code	Petrography	Cryst.	Spontaneous		Induced		Dosimeter		*P*	Disp.	FT age*
				ρs	(Ns)	ρi	(Ni)	ρd	(Nd)	(%)		(Ma ± 1σ)
Hnilec-Delava	KB-1	granite (Ss-type)	16	59.3	490	45.2	373	9.35	6008	67.30	0.01	74.7 ± 5.6
Betliar	KB-2	granite (Ss-type)	14	107.8	1420	88.4	1165	9.39	6008	0.00	0.21	70.4 ± 5.4
Turčok	KB-3	granite (A-type)	24	116.6	1822	94.9	1483	9.59	6008	1.61	0.14	71.3 ± 3.9
Turčok	KB-4	granite (A-type)	32	129.1	2665	102.3	2111	9.64	6008	0.16	0.15	74.2 ± 3.7
Sihla	KB-5	tonalite (I-type)	13	90.8	473	79.1	412	9.29	6008	63.56	0.00	64.9 ± 4.8
Dlhá dolina DD-3	KB-6	granite (Ss-type)	22	116.8	1355	75.2	872	9.24	6008	0.55	0.19	87.7 ± 5.9
Poproč	KB-7	granite (Ss-type)	30	82.6	1737	75.2	1582	9.15	6008	0.93	0.16	61.7 ± 3.4

Note: track densities (ρ) are as measured and are ($\times 10^5$ tr/cm^2); number of tracks counted (N) shown in parentheses; P is probability of obtaining χ^2 value for n degree of greed (when n = no crystals-1); zircon ages calculated using dosimeter glass CN_2 with $\zeta = 122.4 \pm 3.3$.

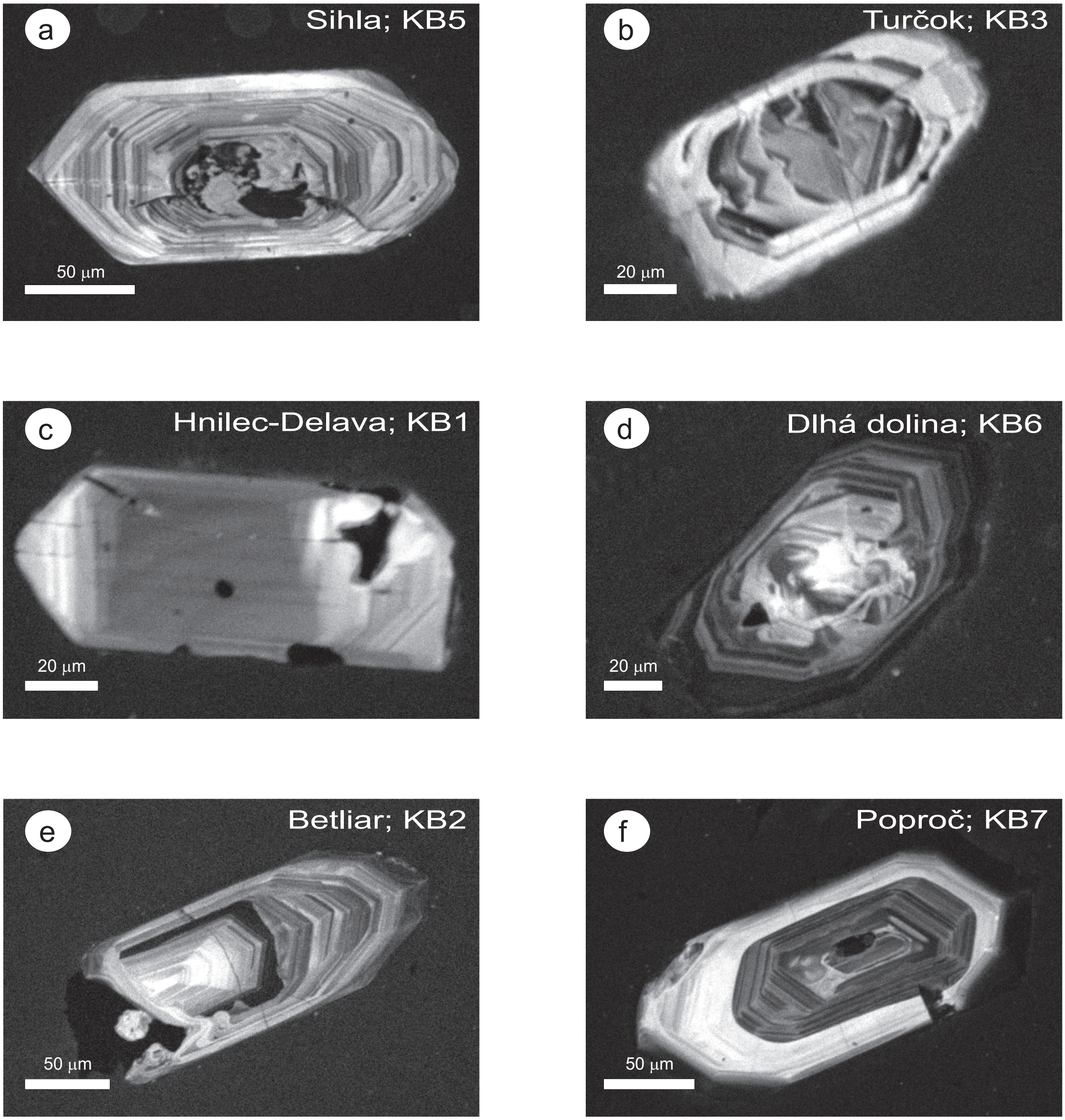

Fig. 2 Cathodoluminescence images of the selected investigated zircons. **a** – locality Tlstý Javor (Sihla I-type granite), example of zircon with inherited core and prolonged crystallization determined by the fine oscillatory zoning; **b** – Turčok (A-type granite), a high-temperature primary zircon of P or D-subtype attacked by corrosive fluids; **c** – Hnilec (specialized S-type granite), change of zircon morphology from high "D subtype" to lower temperature subtype; **d** – Dlhá dolina DD-3 (specialized S-type granite), internal zoning of the zircon strongly overprinted by fluids; **e** – Betliar (specialized S-type granite), magmatic zircon of G type rimmed by a new S3 stage phase; **f** – Poproč (specialized S-type granite), zircon crystal that shows effects of leaching during magmatic growth indicating a highly alkaline environment.

in the basement complexes that we are dealing with in this paper. Therefore we suppose that in spite of a large error included in our ZFT data they generally represent cooling ages, though clearly much influenced either by a long stay of studied rocks within the PAZ, or alternatively a part of them may have been affected by reheating to the PAZ later. In order to evaluate these hypotheses in a regional context, we first briefly review the Alpine geochronological data from the Veporic and Gemeric basement/cover complexes.

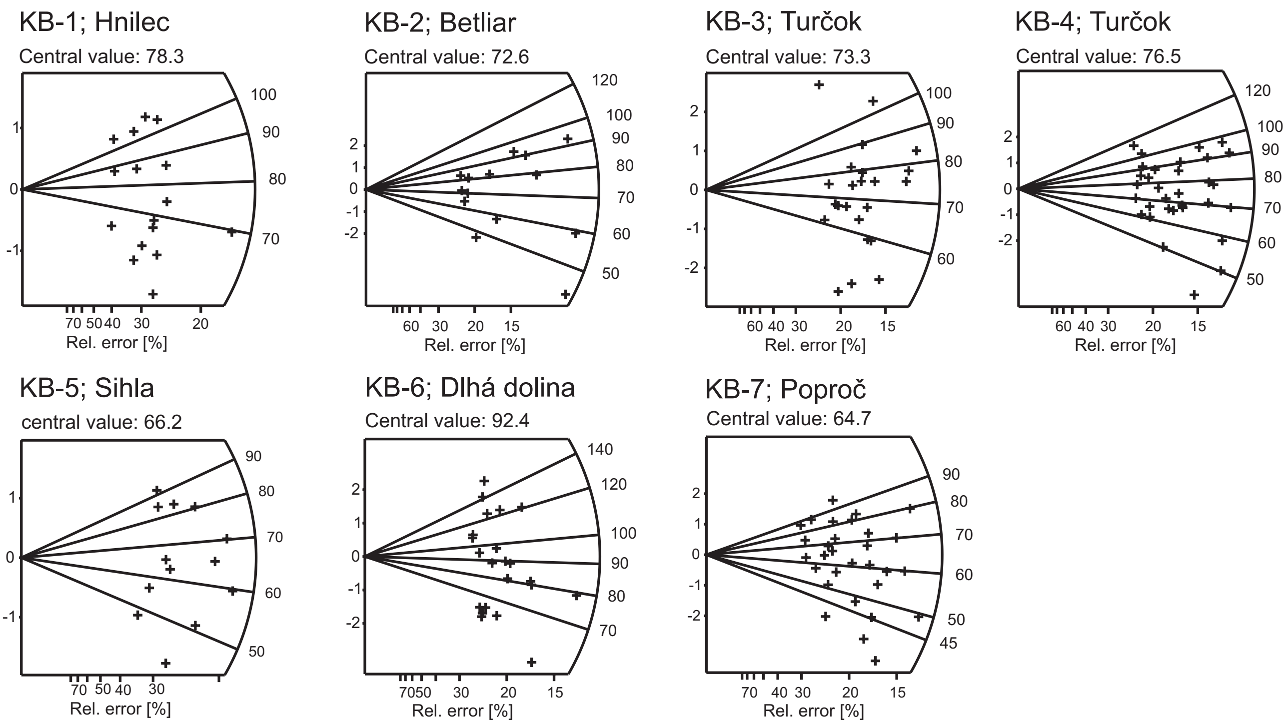

Fig. 3 Radial plots of investigated samples.

The oldest published age data about Alpine metamorphism in the Veporicum were presented by Kantor (1960), who reported K-Ar ages of newly-formed biotites in the range 107–75 Ma. Later on, Burchart et al. (1987) reassessed the Kantor's data and obtained an isochron age 94 ± 18 Ma (see also Cambel et al. 1990). Modern $^{40}Ar/^{39}Ar$ dating techniques were firstly applied to mylonites within the Veporic basement by Maluski et al. (1993). Kráľ et al. (1996) reported discordant $^{40}Ar/^{39}Ar$ age spectra from the Veporic amphibolites showing a wide span from Variscan to Cretaceous ages pointing to mixed ages and/or excess argon, but ages of newly formed tschermakitic amphiboles between 115 and 105 Ma (Kováčik et al. 1996, 1997) probably have some geological meaning (thrusting event followed by onset of metamorphism). Koroknai et al. (2001) presented K-Ar amphibole age of 93.5 ± 5.6 Ma. Other age data probably indicating the thermal peak of Alpine metamorphism in the Veporic basement include Sm-Nd whole rock–garnet isochron (108.8 ± 5.6 Ma; Lupták et al. 2004) and electron microprobe dating of monazite (91 ± 25 and 92 ± 16 Ma; Janák et al. 2001b). Recently published monazite age data of a large sample set from the Veporic basement (Kováčik et al. 2005) exhibit a very wide span (from Precambrian to Cretaceous); the prevailing Alpine data range between 120 and 87 Ma (with a significant error, though).

Comparably extensive dataset of $^{40}Ar/^{39}Ar$ ages comes from the Veporic white micas. Results of Maluski et al. (1993), Dallmeyer et al. (1996, 2006), Kováčik et al. (1996, 1997) and Koroknai et al. (2001) indicate that the cooling ages concentrate between 90 and 80 Ma. Janák et al. (2001a) reported somehow younger ages (77 to 72 Ma) obtained by the UV laser probe technique. The low-temperature data are very scarce, the old published results of apatite FT dating of Veporic granites spread between 89 ± 10 and 53 ± 7 Ma (Kráľ 1977). Another data set comes from boreholes that penetrated the southernmost Veporic basement in northern Hungary – three samples provided ZFT ages in a narrow range between 77.5 ± 3.5 and 74.8 ± 3.9 Ma, the presented AFT age was 51 ± 3 Ma (Koroknai et al. 2001).

During the exhumation and cooling, the contact zone between the Veporic and Gemeric superunits was influenced by a distinct thermal event – reheating due to the Rochovce granitic intrusion (82 ± 1 Ma: U-Pb zircon age according to Hraško et al. 1999, or 75.6 ± 1.1 Ma according to Poller et al. 2001). Thermal effect on the surrounding metasediments is revealed by a contact aureole with newly-formed HT/LP mineral assemblages indicating temperatures *c.* 500 °C at mere 200 MPa (Korikovsky et al. 1986; Vozárová 1990; Krist et al. 1992). These are clearly superimposed on the regional medium-pressure Barrovian-type associations.

Few $^{40}Ar/^{39}Ar$ ages were published from the hanging-wall Gemeric sheet. Amphiboles from the contact zone of the Permian Hnilec granites provided ages around 140 Ma (Vozárová et al. 2000), the geological meaning of which is unclear (exhumation and cooling due to thrusting?). Only one Alpine white mica datum was reported by Dallmeyer et al. (1996, 2006): 105.8 ± 0.3 Ma from mylonitized Gemeric cover metasediments within a ductile shear zone at the Veporic/Gemeric contact, other measurements gave pre-Alpine ages. However, the Alpine metamorphic overprint in the Gemeric basement and cover still reached conditions of the lower greenschist facies (e.g. Varga 1973; Krist et al. 1992). Faryad and Dianiška (1989) described grossular outer rims of garnets from the Gemeric granites, which they considered to be most probably of Alpine age.

The above-listed data suggest that both Veporic and Gemeric granite bodies were heated well above the zircon PAZ during the Alpine (Cretaceous) metamorphism. Metamorphism culminated with maximum temperatures at *c.* 110–90 Ma and cooled below the $^{40}Ar/^{39}Ar$ blocking temperature in white micas mostly between 90 to 80 Ma ago. Consequently, the rocks should have passed the zircon PAZ later than 80 Ma and, assuming a "smooth" exhumation/cooling trend, probably later than 70 Ma ago.

Despite the low reliability due to the age dispersal of individual grains, our samples generally follow this expected trend. The only exception is KB-6 (Gemeric Dlhá dolina granite), which provided the central age 87.7 ± 5.9 Ma (Fig. 1). The reason may be the high structural position of this granite body within the hangingwall Gemeric sheet, i.e. its earlier cooling and exhumation. Originally shallower structural position of the Dlhá dolina body is supported also by a high content of volatiles, which enabled its higher mobility during emplacement in the upper crust.

The most widespread ages range between 70 and 75 Ma (KB-1 Gemeric Hnilec-Delava granite 74.7 ± 5.6 Ma; KB-2 Gemeric Betliar granite 70.4 ± 5.4 Ma; KB-3 and KB-4 from the Gemeric A-type Turčok granite 71.3 ± 3.9 Ma and 74.2 ± 3.7 Ma, respectively). These may be considered as matching the cooling/exhumation trend of the footwall Veporic core complex. On the other hand, these samples were taken from localities within 15 km of the exocontact of the Rochovce granite, which

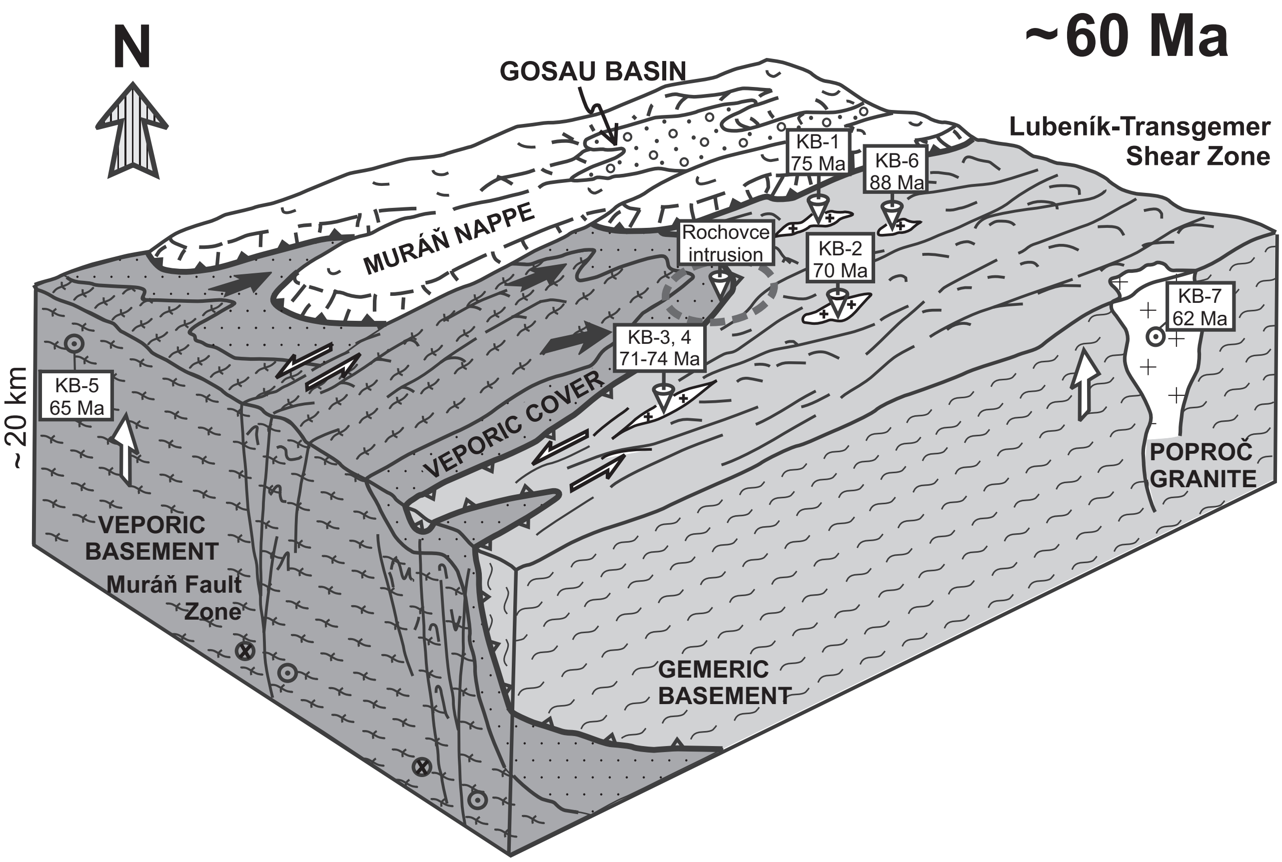

Fig. 4 Interpretative block-diagram of the Vepor–Gemer Belt at about 60 Ma before present showing approximate position of individual samples with their rounded ZFT ages and the overall tectonic regime in the area. Thick solid arrows indicate the sense of subhorizontal extensional unroofing of the Veporic core complex, paired half-arrows specify the sinistral movement within transpressional zones. The Muráň nappe is a décollement cover nappe of the Silicic Superunit overlain by the Senonian sedimentary basin. The grey stippled ellipse indicates position of thermal aureole above the subsurface Rochovce granite intrusion. Shading: dark-grey for the Veporic Unit, light-grey for the Gemeric Unit; Gemeric granites, the Silicic Muráň–Stratená nappe and post-nappe Gosau cover sediments are blank.

shows only a slightly older intrusion age (Fig. 4). Taking into account the well-developed contact aureole, these samples might have been influenced by this thermal event resulting in the observed age dispersal within individual samples. Rocks were either reheated after having cooled below the PAZ, or resided within the PAZ for a longer time during exhumation.

The Veporic Sihla granite (sample KB-5 with the central age 64.9 ± 4.8 Ma) from the centre of the Veporic core complex (Fig. 4) fits well the exhumation trend. Its ZFT age is younger than any other isotopic age from the Veporic basement and yet older than the youngest AFT ages reported by Kráľ (1977) and Koroknai et al. (2001).

The sample KB-7 from the Gemeric Poproč granite (61.7 ± 3.4 Ma) comes from a remoter SE part of the Gemericum. Being aware of non-representativeness of this single datum, we suspect that this youngest obtained age may have resulted from a different tectonic regime and exhumation process in the Poproč area. This locality lies SE of the important tectonic feature of the region, the sinistral Lubeník–Transgemer Shear Zone (e.g. Grecula et al. 1990; Németh et al. 1997; Lexa et al. 2003) (Fig. 4). The latest Cretaceous/earliest Paleogene (70–60 Ma) activity of this transpressional belt was probably triggered by indentation of a rigid block from the south (Lexa et al. 2003), which likely initiated also a renewed uplift and exhumation of the SE part of the Gemeric basement sheet. The post-Senonian compressional tectonic activity in this region is revealed also by reverse faulting within the Mesozoic complexes of the Slovak Karst Mts., a few km south of Poproč, which incorporated also the Gosau-type sediments (e.g. Mello 1997).

7. Conclusions

Our data are the first zircon FT ages from the Variscan basement granitoids of the Vepor–Gemer Belt in the southern part of the Central Western Carpathians. They supplement the various published thermochronological data and collectively support the current ideas about exhumation history of this area during the Late Cretaceous.

Four samples of Gemeric granites show a rather narrow span of central ZFT ages between 70.4 ± 5.4 and 74.7 ± 5.6 Ma. One sample of the Gemeric granites provided an older age of 87.7 ± 5.9 Ma, probably due to its higher structural position. One remoter sample from the SE part of the Gemericum yielded a 61.7 ± 3.4 Ma central ZFT age, which seems to reflect uplift and exhumation associated with a younger compressional tectonic event in that area. One sample from the centre of the Veporic metamorphic core complex indicates cooling though the zircon PAZ at 64.9 ± 4.8 Ma.

Despite the fact that the obtained ZFT age data are rather scattered, they seem to generally follow the exhumation trend of the Veporic metamorphic core complex. Nevertheless, the cooling was apparently not uniform, particularly in the hangingwall Gemeric basement unit at the Gemeric/Veporic contact zone, where some of the measured samples were possibly affected by a thermal event caused by the Late Cretaceous Rochovce granite intrusion. This might have caused either reheating, or a protracted residence of investigated rocks within the zircon PAZ resulting in a scatter in FT ages obtained from the individual samples.

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