Cretaceous Cooling History of the Western Carpathians: New Zircon FT Ages from Gemeric Granites and Pebbles from Conglomerates of the Klippen Belt

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The Pieniny Klippen Belt (PKB) is a prominent Western Carpathian tectonic structure, which separates the External Carpathians (Flysch Belt), representing the Tertiary accretionary complex, from the Central Western Carpathians that originated by Cretaceous nappe stacking. The PKB is a very long (almost 600 km) and narrow (several km) zone with intricate tectonic structure comprising various sedimentary rock complexes of Jurassic to Tertiary age, which are affiliated to numerous tectonic units. Some of these units, the Klape Unit in particular, involve Cretaceous conglomerate-bearing flysch complexes. The conglomerates have been described as "exotic" (e.g. Mišík and Sýkora, 1981), because they contain pebbles of various rocks with an unknown provenance – e.g. Triassic pelagic limestones, various Jurassic and Lower Cretaceous sediments, Jurassic blueschist facies metabasalts, as well as volcanic rocks and granitoids, which are the main objective of our study.

The granitoids from the conglomerate pebbles belong to several types; the exotic character was mainly ascribed to the "Upohlav"-type granites with A-type petrochemical characteristics (Uher and Marschalko, 1993), which do not occur in potential source areas within the presently adjacent units. U-Pb zircon dating revealed their Permian crystallization age (Uher and Pushkarev, 1994). A-type granites with petrochemical characteristics and Permian crystallization ages comparable to the Upohlav-type granite pebbles occur in an original intrusive position in the southern Western Carpathian zones only. These are the Hrončok granite body in the Veporic superunit, the Turčok granite in the Gemeric superunit, and the Velence granite in the Transdanubian Central Range of NW Hungary (e.g. Uher and Broska, 1996, Poller et al., 2002).

The aim of our study is to elucidate exhumation histories of these areas using the low-temperature thermochronology of "exotic" granitoid pebbles in comparison with their possible source areas in the southern Western Carpathian zones, gathered by means of zircon FT measurements. We have studied granitoid samples from pebbles in the PKB Cretaceous conglomerates and from in-situ intrusive bodies in the Gemericum of the inner WC zones. New, yet preliminary FT zircon ages from both areas are presented here. These ages are interpreted as cooling ages following a low-grade thermotectonic event that is indicated by a weak metamorphic recrystallization and by K-Ar and $^{40}Ar/^{39}Ar$ isotopic dating providing ages slightly older than our FT measurements.

Four samples of the Gemeric granites from localities near Turčok (A-type granite), Betliar and Poproč – Zlatá Idka (specialized S-type granites) gave quite consistent age data in the range between 80 and 65 Ma. These ages correspond to the Late Cretaceous white mica $^{40}Ar/^{39}Ar$ cooling ages of the Veporic metamorphic core complex occurring in the footwall of the Gemeric thrust sheet (Janák et al., 2001 and references therein). The difference of nearly 150°C between closure temperatures of $^{40}Ar/^{39}Ar$ system in white micas and zircon FT system represents the difference of about 3 km in structural level of both units, assuming a comparatively high geothermal gradient of approximately 50 °C/km during final stages of extensional tectonic exhumation. This is in line with the field observations.

Six samples of Upohlav-type granitoid pebbles from the PKB show significantly older ages. Upper Cretaceous conglomerates (Coniacian – Santonian Sromowce Fm. of the Kysuca and/or Klape Unit) provided clasts with zircon FT ages ranging from roughly 130 to 90 Ma, while those from mid-Cretaceous wildflysch formations (Albian – Cenomanian of the Klape Unit) gave figures between 130 and 100 Ma. However, the difference seems to be minor and, accordingly, the source area of granitoid pebbles for both mid- and Upper Cretaceous conglomerates apparently remained at the same level of exhumation, or more probably pebbles occurring in the Senonian conglomerates may have been recycled from older mid-Cretaceous conglomerates. The Early Cretaceous FT zircon ages from the exotic granitoids are consistent with the published K-Ar (cf. review by Marschalko, 1986) and unpublished $^{40}Ar/^{39}Ar$ datings from granitoid clasts that provided ages between 140 to 115 Ma.

In general, we interpret the source area of the PKB Upohlav-type granitoid pebbles as an unspecified exhuming terrain that underwent a low-grade metamorphic event in the earliest Cretaceous (140−130 Ma) and subsequently cooled below approximately 240 °C (FT zircon ages) throughout the Early Cretaceous, up to 100 Ma. The short time lag of the cooling ages relative to the depositional age, as well as large sizes of granitoid and other clasts and synorogenic, thickening- and coarsening-upwards character of conglomerate-bearing wildflysch formations, indicate that this source area was an actively deformed, uplifted and rapidly eroded mountain range.

The question about the location of this source area remains open. The traditional concept of the "Pieniny exotic ridge" cannot be definitely excluded (as many entirely hypothetic ideas cannot be), but its existence is highly improbable from point of view of regional tectonics and structural evolution (Plašienka, 1995). We still keep our working hypothesis that the source area for "exotic" granitoids occurred in the southern Western Carpathian zones, which exhibit very similar exhumation history. The difference between zircon FT ages from PKB pebbles and present-day Gemeric outcrops may be explained by the difference in the exhumation level during mid-Cretaceous and Late Cretaceous to Recent times, respectively. An alternative view assumes that the southern Western Carpathian zones experienced compressional tectonic regime during the Early Cretaceous (no sediments, deformation, 140 Ma thermal event – Vozárová et al., 2000), hence the area was likely uplifted and continuously eroded. This would be the first exhumation pulse triggered by compression, surface uplift, erosion and deposition of eroded material (including "exotic" granitoids) in an adjacent flysch basin. After that, the presently measured Upper Cretaceous zircon FT ages from Gemeric granites may have resulted from reheating during extensional unroofing of the Veporic metamorphic core complex in their footwall, i.e. they record the second exhumation pulse associated with extension and nearly no uplift and erosion.

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Re-Os Dating of Molybdenite from the Hnilec Permian Granite-Related Mineralisation – its Tectonic Significance (Gemeric Unit, Slovakia)

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Understanding tectonic and ore evolution in composite orogenic belts (COB) that comprise multistage metamorphic and magmatic processes, for example, in the Alps, Carpathians or Himalayas is often problematic. Polyorogenetic history of modern COB marked by incorporation of pre-Mesozoic crystalline basement rocks into young Alpine fabrics results in formation of composite terranes and ore deposits with multistage ore evolution and mineralisation. However, unraveling ore-forming episodes in composite ore deposits is practically impossible without precise dating. But in many cases silicate gangue and/or