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Devonian/Mississippian I-type granitoids in the Western Carpathians: A subduction-related hybrid magmatism

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ABSTRACT

SIMS zircon U–Pb dating of I-type granitoids from four Variscan crystalline basement outcrops in the Western Carpathians (Tribeč, Nízke Tatry, Čierna Hora and Slovenské Rudohorie Mts.) implies that they originated between 367 and 353 Ma. Therefore, they belong to the earliest Variscan I-type granitoids. The oldest Devonian age at ca. 367–364 Ma is obtained from an enclave-bearing tonalite and associated dikes of the Tribeč Mts. Several granodiorites from the Nízke Tatry, Vepor and Čierna Hora Mts. (353–357 Ma) show younger, Early Carboniferous ages. These data require a re-assessment of older models that explained the genesis of I-type granitoids in the Western Carpathians based on the assumption of younger, Middle to Upper Carboniferous ages.

The I-type granite massifs of the Western Carpathians most probably originated in an arc-related environment within the Galatian superterrane, an assemblage of Gondwana derived fragments. The early age of I-type magmatism in the Western Carpathians marks the beginning of a north-dipping subduction of the Paleotethys ocean under Ibero-Ligerian and intra-Alpine terranes. We suggest a term "Proto-Tatricum" for that part of the Galatian superterrane where Devonian/Mississippian I-type granitoids were emplaced. Now the granitoids are incorporated as a part of crystalline basement into the Alpine Tatric and Veporic units within present West-Carpathian mountain chain.

1. Introduction

I-type granite magmatism is traditionally considered a typical product of melting of meta-igneous rocks involving lower crustal or subcontinental mantle sources (Chappell and Stephens, 1988; Roberts and Clemens, 1993). However, the dominantly crustal character of the most I-type granitoids based mostly on their Nd and Sr data indicates that intermediate I-type protoliths (andesites, tonalites) from (destructed) magmatic arcs may represent the appropriate protoliths to produce I-type melts with the observed characteristics (Clemens et al., 2011). Throughout the Variscan collisional belt I-type granitoids seem to be less abundant compared to S-type granitoids, and in time they cover the wide interval from the Middle/Late Devonian to the Upper Carboniferous/Permian. The earliest include the I-type plutons in the Bohemian massif (Teplá–Barrandian, 375 Ma, Žák et al., 2011 and the Central Bohemian Plutonic Complex, 354 Ma, Janoušek et al., 2010). The granodiorites of the Bavarian zone (344 Ma, Finger et al., 2010) and I-type plutons of the northern Vosges and Schwarzwald (335–325 Ma, Altherr et al., 2000) are younger. The youngest include the post-tectonic, delamination-related Variscan suite of the Central Iberian massif (ca. 300 Ma, Fernández-Suaréz et al., 2011; Gutiérrez-Alonso et al., 2011). Outside the Variscan orogenic belt, in the pre-Alpine basement, I-type diorites of Devonian age are also found (360 Ma, the Western Alps, Guillot et al., 2012).

Here we present new SIMS zircon U–Pb ages for a range of I-type granitoids from the pre-Alpine basement of the Western Carpathians for which reported ages are late Devonian to early Carboniferous (Mississippian) (367–353 Ma). The new ages are significantly older than those previously reported for the I-type suite in the Western Carpathians, and thus require a re-interpretation of its evolution. Based on our synthesis of new and previously published data, we suggest the term "Proto-Tatricum" for a terrane containing the oldest granitoid intrusions within metamorphic complexes of the southern Variscan sector.

The Western Carpathians are divided into the Inner and Outer Carpathians (Bezák et al., 2011) with granitoid plutons occurring in only the Inner Carpathians. While the Outer Carpathians are represented by the Flysh belt from an accretionary wedge, the Inner Carpathians correspond to a Paleoalpine Cretaceous nappe system composed of the basement-involved Tatric, Veporic and Gemeric units. All three units comprise granitoids, however, the granites from the Gemeric unit differ in age and source from those in Tatric and Veporic units (Broska and

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Uher, 2001; Plašienka et al., 1997; Fig. 1). The granitic plutons from Tatric and Veporic units in the Inner Carpathians intruded into the high- to medium-grade basement of the Variscan Upper and Middle crustal nappes (Bezák et al., 1997), which show southward vergency (Bezák et al., 1997; Bielik et al., 2004; Fritz et al., 1992; Putiš, 1992; Siegl, 1982). The granitoids are classified mostly as S-type, a lesser amount of tonalites–granodiorites belong to the I-type. Small bodies of Permian A-type granites and volcanics are also present (Broska and Uher, 2001; Vozárová et al., 2012).

2. I-type granites

2.1. Mineralogical and petrological characterization

Among the Western Carpathian Variscan granites I-type granitoids form a mineralogically and geochemically well defined group. For dating purposes, we have chosen areas with typical I-type granitoid occurrences in the Tríbeč, Nízke Tatry, Slovenské Rudohorie and Čierna Hora Mts. The granitoids sporadically contain mafic microgranular enclaves (Fig. 1; Petrík and Broska, 1989). In contrast to the undeformed I-type granitoids of the Tatric Unit, those of the Veporic Unit (Sihla type) show an intensive Paleo-Alpine Cretaceous metamorphic reworking manifested by strong saussuritization of plagioclase, biotite and allanite recrystallization.

Typically, the I-type granitoids are coarse- to medium-grained, meta- to subaluminous, biotite (leuco)-tonalites to granodiorites, with minor biotite– to muscovite–biotite granites. They contain eu- to subhedral zoned plagioclase (cores $An_{35–40}$, rims An_{20}), biotite with Fe/(Fe + Mg) ratio below 0.5 and relatively low TiO_2 (2–3 wt.%). Hornblende, present in low amounts (1–2 vol.%), is characteristic mainly of the Tribeč tonalite. Common accessory minerals include apatite, magnetite, titanite, Ti-magnetite (enclosed in titanite), allanite-(Ce), epidote and zircon with prevalence of S_{12}, S_{13}, and S_{25} morphological subtypes (Pupin, 1980). The Mg-biotite, late magnetite and titanite indicate a late- to

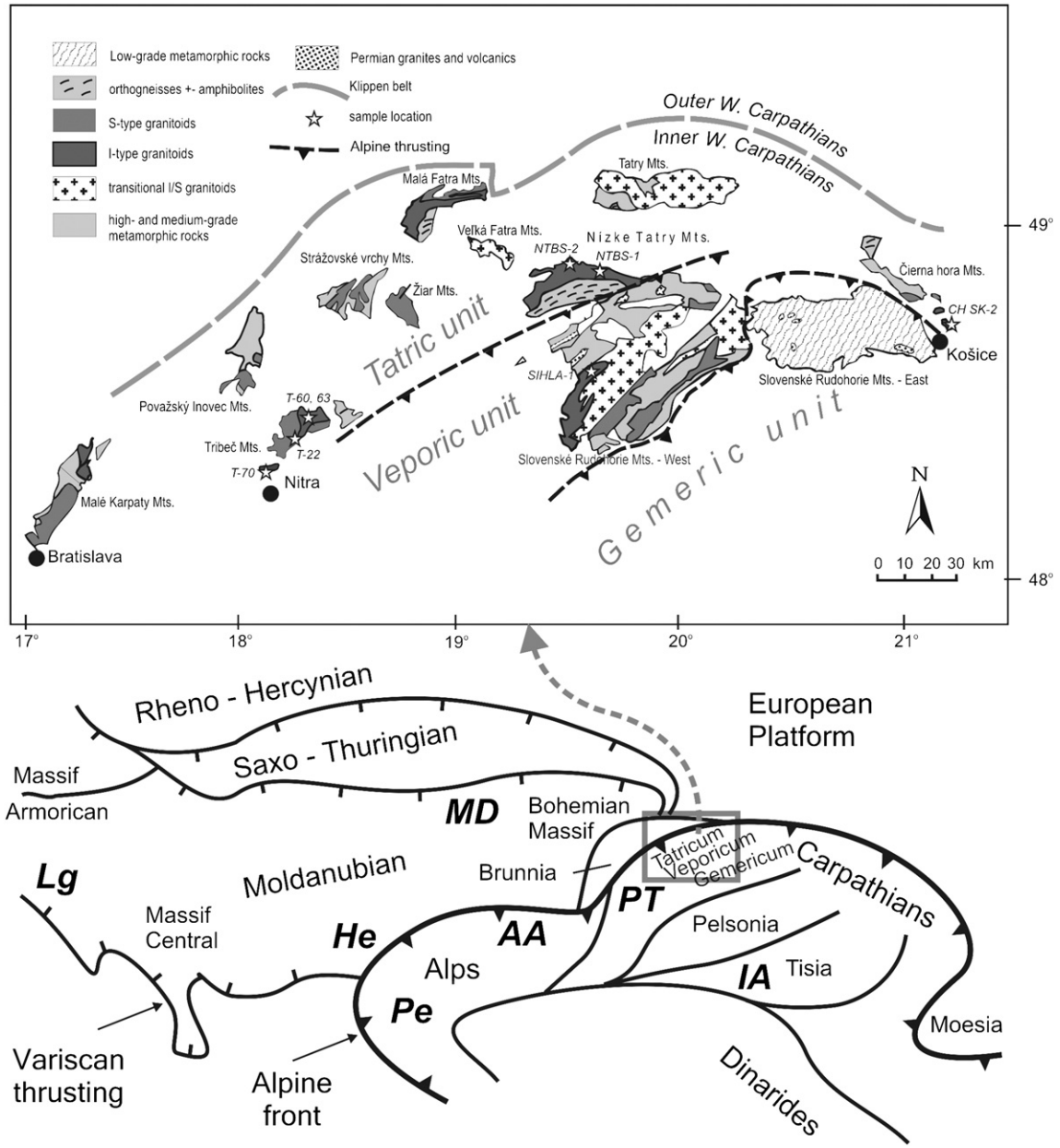

Fig. 1. Distribution of Variscan granites in the Western Carpathians in the framework of Variscan Europe and sample locations. Explanations: Lg — Ligeria (French Central Massif and South Brittany); He — Helveticum and External massifs; Pe — Peninicum; AA — Austro-Alpine; MD — Moldanubian; IA — intra-Alpine; and PT — Proto-Tatricum.