Timing the magmatic activity within the Central Bohemian Pluton, Czech Republic: Conventional U-Pb ages for the Sázava and Tábor intrusions and their geotectonic significance

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The Central Bohemian Pluton (CBP) is an early Carboniferous composite granitoid body that has intruded an important tectonic zone separating the Teplá-Barrandian Unit (mainly weakly-metamorphosed or unmetamorphosed Upper Proterozoic–mid-Devonian sediments) in the NW and the Moldanubian Unit (a tectonic assemblage of medium- to high-grade early Proterozoic–Palaeozoic metamorphic rocks) in the SE (Blížkovský *et al.* 1992; Holub *et al.* 1997a, b; Dörr *et al.* 1998). Its petrological and geochemical diversity provides an opportunity, within a restricted geographical area, for assessing the nature and relative timing of various petrogenetic processes that gave rise to several Variscan granitoid suites, each with own petrography, mineral composition and whole-rock geochemistry (e.g., Holub *et al.* 1997b; Janoušek *et al.* 1995, 2000).

With the sole exception of several intrusions in the SW part of the CBP (Dörr *et al.* 1998), precise U–Pb ages, central to the correct interpretation of the geotectonic setting and genesis of the CBP, are so far missing. For the remaining intrusions the determinations, if available, have errors too high to resolve the rather subtle differences.

The relatively early and geochemically least evolved calc-alkaline **Sázava suite** (Janoušek *et al.* 1995, 2000) builds much of the northern CBP. It is represented by the Sázava biotite–amphibole quartz diorite, tonalite and granodiorite) with associated bodies of (olivine, pyroxene–) amphibole gabbro, gabbrodiorite, (quartz) diorite and rare hornblendite. In addition there are also felsic rock types (the Požáry biotite trondhjemite–leucocratic quartz diorite).

The Sázava intrusion is characterised by ubiquitous presence of mafic microgranular enclaves, and, especially in its western part, of hybrid mafic (mainly quartz dioritic) bodies. The petrological and geochemical evidence shows the near contemporaneity of the acid and basic magmas and a key role for their interaction in its genesis (Janoušek *et al.* 1997a, 1999; Holub 1999). The Sázava mass has been recognized to be a late syn-tectonic intrusion emplaced during highly oblique transpression (Žák *et al.* 2001), and its precise dating is thus important to our understanding of the structural development of the first-scale tectonic boundary between the upper crustal Teplá–Barrandian and lower to middle crustal Moldanubian units. Alas the scarce chronological data are rather imprecise; the Pb–Pb zircon evaporation dating by Holub *et al.* (1997a) yielded ages 349 ± 24 Ma (all errors given in this text are 2σ) for the Sázava and 351 ± 22 Ma for the Požáry masses.

In course of the present study, zircons were separated from the Sázava amphibole-biotite tonalite Sa-22 sampled in the disused Teletín quarry (western part of the body, 8 km S of Jílové). Four fractions consisting of 1–3 abraded zircon grains were analysed. The U–Pb data are slightly discordant (0.6–2.8 %) and define a straight line giving an upper intercept age of 354.1 ± 3.5 Ma (MSWD = 0.04).

The age for the Sázava tonalite corresponds well to the data available from petrologically and geochemically similar calc-alkaline granitoid suites that form a broadly W–E trending belt in the European Variscan orogen (French Massif Central, northern Vosges, Odenwald, northern Schwarzwald, Central Bohemian Pluton and Nasavrky Plutonic Complex, E Bohemia: Finger *et al.* 1997 and references therein; Janoušek *et al.* 1995, 2000; Holub *et al.* 1997a; Altherr *et al.* 1999; Hrouda *et al.* 1999). For instance, the granitoids forming the 'tonalitic line' in Limousin, French Massif Central, were dated at *c.* 355 Ma, pin-pointing the end of nappe tectonics in this area (Shaw *et al*. 1993; Le Carlier de Veslud *et al.* 2000).

The magmatic rocks of the relatively late, K-rich (shoshonitic) **Čertovo břemeno suite** and associated minettes have the most evolved Sr–Nd isotopic compositions within the CBP. This, together with their high mg#, K_2O/Na_2O, Rb/Sr, Cr, Ni, Rb, Cs, U and Th, seem to mirror largely the compositions of their presumed LILE- and LREE-enriched lithospheric mantle source (Holub 1990, 1997; Janoušek *et al.* 1995, 1997b, 2000). The suite contains two important rock types:

(1) coarse Kfs porphyritic amphibole–biotite melagranite to quartz syenite (e.g., Čertovo břemeno and Třebíč masses – the durbachite series sensu Holub 1997), and

(2) biotite–two-pyroxene quartz syenites to melagranites devoid of Kfs phenocrysts (Tábor and Jihlava).

The field evidence shows that the magmatism of the Čertovo břemeno suite closely post-dated the tectonic emplacement of the high-grade Moldanubian Gföhl nappe. However, the age information is still fragmentary: the Čertovo břemeno intrusion has been dated by Pb-Pb single zircon evaporation at 343 ± 12 Ma (Holub *et al.* 1997a) and its cooling by Bt Ar-Ar age of 336 Ma (no error given: Matte *et al.* 1990). An analogous rock of the Třebíč Massif penetrating the Moldanubian Unit further E gave an age of 340 ± 16 Ma (Holub *et al.* 1997a). As yet, no data have been available concerning the age of the two-pyroxene quartz syenites.

The newly-collected sample Ta-10 comes from near the centre of the Tábor intrusion in the SE part of the CBP (disused quarry at Dražice, 7 km NW of Tábor). In this area, the roughly circular Tábor intrusion is composed of finer grained biotite–two pyroxene quartz syenite (Hy > Cpx); towards the margins, secondary Bt and Amph form in expense of Hy by retrogression of the original mineral assemblage (Jakeš 1968).

Two fractions of prismatic and two of needle-like zircon, each consisting of 1–3 abraded grains, as well as a multigrain rutile fraction, were analysed for U-Pb isotope composition. Error ellipses of all zircon fractions overlap with the concordia. A prismatic single zircon with the smallest uncertainty and two other fractions yield a concordia age of 336.6 ± 1.0 Ma. The Pb-Pb age (336.3 ± 0.8 Ma) of the rutile fraction is within error identical with the zircon age. The slightly lower U-Pb age of 333 ± 1 Ma of the second needle zircon fraction is best explained by Pb loss.

The close correspondence of the zircon and rutile ages for the Tábor sample argue strongly for a rapid cooling of the intrusion below *c.* 600 °C (closure temperature of U–Pb system in rutile: Cherniak 2000) or possibly *c.* 300 °C (see the Bt Ar–Ar age for the Čertovo břemeno intrusion).

The U–Pb ages for the Tábor intrusion indicate a narrow time gap of a few Myr between the high-grade metamorphism (dated at *c.* 340 Ma: Kröner *et al.* 2000 and references therein), the emplacement of the granulite-bearing Gföhl nappe and the intrusion of K-rich rocks of the Čertovo břemeno suite that has taken place already at relatively high crustal levels.

The obtained ages for K-rich rocks are well comparable with those determined from analogous rock types cutting Variscan high-grade nappe units (Massif Central, Vosges, Schwarzwald, Bohemian Massif, Alps and Corsica – see e.g. the reviews in Wenzel *et al.* 1997 and Schaltegger 1997) and suggest a nearly synchronous melting of the lithospheric mantle along the Variscan Belt.