THE HERCYNIAN GRANITIC ROCKS OF THE WESTERN CARPATHIANS IN THE FRAME OF EUROPEAN HERCYNIDES

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Abstract: The genesis of the principal Hercynian granitic groups from the Western Carpathian is discussed in the frame of European tectonic evolution during Paleozoic. Different granite types well mirrored changing tectonic processes from subduction and amalgamation of an oceanic lithosphere, through collision with lithospheric thickening, followed by delamination and finished in extensional tectonic. The recycled continental crust with a contribution from lithospheric mantle plays crucial role at their genesis and compositions.

Key words: granitic rocks, tectonic evolution, Western Carpathians, European Hercynides.

Introduction

The distribution of various types granitic and associated mafic rocks within the European Hercynian belt is associated with distinct thermal and tectonic environments. The Hercynian orogeny in Europe is generally related to continent-continent collision processes (Matte, 1986, Burg et al., 1989; Franke, 1992; Franke et al., 1995) connecting with major strike-slip faults Badham (1982). There were recognised following principal stages of the orogenic development within European basement areas: subduction and amalgamation of oceanic lithosphere during *Eo-Hercynian period*; proper collisional tectonics marked by lithospheric thickening with the formation of crustal scale nappe structures and large transcurrent faults – *Meso-Hercynian stage*; lithosphere delamination (slab breakoff) resulting in rapid post-collisional uplift and/or extensional tectonics – *Neo-Hercynian stage*. Changing tectonic processes produced Devonian – Older S-type granites (later transformed in orthogneisses); Lower Carboniferous – Younger S-type peraluminous granites; Upper Carboniferous calk-alkaline I-type granites, and Permian post-orogenic subalkaline A/S-type granites in the Western Carpathians (Petrík & Kohút, 1997).

Discussion

Granitic bodies with discrete composition and different magmatic – intrusion ages mirror the history of this orogenic realm from 400 to 250 Ma. Detailed investigation with precise dating and the geochemical characteristics revealed existence of several distinct granite episodes occurring in many areas over European Hercynides e.g. Vosges, Schwarzwald, Bohemian Massif and Alpine basement. There were described various granite suites: **a**) *high-K – Mg* (*or Mg – K-rich) magmatic suite;* **b**) *peraluminous suite;* **c**) *calk-alkaline suite;* **d**) *ferro-potassic suite;* **e**) *subalkaline intrusions* and **f**) *anorogenic – alkaline intrusions* (Bonin et al., 1993; Finger et al., 1997; Schaltegger 1997; Bussy et al. 2000, amongst others), that occurred during Meso- to Late-Hercynian orogenic stages. However, presence of above identified series within particular basement areas is not uniform and is still matter of debate.

The evolution of the Western Carpathians basement (WCB) is connected with genesis of the crust during three Wilson cycles over the whole Phanerozoic era. The principal Hercynian cycle immediately succeeding the Cadomian cycle, was followed by the Alpine cycle. Geodynamic evolution of the WCB is comparable to the stable Hercynides of the Western and Central Europe, e.g. the Iberian massif, Massif Central, Bohemian massif. Similar evolution was suggested for crystalline basement of the Alpine-Carpathian realm (von Raumer & Neubauer, 1993; Stampfli, 1996; Plašienka et al., 1997; Petrík & Kohút, 1997; Broska & Uher 2001). The collision of two major continental plates – Gondwana and Baltica (Laurasia), involving the closure of oceanic domains and the collision of minor continental fragments evolved from the disruption of the northern margin of Gondwana (Franke, 1992). The Paleozoic history of the WCB in agreement to other stable European areas is divided into three geodynamic stages:

i) Eo-Hercynian stage (Cambrian – Silurian) corresponds to the pre-collision history, reflecting fragmentation of northern Gondwana immature crust. Evolution started on young continental crust, formed at the end of the Cadomian orogeny (Pin, 1990), with rifting events leading to generation of small oceanic basins connected with bi-modal magmatism. These basins were subsequently swallowed and amalgamated due to subduction (Plašienka et al. 1997). It is suggested that the leptyno-amphibolite complex (LAC) according to Hovorka et al. (1994) with granulitic (throndhjemitic) layers and remnants of retrograded eclogites (Janák et al. 1996) originated during this stage in the WCB.

ii) Meso-Hercynian stage (Devonian – Lower Carboniferous) is characterised by proper collisional tectonics marked by lithospheric thickening with the formation of crustal-scale nappe structures and generation of collision-related felsic magmatism. The felsic – granite magmatism is represented by Older granites with ages 405 – 380 Ma

(Poller et al., 2000) subsequently sheared in orthogneisses, and Younger granites 350 – 330 Ma old, however both are peraluminous and S-type. The most voluminous Younger S-type granite suite (including migmatites and evolved pegmatite veins) originated in this time (around 340 Ma) following the peak of metamorphism (Janák et al. 1999). These granites have not experienced the later deformation in contrast to Older ones, reflecting shearing deformation of the peak stadium.

iii) Neo-Hercynian stage (Upper Carboniferous – Permian) is connected with collapse of the collisionally thickened crust. The final collisional shortening was followed by the gravitational instability of thickened lithosphere, which resulted in the process of thinning of lithosphere (lithospheric delamination, detachment of lithospheric root from the light continental lithosphere or slab breakoff (von Blanckenburg & Davies 1995). As a consequence of the rifting during breakoff, the asthenosphere upwells into to a narrow rift, which resulted in high heat flows, and granulitisation of the lower crust. These processes were accompanied by large transcurrent faults. Thermal perturbation leads to melting of the metasomatised lithospheric mantle and subsequently were melted lower crustal calc-alkaline I-type tonalites and granodiorites dominating this period at 310-300 Ma. This period was characterised by a shift from compressional tectonics towards extensional tectonics, generally interpreted as recording the post-thickening collapse of a collisional belt. Extensional tectonic culminated during Permian with appearance of a Basin and Range type province related to formation of half-grabens. Rapid post-collisional uplift was associated with small intrusions of subalkaline A/S-type granites and/or explosive volcanism. Noteworthy, from structural point of view is a rapid post-collisional uplift and exhumation, which caused deep erosion of majority granite plutons, so that the Lower Triassic sedimentation in the WCB started on denudated – naked granite bodies.

However, the Western Carpathians crystalline basement forms discrete fragments within the present Alpine structure, majority of granite bodies have character of the composite plutons and various granitic suites contribute to their fabric. This situation is common not only in the Vepor grand composite massif, where it is notorious since the time of Zoubek's studies, but detailed investigations with precise dating revealed similar situation in the Tatric unit e.g. the Tatry Mts. and the Veľká Fatra Mts. (Kohút et al., 1997, 1999; Poller et al., 2000; Poller & Todt, 2001). Existence of independent – episodic magma pulses within the European Hercynian belt is common feature. Their identification in the frame of individual granitic plutons in the WCB (Kohút et al., 1996; Petrík, 2000) disturbed old simple opinions about comagmatic and fractionation origin of these plutons.

Indeed not all granitic series described in other Hercynian areas (see above) have been satisfactory identified within WCB. Visean high-K-Mg magmatic rocks forming a belt along the whole Hercynian orogen, from Corsica (Rossi & Cocherie, 1991) through the external Alpine massifs, the Vosges and the Schwarzwald (Bussy et al., 2000; Schaltegger, 1997) to Bohemian Massif (Holub et al., 1997) have no widespread analogue in the WCB, although dioritic rocks from the Tatra Mts. and other WCB areas can match this suite with the age and chemical picture (Poller & Todt, 2000; Uher et al., 2001). Voluminously significant Lower Carboniferous peraluminous, two micas granites and granodiorites of the WCB, having not too much analogues westerly from the Carpathians arc, are rather occasional in the European Hercynides. These granites are common only in the Iberian Massif, but with slightly younger age. Westphalian – Stephanian post-collisional, calk-alkaline (I-type) magmatism is running parallel over the whole European Hercynides from Portugal to Caucasus, and typical representative within the WCB is family of so called the Sihla tonalites s.l. A number of small Permian post-orogenic to anorogenic, alkaline intrusions (A-type affinity) have been recognised recently within the WCB (Uher & Broska, 1996) and in Alps (Bussy et al., 1996; Finger et al., 1997). Besides this, there were described subalkaline S-type magmatism in the Gemeric unit (Poller et al., 2002), and small leucocratic intrusions in the Veľka Fatra Mts. – Tatric unit (Poller et al., 2001). Similar leucocratic intrusions were identified in Tauern Alps (Eichhorn et al., 2001) at present.

Conclusion

Although the Western Carpathians granitic massifs form only discrete fragments within the present Alpine edifice, there exist a good correlation to the stable European Hercynides, either in the geodynamic evolution or in the identification of similar magmatic suites during Upper Paleozoic era. This was enabled by detailed investigation with precise dating and geochemical characteristic. There was confirmed episodic character of the Hercynian granite magmatism within the WCB, and separate magmatic pulses with different chemical picture formed mainly composite plutons. In spite of general progress in granite study during last years in the Western Carpathians (see: Petrík, Kohút & Broska [Eds.] 2001: *Granitic Plutonism of the Western Carpathians*), many problems remain there still unsolved.

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