Whole rock chemistry of the Permian Gemeric specialised S-type granites (Western Carpathians) and remark to their correlation

IGOR BROSKA[1] and MICHAL KUBIŠ[2]

[1]Earth Science Institute, Slovak Academy of Sciences, Dúbravská cesta 9, 840 05 Bratislava, Slovakia; igor.broska@savba.sk
[2]DPP Žilina s.r.o., Legionárska 8203, 010 01 Žilina, Slovakia

Abstract: The Permian specialised S-type granite of the Gemeric Unit form small bodies of and high potassium calc-alkaline character porphyritic and equigranular granites intruding low grade Paleozoic metamorphic rocks. Magmatic fractionation in situ led to formation of rare-metal (Li, Sn, W, Nb, Ta, B, F) enriched granitic cupolas resulted in vertical chemical step differences in the granite massif. They show also north-south spatial chemical differences. Their age and main chemistry features indicate genetic connection of Gemeric granites above Paleotethys subduction zone in extension regime.

Introduction

The specialised S-type granites known in the Gemeric Unit (Western Carpathians, Slovakia) are mostly (1) peraluminous porphyritic syenogranites to monzogranites and (2) fine-grained equigranular monzogranites in granite cupolas. They crop out on six areas of the Spiš–Gemer Ore Mountains (Fig. 1) and in their apexes they contain special rare-metal Li–Sn–W–Nb–Ta–B–F granite mineralization. The chemistry of these granites are distinctly different from the widespread sodic-rich Upper Devonian–Lower Carboniferous Variscan granites known in the Tatric and Veporic units of the Western Carpathians. This contribution introduces the chemistry of Gemeric granites and outlines some ideas of their possible correlation and genesis based on the bulk rock composition and age.

Bulk rock chemistry of granites

Gemeric specialised S-type granites show general high contents of Si, Al, K, Na, Rb, P, B, Sn, Nb, Ta, W, F but low Ca, Mg, Sr, Ba, REE (negative Eu-anomaly), Zr and correspond to peraluminous high potassium ($K_2O/Na_2O>1$) calc–alkaline granites with ASI index ~1.2 to 1.4. The bulk rock chemistry and the presence of accessory monazite-(Ce), annite and almandine indicate their S-type character. High primary volatile flux in these granites show high content of boron saturated on tourmaline (schorl to foitite). Boron in cupolas is in hundreds of ppm or even more than 1000 ppm. The concentration of the major and trace elements show quite wide variability and in general, there are some vertical and spatial compositional differences between the northern and southern granite bodies.

Vertical compositional differences

The Gemeric granites show distinct vertical compositional zoning from deeper situated porphyritic biotite–(muscovite) granite to protolitionite Li–F granite and albitite in granitic cupolas. Contents of Si are relatively high in both upper and bottom parts of the granite intrusions but in contents of P, Li, Rb, Cs, Ga, Nb, Ta, Sn, W increase significantly from the bottom to the cupolas. On the contrary, Ca, Mg, Sr, Ba, Ti, Zr and REE contents decrease in this direction. Some representative rock analyses from DD-3 borehole in Dlhá Valley (Dianiška et al. 2010) are shown in Table 1.

Horizontal compositional differences

Granite occurrences named Súľová, Delava a Peklisko in northern Hnilec area (see Fig. 1) show many compositional differences with comparison to granite bodies located more to the south demonstrating evident spatial horizontal evolutionary zoning of the granites occurrences. Granites located on south from the Hnilec area show generally higher content of K_2O, TiO_2, and they contain more than double amount of Ba (~140 vs. ~60 ppm). Moreover, the southern granite occurrences show distinctly higher Zr concentration (~200 ppm; the Poproč granite) which is analogous to the A-type granite suites. On the other hand, southern granites exhibit generally lower contents of P, Nb, Ta, W and Sn (e.g., ~50 ppm vs. ~100 ppm Sn in average in the northern and southern occurrences). The chondrite normalised REE pattern from granites in Hnilec area show higher content of LREE and more flat trend on HREEs in comparison towards those southern granite occurrences (Fig. 2).

Age interval

The Permian ages of Gemeric granites (~280 to 250 Ma) were firstly reported by whole-rock Rb–Sr isochrone method (Kovách et al. 1979, 1986; Cambel et al. 1989) and by monazite U–Th–Pb microprobe dating (Finger & Broska 1999). Later their Permian age was confirmed by using zircon U–Pb MS TIMS (Poller et al. 2002), SHRIMP (Radvanec et al. 2009) and LA-ICP-MS methods (Kubiš & Broska 2010). Kohút & Stein (2005) dated molybdenite from the vein in the Hnilec area by Re–Os isotopes and result ~260 Ma documents the same age and genetic relationship between granite formation and associated Sn–W ore mineralization. The zircon U–Pb dating results (Poller et al. 2002; Radvanec et al. 2009; Putiš et al. this volume) show two principal age intervals for magmatic crystallization of the Gemeric granites: (1) ~270–280 Ma for the southern granite bodies (Zlatá Idka, Rudník and Betliar), and (2) ~250–260 Ma for the northern Hnilec area. In this sense, the solidification of Permian Gemeric granites show large time interval (≤30 Ma) from Cisuralian to Lopingian epochs and their age decreases from south to north.

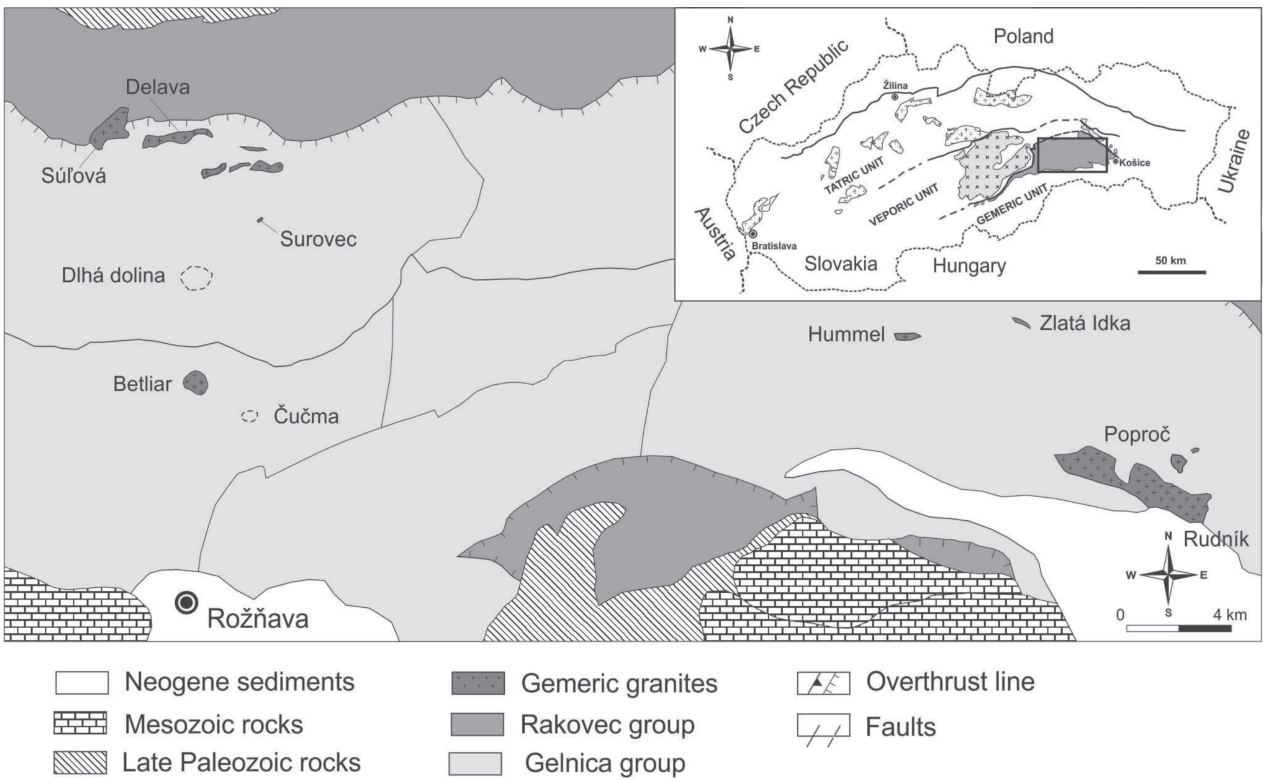

Fig. 1. Position of Gemeric granites in the Gemeric Unit.

Table 1: Contents of representative elements (oxides in wt. %, trace elements in ppm) from the Dlhá Valley granite. Note the differences in composition between albitite and Li–F granite in cupola and deeper porphyritic granite.

Borehole DD3	Granite type	SiO_2	P_2O_5	Rb	Ga	Sn	Nb	Zr	Ce
DD-504	albitite	74.49	0.31	88	56	347	57	19	1
DD-577	Li–F granite	73.24	0.52	1866	43	79	66	25	3
03GA72	Li–F granite	73.91	0.40	1919	42	n.d.	48	29	2
03GA74	Porphyritic granite	76.70	0.27	650	23	n.d.	15	59	10
DD-783	Bt granite porphyr	76.42	0.16	430	22	31	12	88	32
DD-908	Ms–Bt porphyritic granite	76.72	0.12	440	21	21	9	63	21

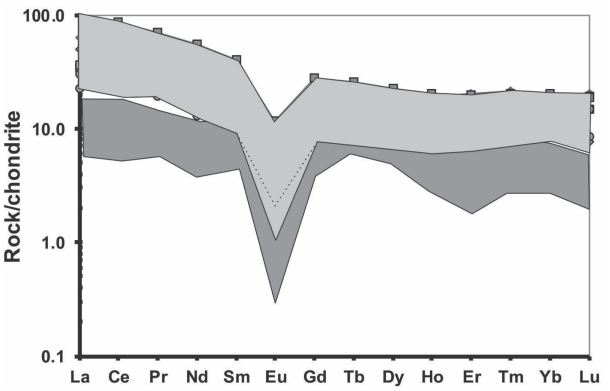

Fig. 2. Comparison of REE patterns normalised acc Evens et al. 1978) from northern (in dark) and southern (in grey) granite bodies.

Correlation of the specialized S-type Gemeric granites

Understanding the genesis of the specialised S-type granites from Gemeric Unit is possible only by spatial correlation their analogs mainly by comparison of bulk rock chemistry, mineralogical character and reliable age data. The Permian magmatic activity resulted in Europe mainly from continuation of Paleotethys subduction and this process has been probably crucial also for the genesis also Gemeric granites although their eventual rift-related origin cannot be excluded because their age coresponds e.g. to Hronic basaltic magmatic activity connected maybe with plume activity (see Demko in this volume). But the Permian Gemeric granites are K-rich calc–alkaline and in this character resemble the granites from northern Aegean region where K-rich and calc–alkaline originated in continental arc setting recently exposed in Strandzha and Sakar Zone (Bonev et al. 2018) and probably also in the Istanbul Zone. The Permian metamorphic activity is documented in wider central European area and even in the Eastern Alps where the regional Permian prograde metamorphism at moderate pressure conditions in area of Plankogel, Saualpe–Koralpe resulted from extension and heat from ongoing Paleotethys subduction (Thöni & Miller 2009). Magmatic Permian activity connected with Paleotethys subduction is described in external Helenides (Zulauf et al. 2015), but also in the Asia (Wang et al. 2017). The Paleotethys subduction could triggered the generation of many granite settings including probably also West-Carpathian specialised Gemeric granites. This circumstances should be discussed from different points of view in order to obtain a satisfactory opinion on the reason for such kind of genesis. Romer & Kroner (2016) proposed genesis of Gemeric granites in similar conditions like Cornubian granites within European extensional province.

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