Accessory minerals of the specialised S-type granites from Gemeric Superunit, Western Carpathians

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The Spiš-Gemer granites, SGG (Uher – Broska 1996; Broska – Uher 2001) represent several small intrusions, which crop out in the Gemeric Superunit of the Western Carpathians. They are typical S-type granitoids with high $^{87}Sr/^{86}Sr$ ratios 0.712–0.720, Permian or Permian/ Triassic in age (Finger – Broska, 1999, Poller et al. 2002) and represented by biotite-muscovite to muscovite leucogranites, albite-, microcline, ± topaz-bearing granites, ± greisens and/or rare granite porphyries. These granites are the most evolved granites in the Western Carpathians with significant enrichments of K, Rb, Sn, F, B and also P. Accessory minerals of the SGG comprise the assemblage of zircon, apatite, tourmaline, garnet (5 genetic types), monazite-(Ce), xenotime-(Y), topaz, rutile, ilmenite, pyrite in granite cupolas, and also topaz, cassiterite, Nb-Ta-W oxide minerals and fluorite in quartz hydrotermal veins.

The morphology of *zircon* crystals is very similar in all granite types. They are dominated by S and L primary zircon with mean point represented by the S_8 morphometric subtype. The G_1 and some L subtypes represent a late magmatic population of zircon. According to Pupin's (1980) classification the morphometric character of primary zircons indicates a crustal origin of granites with some mantle contribution (Jakabská – Rozložník, 1989; Broska et al., 2002). The Zr/Hf ratio of zircons is around a mean value of anatectic rocks (~ 30).

Apatite from Hnilec granites forms two different genetic types. The first type is represented by large primary crystals (~ 250 μm), which are enriched on Fe and Mn (3.04–4.16 wt.% MnO; 0.19–0.9 wt.% FeO), the secondary one is distributed within alkali feldspars where it forms very small crystals (~ 3 μm) with low contents of Mn and Fe.

Monazite-(Ce) in the SGG is usually enriched in brabantite molecule (usually above 10 vol. %), but locally also the brabantite end-member was detected (the Dlhá dolina valley).

Xenotime-(Y) is common. Very low content of LREE is typical, except Y dominated also by Gd and Dy. UO_2 and ThO_2 range between 1.2 to 3.5 and 0.6 to 1.3 wt. %, respectively.

Topaz is present mainly in rare metal Li-F-granites and greisens in the Dlhá Valley, Hnilec and Zlatá Idka as a secondary but also primary (?) phase. Li-F-granites contain 3–5 vol. % of topaz.

Tourmaline is a widespread phase in all granite types and their altered products. It forms columnar crystals to aggregates of irregular grains, 0.1 mm to 10 cm in size. It is mainly *schorl*, rarely *foitite* with high at. Fe/(Fe+Mg) = 0.75 to 0.99 and locally elevated Mn and F contents (≤0.3 to 1.4 wt. %, ≤0.06 to 0.7 apfu, respectively). Large X-site vacancies are characteristic of late- to post-magmatic blue Na-deficient schorl to foitite rims or irregular zones in crystals ($X_?$ = 0.4–0.6), the anhedral, interstitial brown schorl has lower X-site vacancies (0.1–0.4 $X_?$ pfu). The vacancies are charge-balanced by Y-site Al following to the $X_?YAlXNa_{-1}(Fe,Mg)_{-1}$ substitution. The Mössbauer spectroscopy data from SGG tourmaline indicate the dominance of Fe^{2+}.

Ferrocolumbite to *manganocolumbite* are most widespread Nb-Ta phases in the SG granites. They form euhedral to anhedral, up to 0.4 mm large crystals in rock-forming minerals, often with cassiterite and Nb-Ta rutile. Ferrocolumbite and manganocolumbite show an oscillatory zoning often corroded by younger irregular zones along crystal margins. Generally, an increase of Ta and W from centre to rim of the crystals was detected.

W-rich *ixiolite* represents a disordered columbite group phase with 19–31 wt. % WO_3. The mineral forms strongly inhomogeneous, up to 0.3 mm large grains. A phase was identified with stoichiometry analogous to *qitianlingite* (?), $(Fe,Mn)_2(Nb,Ta)_2WO_{10}$ (Yang et al. 1985), containing 32–39 wt.% WO_3, Mn/(Mn+Fe) = 0.26–0.39 and Ta/(Ta+Nb) = 0.05–0.35. It forms rare, max. 15 μm thick probably exsolution lamellae in intergrowths with W-rich columbite/ ixiolite and Nb, Ta-rich ferberite in Dlhá Dolina, Hnilec and Poproč Li-F or muscovite-topaz granites (Johan – Johan 1994).

Minerals of the wolframite series; *ferberite*, rarely hübnerite [Mn/(Mn+Fe) = 0.19–0.56], occur as platy crystals and fan aggregates, 0.1 mm to 2 cm in size, in Li-F granites and quartz veins in greisens. Niobian and tantalian *rutile* (*ilmenorutile* and *strüverite*) forms 30–50 mm anhedral, strongly zoned crystals in Li-F granites and albitites, containing up to 7 wt.% WO_3, 30 wt.% Nb_2O_5 and 22 wt.% Ta_2O_5; Ta/(Ta+Nb) = 0–0.58.

Cassiterite, the most common phase of the ore mineralization, occurs in crystals up to several mm, mainly in the greisens. It contains only up to 1.2 wt.% Nb_2O_5 and 2.2 wt.% Ta_2O_5. Locally, tiny ferrocolumbite inclusions occur in cassiterite.

Microlite to *uranmicrolite* forms inhomogeneous subhedral grains, max. 0.2 mm large, in the Dlhá Valley albitites and greisens. Locally, it is rimmed by ferrocolumbite. Complex Y-HREE-Nb-Ta oxides, most probably *polycrase-(Y)* and *uranopolycrase,* were detected as up to 50 μm irregular grains in silicified phyllite and in quartz albitite vein from exocontact aureole of the Dlhá Valley granite.

SGG granites show isotopical and geochemical S-type characteristics. The enrichment of these granites in several rare elements was followed by precipitation of the described special primary and secondary mineralisation. This resulted in their classification as specialized S-type granites.

References

Broska, I. – Kubiš, M. – Willimas, C. T. – Konečný, P. (2002): Bull. of the Czech Geol. Survey, 77, 5, 147–155.
Finger, F. – Broska, I. (1999): Schweiz. Mineral. Petrogr. Mitt., 79, 439–443.
Jakabská, K. – Rozložník, L. (1989): Geol. Zbor. Geol. Carpaht., 40, 141–159.
Johan, V. – Johan, Z. (1994): Mineral. Petrol., 51: 323–343.
Poller, U. – Uher, P. – Broska, I. – Plašienka, D. – Janák, M. (2002): Terra Nova, 14, 41–48.
Uher, P. – Broska, I. (1996): Geol. Carpath., 47, 113–121.
Yang, G. – Wang, S. – Peng, Z. – Bu, J. (1988): Am. Mineral., 73, 1497.

The high-pressure granulites of the Złote unit: Sm-Nd and single grain U-Pb zircon ages from the Rychleby Mts.

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At the NE margin of the Bohemian Massif, granulites occur in the Złote unit which is exposed in the border region between Poland and the Czech Republic (Pouba et al., 1985; Bakun-Czubarow, 1992). This tectonic unit belongs to the Orlica-Śnieżnik dome (OSD) which is mainly composed of amphibolite-facies orthogneisses. Granulite occurrences (with very small eclogite domains) are restricted to the Złote unit; eclogite blocks and lenses, but no granulites, are also found in other tectonic units of the OSD. On the Polish side, outcrop conditions in the Złote unit are rather poor. Besides some isolated blocks, granulites are mainly restricted to a very small occurrence near Stary Gierałtów. This exposure has attracted much attention due to findings of presumed coesite pseudomorphs, as inferred from radial fractures around polycrystalline quartz inclusions in garnet (Bakun-Czubarow, 1992). Peak metamorphic conditions were estimated between 21 and 28 kbar at 800 to 1000 °C (Kryza et al., 1996; Klemd – Bröcker, 1999). Previous geochronology indicated metamorphic ages of c. 350–340 Ma for an eclogite (Brueckner et al., 1991) and mafic granulites (Klemd – Bröcker, 1999), collected at the Stary Gierałtów key location. Additional outcrops of the Złote unit are found on the Czech side in the Rychleby Mts (Pouba et al., 1985) and the focus of this study is on the geochronology of these occurrences. By means of the Sm-Nd method (garnet, cpx, whole rock) and single grain U-Pb dating of zircon, we have studied felsic and mafic granulites collected near the location Červený Důl near Javorník.

First results can be summarized as follows: A felsic granulite yielded a Sm-Nd age of 337 ± 4 Ma (two grain-size fractions of garnet, whole rock). Two mafic granulites provided Sm-Nd ages (two grain-size fractions of garnet, cpx and/or whole rock) of 357 ± 10 Ma and 351 ± 10 Ma, respectively. The new Sm-Nd results are in good agreement with metamorphic ages reported for other Bohemian granulites and further document the significance of high-pressure/high-temperature metamorphism at c. 350–340 Ma.

Single-grain zircon dating of air-abraded grains provided concordant U-Pb results. Zircons from a mafic granulite yielded ages between 415–343 Ma, but mostly cluster at 362 ± 1 Ma. A similar age (360–369 Ma) was previously reported for a mafic granulite from Stary Gierałtów, based on conventional multigrain analyses of zircon (Klemd – Bröcker, 1999). This age is considered to approximate the timing of crystallisation from a melt. However, it still remains unclear whether this process took place before or during early stages of high-pressure metamorphism. The studied felsic granulite yielded a range in zircon ages between 396 to 328 Ma, recording magmatic inheritance and subsequent metamorphic overprints. Of special interest is the age cluster at 328 ± 2 Ma which is interpreted to document anatectic processes post-dating the pressure peak. Published geochronological information related to the HP granulites from the Złote unit is based on a limited dataset from a single outcrop at Stary Gierałtów. The results presented here provide additional constraints for the timing of metamorphism/magmatic activity and thus help to substantiate regional geologic considerations.

References

Bakun-Czubarow (1992): Arch. Mineral. 48, 3–25.
Brueckner, et al. (1991): N. Jahrb. Mineral., Abh., 163, 169–196.
Klemd, R. – Bröcker, M. (1999). Contrib. Mineral. Petrol. 136, 358–373;
Kryza, R. – Pin, C. – Vilzeuf, D. (1996): J. metamorphic Geol. 14, 531–546.
Pouba, et al. (1985): N. Jahrb. Mineral., Abh. 151, 29–52.