MINERALOGICAL EVIDENCE OF VERTICAL ZONALITY IN A HIGHLY FRACTIONATED P-RICH RARE METAL-BEARING GRANITE SYSTEM, PODLESI, CZECH REPUBLIC

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Geological setting

The Podlesi granite has intruded lower Paleozoic phyllites, forming a stock 300 m across. The studied drill core consists of phyllites (at the depth 0–50m) and albite-topaz-protolithionite granite (»stock granite«, in average 0.5% P_2O_5, at 50–310m). The upper part of the stock granite is intercalated by ten subhorizontal 0.2–7.0 m thick layers of albite-topaz-zinnwaldite »dyke granite« (up to 2% P_2O_5, at 78–115m), and several thin dykes of zinnwaldite-topaz pegmatite (BREITER & SELTMANN, 1995).

Results

Whole-rock chemical data confirmed peraluminous (ASI 1.2–1.4), strongly differentiated character of the whole suite. The high degree of fractionation is demonstrated by high content of rare alkalies (Li: 700–2000 ppm, Rb: 1500–3000 ppm, Cs: 100–150 ppm, mainly concentrated in zinnwaldite), rare metals (Sn: up to 100 ppm, Nb: up to 95 ppm, Ta: up to 55 ppm, concentrated in cassiterite, columbite and ilmenorutile), as well as high U/Th and Hf/Zr ratios. The REE contents are generally very low, the chondrite-normalized patterns are flat (Ce/Ybcn: 4–12), with prominent negative Eu anomaly.

Alkali feldspars from all granite types are characterized by high content of P_2O_5 that is incorporated into feldspar structure by the $Al^{3+} + P^{5+} = Si^{4+} + Si^{4+}$ substitution (FRYDA & BREITER 1995). Orthoclase from the stock granite does not show any zonality in phosphorus distribution and its P content equals to that of the whole rock. In the other hand, orthoclase from the dyke granite shows a distinct zonality, with rims of crystals enriched in P. As the KDP fluid/melt is $<<1$, the P-rich rims of orthoclase crystals in the dyke suite appears to have crystallized from the rezidual melt, while the overlying stock granite was affected only by relatively P-poor fluids.

Micas are represented by Li-rich members,whose chemistry also differs depending on the host granite type. For the dyke granite, the zinnwaldite crystals are also distinctly zoned, with cores being enriched in Fe, Mg and Ti, and rims in Si and Li. Still, the calculated Li content (according to TINDLE & WEBB 1990), is in an overall agreement with that of the zinnwaldite separates (obtained with AAS). In contrast to the above elements, there is no zoning in Rb and F. The zonality in Si, Fe, Mg and Ti can be explained by changes of melt chemistry during the zinnwaldite crystallization. On the other hand, the homogenous distribution of Rb and F is most probably result of post-crystallization redistribution of these weakly bound atoms. Fluorine content is very high (>8 wt.% F) with F atoms occupying nearly completely the OH-F positions.

Protolithionites from the stock granite are poorer in Li, Rb and F, and also without any distinct zonality. This character argues for relatively constatnt melt composition during their crystallization.

The main accessories of all rock types are topaz and apatite, in the dyke granite also childrenite. Major ore minerals found in the stock granite are wolframite, cassiterite and Nb-rutille, in the dyke granite there are columbite, Nb-Ta-rutile, ixiolite, U-mikrolite and U-tantalite.

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