Beryllophosphate assemblages in late hydrothermal stage of the Rožná lepidolite pegmatite

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ABSTRACT

Two assemblages involving beryllium phosphates were recognized in Rožná lepidolite pegmatite. The assemblage I consists of beryllonite + hurlbutite + hydroxylherderite + fluorapatite, the assemblage II of bertrandite + quartz + hydroxylherderite + fluorapatite. Both assemblages originated by decomposition of primary beryllonite and/or beryl.

Keywords: *beryllium, phosphorus, granitic pegmatite, hydrothermal replacement.*

INTRODUCTION

Beryllophosphate (BEPH) assemblages are rather rare constituents of rare-element granitic pegmatites and highly fractionated granites. Nevertheless, they are known from various RE-pegmatite subtypes, e.g. beryl-columbite(-phosphate) (Nysten & Gustaffson 1993, Cempírek et al. 1999), petalite (Černá et al. 2002), spodumene (Walter 1992), amblygonite (Lahti 1981), pollucite-rich (Palache & Shannon 1928) or lepidolite (various occurrences in Maine, USA and Brasil, Černý 2002). In granites, their presence is reported from Beauvoir granite, France (Charoy 1999) and Yichun granite, China (Huang et al. 2002). Review of occurrences is given by Burt (1975) and Černý (2002).

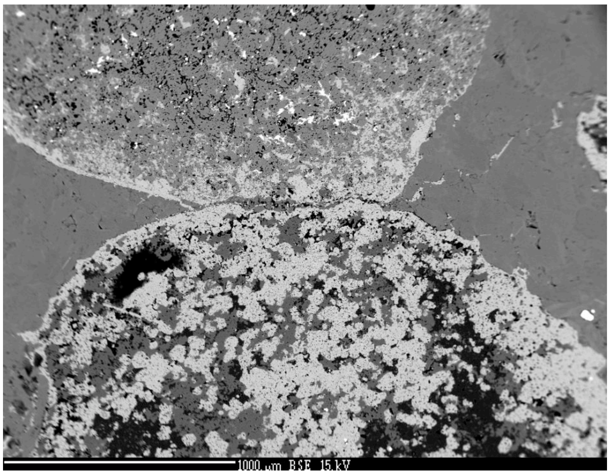

FIGURE 1. Two Be-rich assemblages; I with beryllonite, hurlbutite, hydroxylherderite and fluorapatite (upper grain), and II with bertrandite, quartz and fluorapatite (lower grain). Scale bar is 1 mm.

BEPH as primary minerals are rare, whereas beryl is much more abundant. However, there are several BEPH known related to primary (magmatic) crystallization (e.g. hurlbutite in blocky quartz of Cempírek et al. 1999; see beryllonite and hydroxylherderite in Černý 2002). Most BEPH assemblages are related to the hydrothermal activity in the late stage of pegmatite/ granite evolution, and to the replacement of primary Be-minerals, e.g. beryl, beryllonite or hurlbutite.

In lepidolite pegmatite at Rožná, western Moravia, the origin of BEPH assemblages were deciphered recently (Cempírek and Novák 2006), as products of hydrothermal replacement of primary beryllonite. The complexity of assemblage, transition of Be from phosphates into late silicate makes this BEPH occurrence interesting for more detailed study.

MINERALOGY OF THE ROŽNÁ BEPH ASSEMBLAGES

The lepidolite pegmatite dike, ~ 1 km long and ~ 35 m wide at Rožná was mined on two outcrops on the Hradisko hill and the Borovina hill. It shows almost symmetrically zoned internal structure (for details see e.g., Novák and Selway 1997). Pseudocubic pseudomorphs after unknown mineral consisting of herderite and apatite, up to 5 cm in size, were described by Sekanina (1950). They are enclosed in quartz and albite and closely associated with blue elbaite and muscovite at the Borovina outcrop of the Rožná pegmatite. Powder X-ray diffraction, electron microprobe and cathodoluminescence (CL) microscopy study revealed that several Be-minerals occur in the pseudomorphs and two distinct assemblages involving hydroxylherderite and fluorapatite as dominant minerals were recognized. The assemblages occur separately, each in separate grains of pseudomorphs (Fig. 1). The **assemblage I** consists of beryllonite + hurlbutite + hydroxylherderite + fluorapatite, the **assemblage II** of bertrandite + quartz + hydroxylherderite + fluorapatite.

Beryllonite occurs in tiny inclusions (up to 100 μm) in hurlbutite or hydroxylherderite. Rare **hurlbutite** was found in grains, up to 50 μm in diameter, surrounding beryllonite (Fig. 2) or as small grains in hydroxylherderite. Dominant **hydroxylherderite** is always fine-grained, in grains less than 200 μm in diameter. It usually forms matrix enclosing most of minerals of the both assemblages. In CL microscope or under electron beam it has strong, deep blue luminescence. Chemical composition of hydroxylherderite in both assemblages varies in F; in the most widespread hydroxylherderite exhibits 0.07 - 0.18 apfu, in rare F-rich zones 0.38 - 0.44 apfu F. Compared to the data of Leavens et al. (1978), F-rich hydroxylherderite is one of the most F-rich samples of the herderite series. **Fluorapatite** is always younger and replaces hydroxylherderite in both assemblages and it usually corroded earlier Be-phosphates. It is usually dispersed within the outer parts of the pseudomorphs, commonly corrodes grain rims. Locally it forms veinlets in fractured tourmaline or within the sheets of micas. It has strong greenish-yellow luminescence in CL or under electron beam.

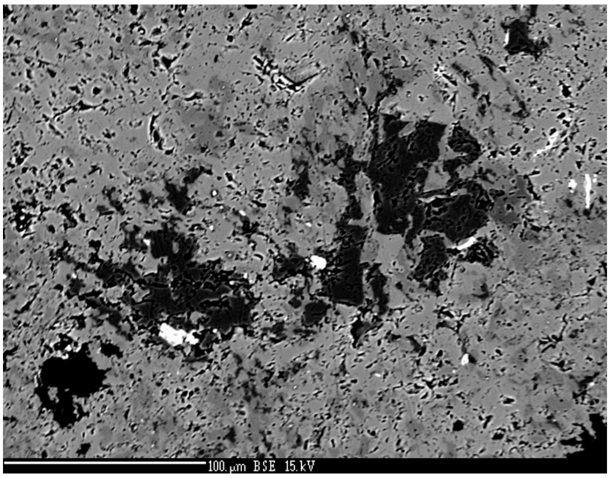

FIGURE 2. Assemblage I - relics of beryllonite (almost black) are replaced by hurlbutite (dark grey) and hydroxylherderite (light grey). Bright white spots are inclusions of unknown phosphates of Ba and Sr. Scale bar is 0.1 mm.

Bertrandite usually forms intergrowths with quartz in the assemblage II, but locally isolated bertrandite and quartz grains were found enclosed in hydroxylherderite or fluorapatite. In both assemblages, small inclusions of unknown **Ba and Sr phosphates** occur (Fig. 3). They best correspond to Ba and Sr equivalents of hurlbutite based on their stoichiometry.

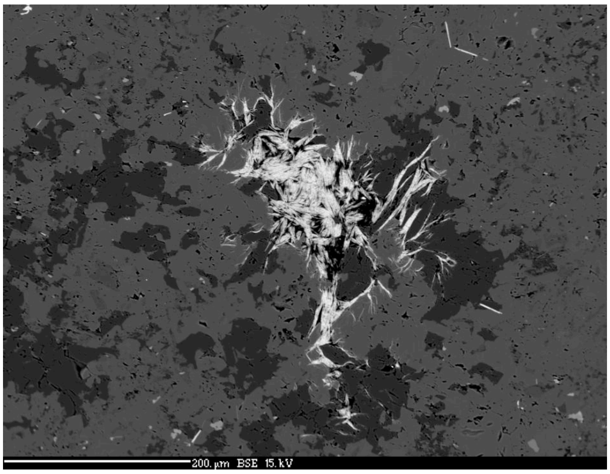

FIGURE 3. Unnamed Ba-phosphate (white) enclosed in beryllonite (dark grey) and hydroxylherderite (grey). Scale bar is 0.2 mm.

DISCUSSION

Beryllonite was very likely the original primary mineral in the pseudomorphs with the assemblage I. In the assemblage II, the primary mineral might be beryllonite or beryl. Theoretically, replacement reactions involve only income of Ca^{2+} and $(OH,F)^-$:

(1) 2 beryllonite + $Ca^{2+}_{(aq)}$ ⇒ hurlbutite + 2 $Na^{+}_{(aq)}$
(2) beryllonite + $Ca^{2+}_{(aq)}$ + $(OH,F)^-$ ⇒ OH-herderite + $Na^{+}_{(aq)}$
(3) hurlbutite + $Ca^{2+}_{(aq)}$ + 2 $(OH,F)^-$ ⇒ 2 OH-herderite
(4) 3 hydroxylherderite + 2 $Ca^{2+}_{(aq)}$ + F^- ⇒ fluorapatite + 3 $Be^{2+}_{(aq)}$ + 3 $(OH)^-$

Calculations involving constant volume of pseudomorphs suggest that Be must have been mobile during the reactions 2-4 and its content in the BEPH assemblages was continually decreasing. The last introduction of Ca,(P)-rich fluids, together with increase in $a(SiO_2)$, caused breakdown of Be-phosphates and stabilized the assemblage fluorapatite + bertrandite + quartz. High mobility of Be in this stage is well documented on veinlets of bertrandite + quartz at the edge or out of the pseudomorphs.

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