Compositional features of beryl from Koktokay no.3 pegmatite (Altai, NW China): From variations between internal zones in pegmatite to micro-scale heterogeneity in crystals

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ABSTRACT

We present here a study on chemical variations of beryl from the Koktokay no.3 pegmatite in Altai district, China. Beryl displays an increase, from the outer zone to the inner zone, in alkali contents in channel, especially in Cs_2O. Additionally, the beryl crystals reveal complex heterogeneity on crystal scale. Three type of late re-equilibration can be distinguished: (1) blebby mosaic texture in beryl; (2) Cs-enriched veinlet in beryl, and (3) hydrothermal Na-enriched rim on beryl. Chemical features described in beryl indicate an evolution of crystallization from magmatic to hydrothermal conditions.

Keywords: *beryl, chemical composition, heterogeneity, Koktokay no.3 pegmatite, China.*

INTRODUCTION

Geochemical studies on beryl (ideally $Be_3Al_2Si_6O_{18}$) from pegmatites are mainly focused on the contents of alkali elements (Roda, 1993; Černý et al., 2003; Neiva and Neiva, 2005). Many cations can be incorporated in beryl, either in the structural sites or in the channels. Be^{2+} can be replaced by Li^+ combined with alkalis filled in channel as charge-balancing cations, giving an isomorphic series between the beryl and the exotic pezzottaite [$Cs(Be_2Li)Al_2Si_6O_{18}$] (Hawthorne et al., 2004).

The Koktokay no.3 pegmatite, Altai, northwestern China, a strongly zoned spodumene-subtype pegmatite, consists of eight internal zones. It has generated the most important production of rare metals (Ta, Nb, Li, Be, Cs) in China. Beryl is the only ore mineral of beryllium in the Altai pegmatites, and merits a detailed mineralogical study. Systematic electron-microprobe analyses (back-scattered image observation as well as spot chemical analyses using JEOL JXA 8800M instrument) have been made on chemical features of beryl in internal zones (Zones I to VII) of the Koktokay no.3 pegmatite.

RESULTS

Overall chemical variations of beryl in Koktokay no.3 pegmatite

Electron-microprobe results revealed week contents of Fe, Mn, Mg, Ti (<1 wt%), but relatively higher alkali contents. A geochemical evolution was found in beryl from outer zones (I to VI) to inner zones (V to VII). This evolution was marked by increases in alkali contents in channel, especially in Cs_2O (from 0.01 wt% in zone I to 3.83 wt% in zone VII, Fig. 1), as well in Na_2O as well (from 0.49 wt% in zone I to 1.97 wt% in zone VII). Two sub-groups can be clearly divided, one consists of I to IV zones with minor components in channel, the other of V to VII zones which are relatively enriched in alkali cations. Increases in their contents from the outer to the inner zones reflect progressive fractionation.

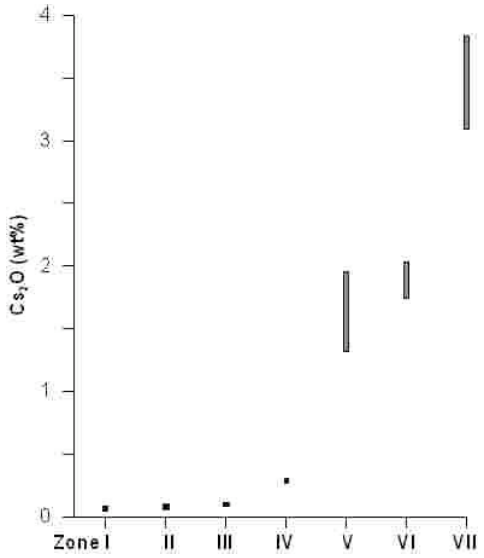

FIGURE 1. Concentrations of cesium in internal zones of the Koktokay no.3 pegmatite.

Heterogeneity in single crystal of beryl

Chemical variation was also found in single crystal of beryl, in particular, heterogeneity of Cs was observed in those from inner zones. Three principle types were distinguished.

(1) Blebby mosaic texture is common in beryl from zone VII, and consists of Na-enriched phase and Cs-enriched phase.

(2) Cs-enriched veinlets (several microns wide, but several centimeters long) are observed in beryl (Fig. 2). The veinlet contains up to 7 wt% Cs_2O, clearly higher than the host beryl.

(3) Hydrothermal Na-enriched rim (up to 50 microns wide) was found along fissure of beryl crystals.

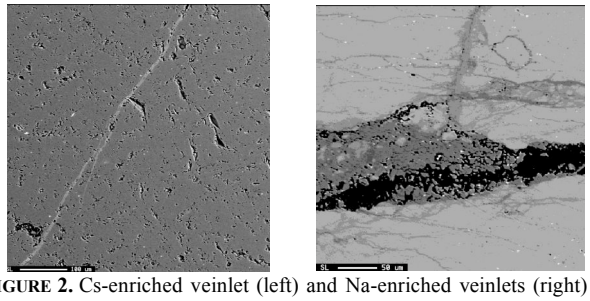

FIGURE 2. Cs-enriched veinlet (left) and Na-enriched veinlets (right) in beryl from the Koktokay no. 3 pegmatite.

DISCUSSION

Like other accessory minerals in the Koktokay no.3 pegmatite, such as Nb-Ta oxide (Zhang et al., 2004), pollucite (Wang et al., 2006), geochemical features of beryl indicate that the outer zones corresponding to the early stage of pegmatite crystallization are magmatic, whereas the inner zones crystallize at the magmatic-hydrothermal transitional stage.

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