

Optimising the REE-Zr-Nb potential of eudialyte and its alteration products in the Ilímaussaq complex, South Greenland

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Rare earth elements (REE) are critical to the development of a sustainable hi-tech economy [1]. Eudialyte-bearing nepheline syenites provide promising alternatives to currently mined REE-deposits in China, and techniques for their economic and environmental friendly exploitation are being developed. Europe hosts substantial eudialyte deposits within three rift-related peralkaline complexes, i.e. Ilímaussaq (Greenland), Lovozero (Russia), and Norra Kärr (Sweden) [2,3]. Despite being relatively low grade (c. 2 wt% TREO) compared to conventionally exploited REE phases, eudialyte is attractive for exploitation because of its (1) associated enrichment in other critical metals e.g. Zr, Nb and Ta; (2) high proportions of heavy relative to light REE (up to 1:1), (3) low U and Th contents, and (4) easy magnetic separation.

As eudialyte crystallises in unusually Cl, F and OH-rich peralkaline melts, it is commonly replaced by finely intergrown secondary REE, Zr, Nb phases during late-magmatic fluid activity [4,5]. Here we present the results of a detailed petrographic study of eudialyte alteration in the rhythmically layered floor cumulates of the Ilímaussaq complex, i.e. the world's largest eudialyte deposit. Three types of alteration assemblages are identified, characterised by different Zr-phases, i.e. catapleiite, zircon and gittinsite. Niobium is concentrated into nacareniobsite-(Ce), fergusonite-(Y) and fersmite. The REE are redistributed into finely disseminated britholite-(Ce), monazite-(Ce), allanite-(Ce), and a group of poorly identified Ca-Ba-REE-phospho-silicates [4,5]. The latter are most common, but too small (<10 µm) for quantitative analyses using common analytical techniques. Semi-quantitative mass balance calculations suggest that Zr, Nb and REE were immobile, and hence, the overall ore grade is unaffected by hydrothermal activity. However, a large proportion of the metals now reside in unknown minerals which could significantly hinder metal recovery as illustrated in recent hydrometallurgical studies [6,7] describing issues with silica gel formation, acid consuming gangue minerals and resistant secondary phases. To overcome these issues, high purity eudialyte concentrates and further mineralogical studies of alteration products are required. Future work will therefore use synchrotron radiation and nano-techniques (µ-XRF, µ-XRD, XAS, TEM) to study the structure and composition of secondary phases in altered eudialyte. Element mapping and REE speciation studies will provide insight into how the REE are redistributed on the micro- to nano-scale. Ultimately, the results will contribute to optimising the economic potential of eudialyte and similar resources in and outside Europe.

References

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