REE-mineral phases replacing helvite, niobian-rutile, bastnäsite-(Ce) from alkaline pegmatites of Mount Malosa, Zomba District, Malawi

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ABSTRACT

The niobium-yttrium-fluorine (NYF) miarolitic, granitic, alkaline pegmatites, crystallized at shallow depth (~1Kb), associated to the Zomba-Malosa Giurassic pluton are characterized by an unique mineralogy. This study, focused mineral replacement processes in pegmatitic cavities, such as helvite replaced by quartz + zircon + thorite; bastnäsite-(Ce) by cerianite and niobian-rutile by rhabodphane-(Ce) + bastnäsite-(Ce) + cerianite + monazite-(Ce).

Keywords: *Mount Malosa, alkaline pegmatites, bastnäsite,helvite, niobian-rutile.*

INTRODUCTION

The Zomba-Malosa pluton, emplaced approximately 113 Ma, is composed by qz-syenite and peralkaline granite and belongs to the Chilwa-alkaline province of Cretaceous age (Woolley, 1987; Eby et al., 1995). The associated niobium-yttrium-fluorine (NYF) miarolitic, granitic, alkaline pegmatites are characterized by an unique mineralogy including aegirine, arfvedsonite, cerian-pyrochlore, fluorite, hingganite-(Y), Nb-Ta-Y oxides, niobophyllite-astrophyllite, REE-carbonates, several Na-Be-Zr-silicates, xenotime-(Y) and zircon (Guastoni *et al.*, 2003). These pegmatites outcrop close to the summit of Mount Malosa (~2000 m.a.s.l.) and they are subhorizontal, strongly miarolitic and often contain large, metric cavities. The rock textures and the mineral assemblage indicate that these alkaline pegmatites crystallized at shallow depth. Indeed recent structural investigation by single-crystal X-ray diffraction performed on aegirines from Mount Malosa collected in the cavities indicate the crystallization occurred at ~1kb and at temperature of 300-400 C°. (Secco *et al.*, submitted). In addition the studies on fluids inclusions in quartz crystals from miarolitic cavities of Mount Malosa estimate entrapment pressure at 130 MPa (Zajacz et al., 2006).

REPLACEMENT PROCESSES

This study, performed by X-ray diffraction and SEM-EDS analysis, is focused to minerals replaced that occur in the pegmatitic cavities at Mount Malosa. Elsewhere mineral replacements were frequently observed in alkaline pegmatites: for example at Lovozero Massif and at Mount Saint Hilaire and (Pekov, 2000; Horváth & Gault, 1990). The more common substitutions observed at Mount Malosa are goethite + albite after parisite, quartz after epididymite, quartz + albite after apatite?, (or milarite? or phenakite?) and illite after bastnäsite. Moreover a number of additional unknown minerals, usually forming large pluricentimetric euhedral crystals, occur in the cavities and they show replacements by REE-minerals and Zr- Th silicates.

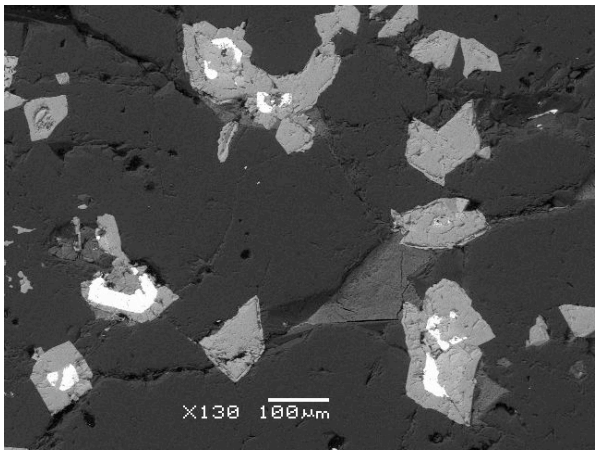

FIGURE 1. Backscattered image of an ex-helvite replaced by quartz (dark grey) euhedral zircon crystals (grey) hosting thorite at the core (bright white).

Tetrahedral ("pseudoctahedral") pluricentimetric brown crystals of a mineral having the typical crystal morphology of helvite is replaced by quartz + zircon + thorite + subordinate niobian-rutile (Fig.1). Yellow-brownish prismatic, columnar crystals of bastnäsite-(Ce) show a core composed by brown-orange vitreous bastnäsite-(Ce): the remnant portion of the crystals is composed by an earthy, spongy overgrowth of cerianite + bastnäsite-(Ce). Specimens containing replacements after helvite and after bastnäsite-(Ce) were observed together associated with microcline and aegirine in the pegmatite cavities. Another significant pseudomorphosis is after the tabular, prismatic crystals of niobian-rutile. These crystals show an outer earthy, spongy brownish rim composed by rhabodphane-(Ce) + minor bastnäsite-(Ce). Internally relics of niobian-rutile are embedded and partially replaced by bastnäsite-(Ce) + cerianite + monazite-(Ce). Locally submillimetric cerian-pyrochlore and zircon crystals line small secondary vugs of these crystals.

CONCLUSIVE REMARKS

Replacements occur at the late stage of the crystallization and involve rare accessory phases including beryllium silicates, REE-carbonates and niobian-rutile. Quartz, albite, zircon + thorite generally replace beryllium silicates. REE-carbonates

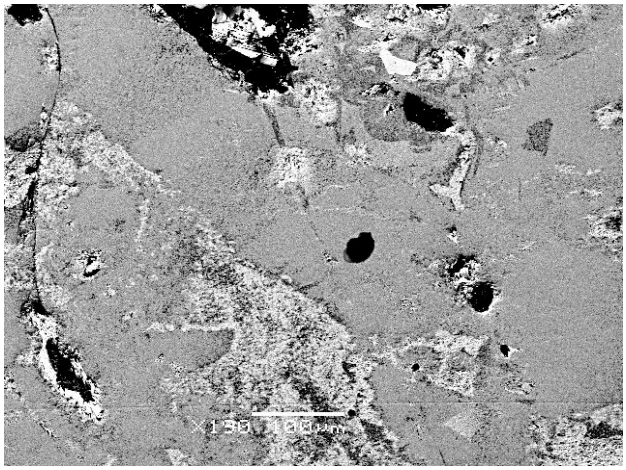

FIGURE 2. Backscattered image of niobian rutile replaced by bastnäsite-(Ce) + cerianite (grey) and monazite-(Ce) (lighter grey). Minor bright white areas are composed by relics of niobian-rutile.

are replaced by iron and cerium oxides: it is not yet clear if parisite→bastnäsite replacement also occurs. Niobian-rutile shows complex substitutions processes mainly by phosphate and carbonates of cerium. Further studies are needed to address the complex geochemistry of alkaline fluids responsible for the destabilization of Be, Nb, and REE bearing rare accessory minerals.

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