THE Nb-Ta-U OXIDE MINERALS FROM MARÍA ELENA PEGMATITE, SAN LUIS, ARGENTINA

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INTRODUCTION

Minerals of the pyrochlore group are relatively common minor accessory phases in the granitic pegmatites of the Sierras Pampeanas, usually in subordinate quantities relative to the columbite-group minerals (Galliski & Cerný 2006). However, in the María Elena pegmatite, San Luis Range, Argentina, we found an assemblage of plumbomicrolite, plumbopyrochlore, uranpyrochlore and liandratite associated with columbite-(Mn) that are uncommon in granitic pegmatites of Argentina where most of the associations contain microlite, uranmicrolite or pyrochlore. We introduce the paragenesis and geochemistry of these phases as the first step in the detailed examination of this pegmatite.

GEOLOGICAL SETTING

The northern part of the San Luis range, located in the Eastern Sierras Pampeanas, contains a large population of granitic pegmatites comprising the Conlara pegmatite field, which is one of the most representative and exploited of the rare-element pegmatite fields of Argentina (Galliski 1994a). This pegmatite field is hosted in a crystalline basement almost entirely formed by a thick psammopelitic succession of Upper Proterozoic-Lower Paleozoic age, that underwent a low-pressure, high-temperature metamorphism during the polyphasic deformation attributed to the Pampean (~ 600-520 Ma) and Famatinian (~490-440 Ma) orogenic cycles. The dominant lithologies are gneisses and micaschists of medium metamorphic grade, with minor amphibolite and marbles belonging to the Conlara Metamorphic Complex (Sims *et al*. 1997). Several granitic suites have intruded the metamorphic rocks. Most of the pegmatites are spatially associated, and genetically related, with a slightly late-orogenic granitic suite of S-like affinity, represented by small- to medium-sized, two-mica peraluminous granites. This suite of pegmatites is representative of different types and subtypes of the rare-element class of the LCT petrogenetic family of granitic pegmatites (Cerný and Ercit 2005).

Another group of pegmatites, so far poorly studied, is contained in some plutons that form a major batholith of post-orogenic granites known as Las Chacras-Piedras Coloradas. These rounded interior pegmatites are zoned

bodies, with accessory biotite, muscovite, beryl, tourmaline, hematite, ilmenorutile, monazite and locally primary fluorite. They were provisionally classified as rare-element pegmatites of beryl type and of hybrid signature by Galliski (1994b) and their review is currently in progress. Similar pegmatites are locally hosted by the metamorphic rocks of the basement, and were previously mined for beryl and ceramic minerals. The María Elena is a pegmatite broadly similar to this category.

GEOLOGY OF THE MARÍA ELENA PEGMATITE

The María Elena pegmatite is located in the northern part of the San Luis range, close to the small village of San Isidro at 32º32′31′′ S and 65º28′46′′ W. The pegmatite is a zoned dyke, exposed and mined in three quarries, outcropping along more than 530 m with variable width (5 to 7 m). It has a predominant north strike and dips subvertical to 65º W. The host rock is dominantly a dioritic rock with a minor proportion of a micaceous gneiss in the southern part. The outer zones comprise a centimetric border zone, only visible in the southern part, formed by Ab-Qtz-Mu, and a wall zone with variable thickness (1 to 2 m) and composed of Ab-Mu-Qtz-Mc-Sch-Grt. The intermediate zone is the most developed internal unit and it is formed by Mc in 1-2 m crystals that have graphic texture in the outer parts, imbedded in a medium-grained matrix of Ab-Qtz-Mu. Schorl in 1-3 cm prismatic crystals and greenish beryl are common accessory phases, fluorapatite is scarce. Fine-grained muscovite is common as fracture filling. A segmented unit of milky quartz forms the core. A network of mostly transversal fractures of millimetric thickness is filled with veins of purplish fluorite associated with carbonates, mainly calcite and subordinate siderite. Some surfaces are also covered by a bluish-gray, very fine-grained material, identified as dravite. In the southern quarry, veining is reduced but irregular, 10 to 25 cm vugs are found here with euhedral 1 to 5 cm crystals of quartz, covered by violet cubes of fluorite. The accessory phases are abundant yellow crystals or masses of beryl, several decimeters in size, plus rare subhedral cm-sized crystals of columbite and nodules of bismuth minerals with abundant inclusions of zircon.

The columbite crystals are commonly brecciated and penetrated by irregular fillings of K-feldspar, quartz, and albite in veinlets of 0.3-0.5 mm and scarce milky opal. The minerals of the pyrochlore group form irregular veinlets and patches of dark brown colour and vitreous luster in columbite. Liandratite occurs as irregular millimetric veinlets and patches of bright yellow colour.

Columbite-(Mn) has a uniform chemical composition with Nb ~6.58 *apfu* in the *B* site and Mn ~2.65 *apfu* in *A* site. Most of the minor-element contents are negligible except Ti which ranges from 0.041 to 0.376 *apfu;* U contents are 0.01 to 0.80 wt.%. The chemical compositions of pyrochlore-group minerals of the María Elena pegmatite are very variable. Plots of the data in the Nb-Ta-Ti and Pb-Ca-U diagrams (Fig. 1a, b) show the presence of plumbomicrolite, plumbopyrochlore, uranpyrochlore and liandratite. These species are rather uncommon in granitic pegmatites, especially plumbomicrolite and plumbopyrochlore. Liandratite is a U-rich, low-temperature alteration product of pyrochlore-group minerals, initially found in a granitic pegmatite of Antsakoa, Madagascar (Mucke and Strunz 1978).

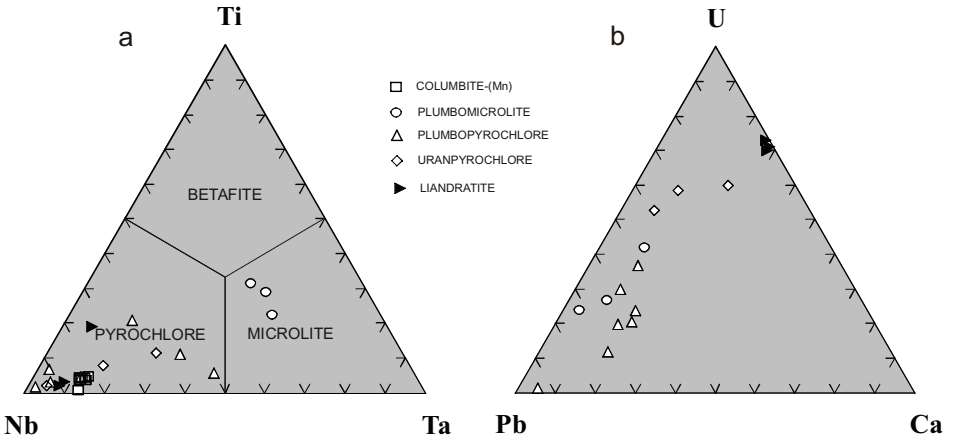

Fig. 1: (a) Compositional triangle of the pyrochlore-group minerals (modified after Hogarth 1977) showing the data from María Elena pegmatite for the dominant cations in the B site. (b) The same data plotted in the the U-Pb-Ca triangle showing the data for the dominant cations in the A structural site.

DISCUSSION

The location in the pegmatite and the textural relationships, in hand specimens and under the microscope, show that columbite-(Mn) crystallized as a late-magmatic phase when it attains saturation in the residual melt (Linnen & Keppler 1997). Later on, the columbite suffered brecciation and was cemented by minerals precipitated from a late-stage hydrothermal fluid enriched in Pb and Ti; the ensuing pyrochlore-group minerals were accompanied by albite, muscovite and quartz. The pyrochlore-group minerals were possibly formed by partial reworking of early columbite. This is suggested by the results that show similar #Ta [Ta/(Ta+Nb) *atom*.] for uranpyrochlore, plumbopyrochlore and columbite-(Mn), and a higher #Ta for plumbomicrolite as it is usual when minerals of both groups coexist (Cerný *et al*.1986). Regarding to the provenance of Pb in granitic pegmatites, it is necessary to mention that, except when there is contamination from the host-rock, this element is frequent in pegmatites of NYF signature with amazonite that can have plumbomicrolite and plumbopyrochlore as it happens in those of Mt. Ploskaya, Russia (Stepanov *et al.* 1982).

The mineralogical assemblage of Nb-Ta-U minerals of the pyrochlore-group resembles some associations that occur in pegmatites of NYF signature. Likewise, the pegmatite is relatively close (less than 2 km) to the oval-shaped post-orogenic granite of Los Alanices. However, the textural relationships between these minerals and columbite-(Mn) show that they are secondary hydrothermal phases, instead of primary minerals, and possibly the Pb content was derived from an external source. Consequently, the major accesory minerals as beryl and columbite-(Mn) suggest that María Elena is a rare-element pegmatite of beryl-columbite subtype and possibly of LCT signature, as many of this kind in this pegmatite district.

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