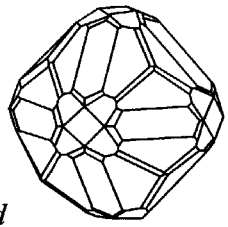

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THE FE-MN PHOSPHATE MINERAL ASSEMBLAGES FROM LA VIQUITA PEGMATITE, SAN LUIS, ARGENTINA

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INTRODUCTION

Accessory Fe-Mn phosphate nodules are common in the LCT (Li,Cs,Ta) rare-element pegmatites of the San Luis Ranges, Argentina. Most of these phosphates occur in pegmatites of beryl-type and spodumene subtype. As usual in other pegmatite fields, the primary assemblages are not very complex, consisting in members of the series triphylite-lithiophilite, beusite-lithiophilite, graftonite-beusite, triplite-zweiselite, and rarely bobfergusonite. The derived species form secondary assemblages that are mineralogically more complex and normally shed light on the conditions of the subsolidus alteration process. In this contribution we describe the phosphates occurring in La Viquita, a spodumene subtype, complex rare-element pegmatite of the Rare-Element-Li (REL) class according to the classification of Cerný & Ercit (2005).

GEOLOGY OF THE PEGMATITE

La Viquita pegmatite is located in the La Estanzuela range, at 65°06'30" W and 31°51'00" S, in the Chacabuco Department, San Luis Province, Argentina. The host rock is a dark-grey Qz-Bt-Mu-Pl schist with random occurrence of staurolite and garnet porphyroblasts. The internal structure is zoned and consists of fine-grained Qz + Mu border zone, followed by the wall zone composed of medium- to fine-grained Kfs+Qz+Ab+ Mu assemblage± Grt, Tur, Brl, CGM, Apt, Fe-Mn phosphates and secondary Fe-Mn oxides. The intermediate zone is subdivided into outer, middle and inner subzones, all of them coarse-grained and dominated by Kfs+Qz+Ab in the outer parts followed inward by increasing participation of Spd that reaches 15% in the core zone. These units have accessory muscovite, beryl, dm-sized nodules of montebrasite, nodules of members of the triphylite–lithiophilite series in the outer subzone, and minor phases as apatite supergroup minerals, eosphorite-childrenite aggregates, columbite-group minerals and wodginite-group minerals (Galliski et al. 2008). The core of the pegmatite is composed of Qz, Spd, minor Kfs, and traces of pyrite. In general, the decimetric crystals of spodumene are moderately to highly altered. Besides the Fe-Mn phosphates described in this abstract, up to 40 cm diameter nodules of dominantly montebrasite are common, and late-stage millimeter crystals of hydroxylherderite are occasionally found covering small cavities in the core margin association. From the geochemical point of view, La Viquita is a relatively Fe-enriched pegmatite compared with other pegmatite occurrences of the San Luis ranges.

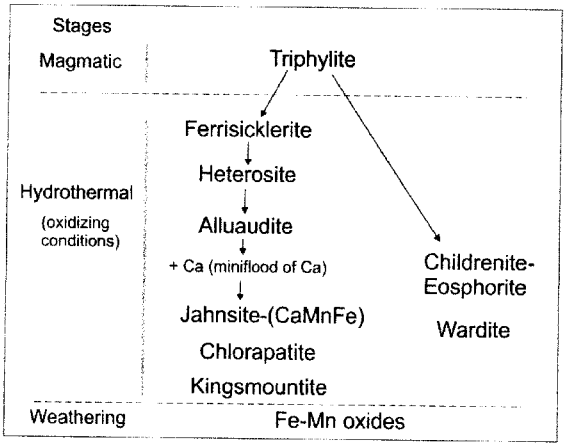
THE PHOSPHATE ASSEMBLAGES

Fe-Mn phosphates occur in several zones. In the wall zone, triphylite is present in cm-sized dendritic and skeletal crystals intergrown with albite and minor muscovite. In the same association rare chlorapatite is present in irregular crystals, as well as clusters of fibroradial crystals of members of the childrenite-eosphorite series. This triphylite is invariably replaced by ferrisicklerite in a first stage, up to a point where no remnants of the primary phase are visible. Ferrisicklerite itself develops, in a second stage, elongated, subparallel areas with irregular borders that coalesce with patches of heterosite. Later on, in the previous sequence, alluaudite appears, initially in thin veinlets and then in patches with advanced replacement, which irregularly and partially replace the assemblage ferrisicklerite + heterosite.

In the outer intermediate zone of the pegmatite, triphylite occurs in dispersed nodules of up to 10-20 cm in diameter. Most of these nodules are altered to a mass of secondary phosphates and black Mn-Fe oxides. Exceptionally one nodule was found with fresh blue triphylite inmersed in a groundmass of Qz + Ab + Kfs + Mu. This triphylite has $Fe_t/(Fe_t+Mn)$ ratios of 0.71-0.72.

The childrenite-eosphorite series usually appears in fibroradial clusters from 1 millimeter up to 1 cm that seldom form rosettes included in Ab + Mu + Qz in the wall and outer intermediate zones. The color varies from yellowish green to yellow and the chemical composition spans the range Ch_{57-26}, meaning that both members of the series are present. In the NE wall of the quarry 1 cm diameter rosettes with red centers that grade to light green in the borders of the blades were sampled. X-ray diffraction diagrams show good matching with ernstite, the Mn-dominant monoclinic member of the group. The chemical composition of this mineral is variable showing parts with Fe>Mn and others with Mn>Fe in the range 0.55-0.27 of the $Fe_t/(Fe_t+Mn)$ ratio, meaning that the Fe (possibly Fe^{3+}) dominant member of the monoclinic series is stable in nature. There are some evidences suggesting that these minerals do not form in a primary magmatic stage but in a late-hydrothermal one. One piece of evidence is the habit in fibro-radial aggregates, more typical of hydrothermal formed minerals. Another piece of evidence is the development of very thin prismatic crystals of childrenite disposed with comb textures starting from pericline twin composition planes in plagioclase. Additionally, the $Fe_t/(Fe_t+Mn)$ ratio of magmatic (triphylite) and derived oxidate and lixiviates species (ferrisicklerite, heterosite) (~0.70) and childrenite-eosphorite series (0.55-0.27) show a marked contrast, even when they coexist in the same thin section.

The later postmagmatic Ca-rich oxidizing hydrothermal stage develops secondary jahnsite-(CaMnFe), rare kingsmountite and minor chlorapatite. Jahnsite-(CaMnFe) occurs widespread as fine yellowish veinlets and coatings developed in cracks of ferrisicklerite-heterosite. Kingsmountite occurs in small colorless crystals developed on plagioclase from the wall zone associated with small irregular crystals of chlorapatite; both minerals are considered secondary based in their shape and chemical composition. In the intermediate zone, plagioclase is slightly replaced by tiny anhedral grains of wardite and fluorapatite, both associated with childrenite-eosphorite.



Supergenic alteration of the nodules produces coatings and masses of Fe-Mn oxides widespreadly distributed in the quarry after a long time exposure without mining operation.

CONCLUSIONS

The alteration of the primary, magmatic Fe-Mn phosphates from La Viquita dominated by triphylite develops under hydrothermal oxidizing conditions a sequence of ferrisicklerite→heterosite→ alluaudite. Later on, minerals of the series childrenite-eosphorite (±ernstite) form in small quantity. The subsolidus alteration process of ferrosicklerite ends with the formation of jahnsite-(CaMnFe), kingsmountite wardite and chlorapatite due to the late Ca-enrichment of the hydrothermal solution. Finally, weathering of the entire assemblage produces Fe-Mn oxides.

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Fig. 1. Schematic diagram showing the alteration sequence of the Fe-Mn phosphate minerals from La Viquita pegmatite.