

Trace elements behaviour in tourmaline and mica from the Pinilla de Femoselle rare-element pegmatite (Zamora, Spain)

Roda-Robles, E.^{1*}, Gil-Crespo, P.¹, Pesquera, A.¹ & Torres-Ruiz, J.²

¹Dpt. De Mineralogía & Petrología, Universidad del País Vasco (UPV/EHU), Bilbao, Spain (*encar.roda@ehu.es)

²Dpt. de Mineralogía & Petrología, Univ. de Granada, Spain

The rare-element Pinilla de Femoselle, (PF) pegmatite, crops out in the apical part of a leucogranite body. It shows a clear non-symmetrical vertical zoning from the contact with the leucogranite to the contact with the metamorphic country-rocks. The pegmatitic facies evolve upwards from (1) the undifferentiated lower border zone (LBZ), with quartz, feldspars, muscovite, biotite and black tourmaline, through (2) the intermediate zone (IZ), with quartz, muscovite, zinnwaldite, black tourmaline and Fe-Mn phosphates, to (3) the highly evolved upper border zone (UBZ), with quartz, albite, lepidolite, Fe-lepidolite, elbaite and beryl.

Trace element analyses of representative samples of mica and tourmaline from the three zones of the pegmatite have been performed by Laser Ablation. In addition, micas from greisenization bodies inside the UBZ and from the associated leucogranites, plus tourmaline associated to hydrothermal veins occurring inside this granite, have been also analyzed for trace elements. Li, Be, Sc and Sr show a similar behaviour for the white and ferro-magnesian micas and tourmaline. Li and Be contents increase from the leucogranite to the most evolved pegmatitic facies (UBZ), whereas Sc and Sr contents decrease upwards. The rest of the trace elements have different behaviour depending on the mineral phase. In the case of the tourmaline, Nb and Ta contents increase upwards, with the increasing evolution degree of the pegmatite facies, whereas Zn contents decrease in this sense and Mn contents increase till intermediate degrees of evolution (IZ), to decrease again in the pinkish elbaite. Rb and Cs show the same trends for white and ferro-magnesian micas, with a gradual increase upwards. Ta and Tl increase from the leucogranite to the UBZ in the white micas, whereas Ga increases till the IZ and later decreases in the UBZ. In the case of the ferro-magnesian micas, Zn, Ga, Nb, Sn, Ta and W show a similar trend, with a gradual increase from the leucogranite to the IZ, and a final decrease in the UBZ. In general, the three mineral phases are depleted in REE. A slight decreasing trend is observed for the HREE in the pegmatitic white micas, whereas for the ferro-magnesian micas the LREE contents decrease with the pegmatitic evolution. White micas are also present in small greisenization bodies occurring in the UBZ. This late mica shows the highest contents in Li, Rb, Cs, Nb, Ta and Tl; and the lowest in Mn, Ga and Sr.

Regarding the distribution of these trace elements among the three mineral phases in the different facies where they occur together (leucogranite, LBZ, IZ and UBZ), Li, Rb, Cs, Mn, Nb, Ta and Tl are mainly partitioned into ferro-magnesian micas. Be, Sc, and W are partitioned into white micas, whereas REE are partitioned into tourmaline. In general, tourmaline is the poorest phase in Li, Rb, Cs, Be, Sc, Sr, Nb, Ta, W, and Tl contents; whereas white mica is the poorest in Mn, Zn and LREE contents. Ferro-magnesian micas are the poorest in Ga and HREE contents.

Chemical variation in micas and tourmaline is consistent with an internal evolution by crystal fractionation processes. Li, Be, Sr and Sc in micas and tourmaline may be indicative of the degree of evolution in the PF pegmatite. Other elements that may be used to establish the degree of evolution in this body are the Rb, and Cs for the micas; and the Nb and Ta for the white-micas and tourmaline. The transition metals Mn and W seem to be a good indicative of fractionation just in the ferro-magnesian micas.

Graftonite-triphyllite-sarcopsidite intergrowths from the Palermo No. 1 pegmatite (New Hampshire, USA): textures and chemistry

Roda-Robles, E.^{1*}, Nizamoff, J.W.², Simmons, W.B.², Falster, A.U.² & Hatert, F.³

¹Dept. De Mineralogía y Petrología, Universidad del País Vasco (UPV/EHU), Bilbao, Spain (*encar.roda@ehu.es)

²Dept. of Earth & Environmental Sciences, University of New Orleans, USA

³Laboratoire de Minéralogie, Université de Liège, Belgium

The Palermo No. 1 (P1) rare-element pegmatite (North Groton, New Hampshire, USA) belongs to the Grafton pegmatite field, where beryl-columbite-phosphate and beryl-phosphate pegmatites are the most evolved [1]. The P1 pegmatite is hosted by sillimanite-muscovite grade schists of the Devonian Littleton formation. The pegmatite is pod-shaped and mainly concordant with the host rocks. Major minerals in this body are quartz, feldspars, muscovite, phosphates and beryl, with minor schorl.

The core margin and core zones of the P1 pegmatite contain locally abundant phosphate pods (up to 5 m long and 2.5 m across). In these pods, close to 90 different phosphate phases (primary and secondary) have been identified. Triphylite is the most abundant primary phosphate in the pods. Periodically triphylite occurs intergrown with graftonite ± sarcopsidite. The most common intergrowth is an assemblage of graftonite containing coarse lamellae of triphylite (or ferrisicklerite and/or heterosite). Most lamellae are platy and form a single set that shows a quite uniform optical orientation, enclosed in monocrystalline graftonite, giving rise to a laminated parallel intergrowth. Less commonly graftonite and triphylite show a granular texture, probably as a result of deformation, where the triphylite lamellae are not as regular, and the single crystallographic orientation is lost. In both cases, the triphylite lamellae may in turn host lamellae of sarcopsidite.

All the phosphates analyzed belong to the Fe-rich end-members, with values for the Fe/(Fe+Mn) ratio in the range 0.57 to 0.73 for graftonite, 0.74 to 0.89 for triphylite, and 0.81 to 0.88 for sarcopsidite, with a clear correlation among the ratios of the different phases belonging to the same sample. The Ca content in graftonite varies considerably, from 8.64 to 13.23 wt.% CaO. Graftonite intergrown with triphylite + sarcopsidite is the richest in Ca, whereas no correlation has been found between the Ca contents of graftonite and its Fe/(Fe+Mn) ratio.

In relation to the distribution of Fe, Mn and Mg among coexisting phases, in all the cases, graftonite shows a strong preference for Mn, whereas both triphylite and sarcopsidite are Fe-rich, with a slight preference of sarcopsidite over triphylite for this element. Mg is clearly partitioned preferentially into triphylite, with graftonite being the Mg-poorest of the three phases.

Taking into account the textural and chemical features of the graftonite, triphylite and sarcopsidite from the P1 pegmatite, they all may be considered as primary phases. Exsolution processes from a disordered homogenous precursor most likely could have been responsible for the development of the intergrowths present. In the case of the graftonite-triphyllite intergrowths, graftonite exsolved triphylite. In the case of the graftonite-triphyllite-sarcopsidite intergrowths, a Ca-richer graftonite exsolved triphylite, which in turn broke down to triphylite with sarcopsidite lamellae.

[1] Nizamoff, J. (2006) *The mineralogy, geochemistry & phosphate paragenesis of the Palermo #2 pegmatite, North Groton, New Hampshire*. Master's Thesis, University of New Orleans, USA.