EVOLUTION OF TOURMALINE FROM Li-POOR, F-RICH PEGMATITES AT THE SE BORDER OF THE MOLDANUBIAN ZONE, BOHEMIAN MASSIF

Scarlett Urbanová, Jan Cempírek
Masaryk University, Faculty of Science, Department of Geological Sciences, Kotlářská 2, 611 37 Brno

MUNI SCI Department of Geological Sciences

Introduction

Pegmatites are predominantly magmatic rocks formed by solidification of fluid-rich silicate melts. They typically have granitic composition, and from the other igneous rocks they differ by their extremely coarse but variable grain size or by a large number of crystals with skeletal, graphic or other directed growth textures. Pegmatites occur as dikes or sharply bounded homogeneous to zonal bodies in the igneous and metamorphic host rocks.

There are relatively high contents of rare elements in pegmatites (e.g. Li, Be, Ta, Nb, Sn, W, Cs, Rb) and they are the source of some rare raw materials (especially Ta, Li, Cs, Rb, Sn) and some gemstones (aquamarine, rubelite, topaz, indigolite, heliodor, verdelite, morganite, etc).

Rare-element mineralization

Ctidružice: greenish cleavelandite, **garnet** (Buřival and Novák 2018), and accessory Mn-rich polylithionite-masutomilite, fluorapatite, topaz, zircon, **W-rich ixiolite**, **columbite**, **cassiterite**, **xenotime**, **monazite** (Fig. 2), and secondary stokesite and Be,B-minerals (e.g. hambergite, bertrandite).

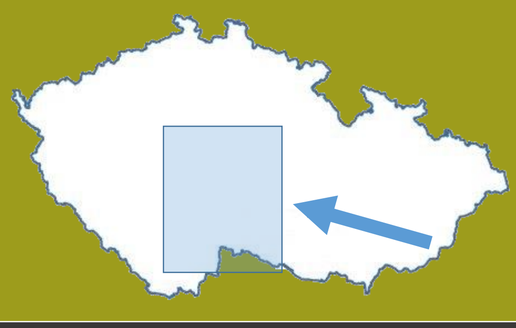
Hrotovice: lepidolite (polylithionite and sokolovaite), accessory **topaz**, Be-rich cordierite/sekaninaite (Hreus 2021), **W rich Nb-Ta oxides** with strong Mn/(Mn+Fe) fractionation (**columbite, ixiolite, qitianlingite**), fluorapatite, **cassiterite**, uranmicrolite, **xenotime**, and **monazite**.

Křižínkov: greenish cleavelandite that contains the lithium mineralization, **topaz**, fluorapatite, **cassiterite**, **wodginite**, **ixiolite**, **Nb-rutile**, zircon, **xenotime**, **masutomilite**, and garnet (Urbanová 2017)

Geological position

The studied pegmatites are situated in the easternmost part of the Moldanubian Zone, characterized by presence of S-type granites and leucogranites in the thermal aureole of the Třebíč durbachite pluton, and various metamorphosed, strongly migmatized paragneiss to migmatites of the Gföhl Unit of the Moldanubian Zone.

Eastern margin of the Moldanubian Zone is characterized by common occurrences of rare-element pegmatites (Fig. 1), loosely grouped in two large pegmatite fields : Strážek and Vratěnín-Radkovice. The two pegmatite fields include ca. 15 fractionated pegmatite dikes containing rare elements such as Li, Rb, Be, Cs, Nb, Ta, Sn and W. The pegmatites range from lepidolite subtype to elbaite subtype of the complex type of the rare-element class of granitic pegmatites, with thickness from 10 cm to more than 20 m. We studied mineralogy and tourmaline evolution in three highly to moderately fractionated elbaite-subtype pegmatites – Ctidružice, Hrotovice and Křižínkov.



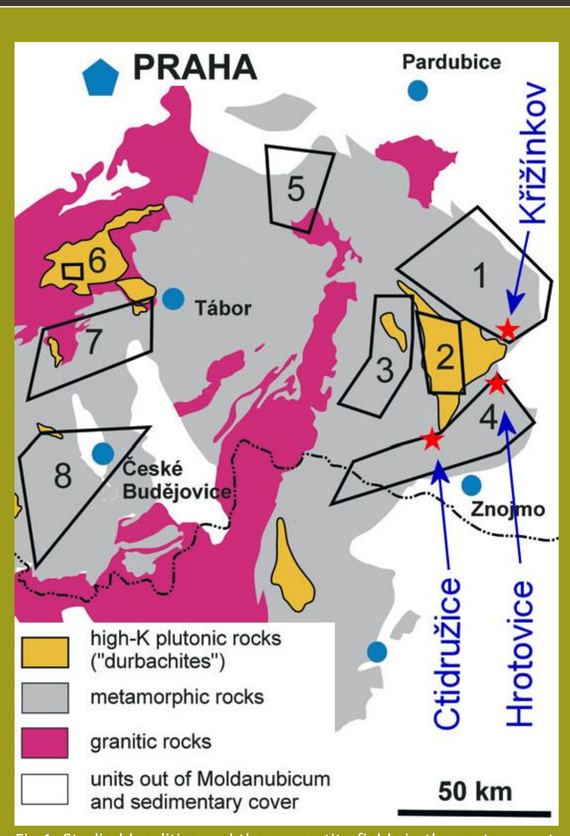


Fig.1: Studied localities and the pegmatite fields in the eastern part of the Moldanubian Zone (after Novák and Cempírek 2010). Names of the pegmatite fields: 1 – Strážek, 2 – Třebíč, 3 – Jihlava, 4 – Vratěnín-Radkovice, 5 – Vlastějovice, 6 – Vepice, 7 – Písek, 8 – South Bohemian pegmatite field.

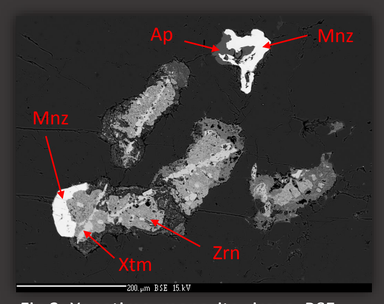


Fig.2: Xenotime, monazite zircon, BSE (locality Ctidrtužice)

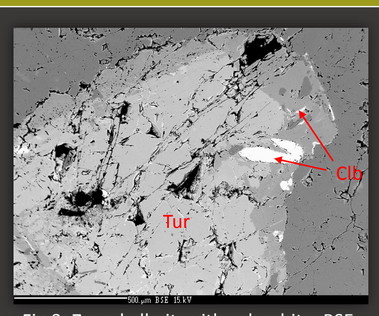


Fig.3: Zoned elbaite vith columbite, BSE (locality Ctidružice)

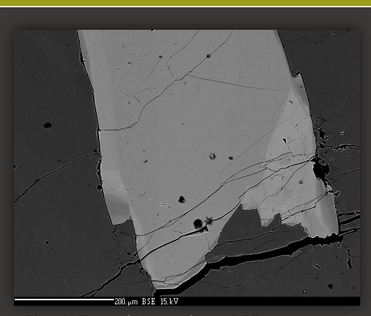


Fig. 4: Zoned tourmline, BSE (locality Hrotovice)

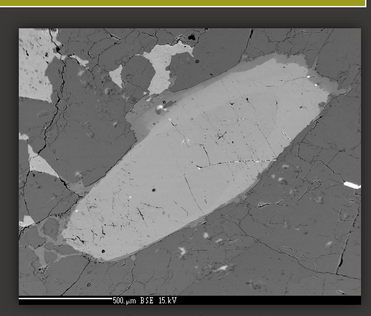


Fig.5: Zoned tourmaline, BSE (locality Křižínkov)

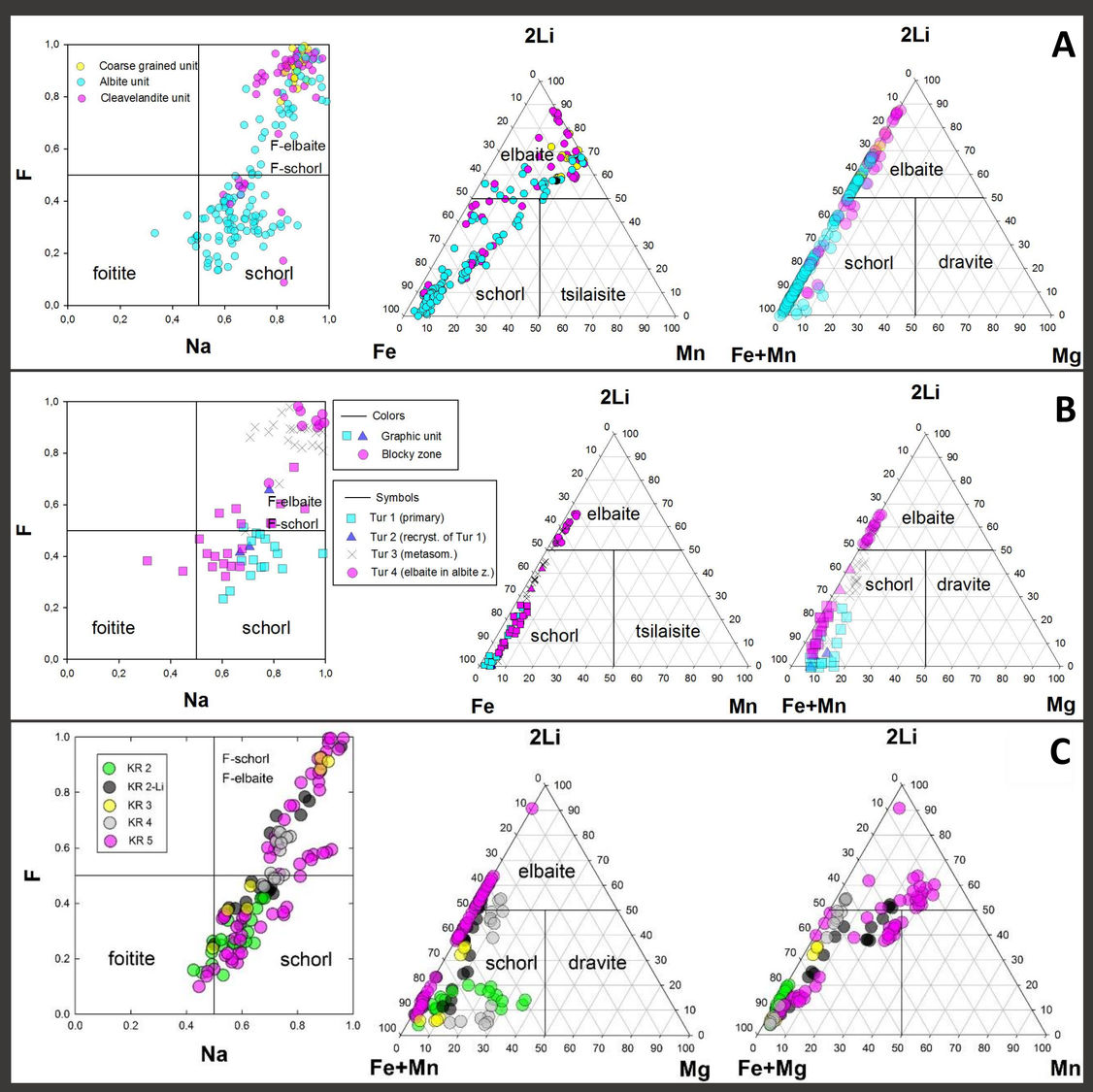


Fig. 6.: Evolution of tourmaline from Ctidružice (A), Hrotovice (B) and Křižínkov (C)

Compositional evolution of tourmaline

Tourmalines from albite unit and cleavelandite unit from **Ctidružice** (Fig. 3) have typically fluor-schorl core with fluor-elbaite rim. The coarse grained unit is characterized by presence of fluor-elbaites with high contens of Na (0.83 – 0.91 apfu), F(0.83 – 0.98 apfu) and Li (0.84 – 1.13 apfu) (Fig. 6a).

In pegmatites from **Hrotovice** (Fig 4) are present three types of tourmaline (Fig. 6b): **primary** (black) **tourmalines** with lower amounts of F (0.24 – 0.66 apfu) and Na (0.69 – 0.83 apfu), **metasomatic** and **recrystallized tourmalines** with their composition affected by composition of the replaced primary tourmaline (elevated Mg), and **late** (dark green) **tourmaline** (fluor-elbaite) with high contents of Na (0.85 – 1 apfu), F (0.83 – 0.98 apfu), Li (0.78 – 1.03 apfu)

The most common tourmaline in **Křižínkov** (Fig. 5) is schorl, which is present in all samples. Latest tourmalines are characterized by increased to high contents of F (≤ 0,95 apfu) and Li (≤ 0,94 apfu) (Fig. 6c). Typical evolution from foitite to schorl to fluor-schorl and fluor-elbaite, indicating increase of Na, F and Li, Mn

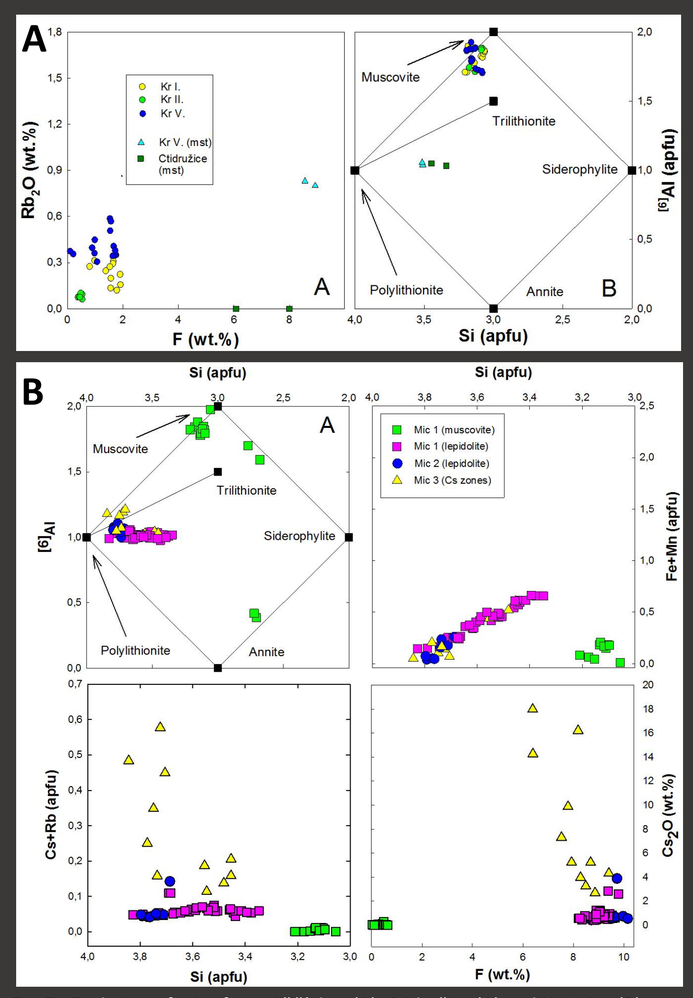


Fig. 7.: Evolution of mica from, Křižínkov (A), Ctidružice (A) and Hrotvice (B)

Compositional evolution of mica

All the measured samplesof mica from Křižínkov correspond to muscovite composition (Fig. 7a). Massutomilite (Fig. 10) after garnet alteration from Křižínkov has a similar composition as massutomilite from Ctidružice with increased content of Mn (0.42-0.48 apfu). In Hrotovice are observed three types of mica, Fe rich primary mica (muscovite and early lepidolite) with higher Mn an Mg contents (Fig. 9), younger lepidolite with higher Rb and lower Mn and Mg, and Cs-rich zones (0.12-0.55 apfu Cs) (white zones on lepidolite in BSE) with polylithionite to sokolovaite composition (Fig. 8).

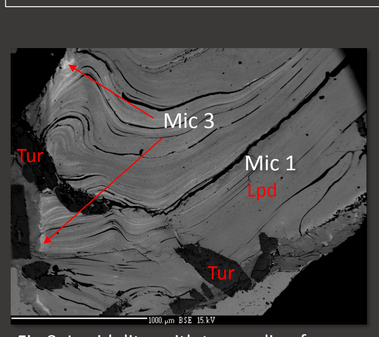


Fig.8: Lepidolite with tourmaline from blocky zone, BSE (locality Hrotovice)

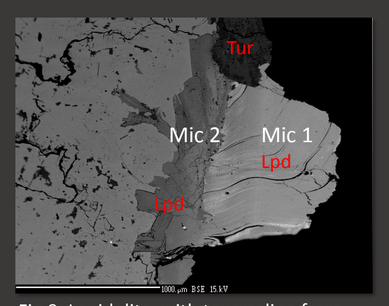


Fig.9: Lepidolite with tourmaline from blocky zone, BSE (locality Hrotovice)

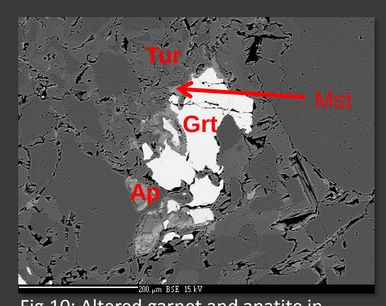


Fig.10: Altered garnet and apatite in tourmaline, BSE (locality Ctidružice)

Summary

The Křižínkov and Ctidružice pegmatites indicate a magmatic activity which produced melts enriched in rare elements (especially Li, Rb, Sn, Nb + Ta, and W) Tourmaline have increased and high contents of F, Li, Mn+Fe and high initial contents of Fe, that indicates relatively high initial fractionation of the melt.

The Hrotovice pegmatite has a very very poor Li-mineralization with albite zone rich in F (lepidolite, F-elbaite, topaz). The evolution of tourmaline is rather simple with primary and metasomatic generations and rare fluor elbaite zones. The decreasing content of F in the end of crystallization of tourmaline is affected by presence of lepidolite.

Acknowledgements:
This work was supported by the research projects GAČR 19-05198S and MUNI/A/1594/2020.

References

Buřival, Z., & Novák, M. 2018: Secondary blue tourmaline after garnet from elbaite-subtype pegmatites. Journal of Geosciences, 63, 111–122.

Hreus, S., Novák, M., Cempírek, J., Toman, J., Urbanová, S.: Role of early cordierite crystallization on tourmaline composition in rare-element pegmatites Věžná I and Hrotovice – TUR2021, Abstracts Volume.

Novák, M. & Cempírek, J. 2010: IMA 2010 field trip guidebook CZ2.

Urbanová S. (2017) Rare-element pegmatites in SE part of the Strážek Moldanubicum – MSc. thesis Masaryk University, Brno.