Pavel Uher, PhD
Professor of Mineralogy
Department of Mineralogy and Petrology
Faculty of Natural Science, Comenius University
Ilkovičova 6
842 15 Bratislava, Slovakia

Review of doctoral dissertation by mgr. inż. Adam Włodek: „Mineralogical study of phosphate-bearing pegmatite from Lutomia".

General characteristics and main scientific results

The reviewed manuscript represents a mineralogical description of phosphate minerals and associated rock-forming as well as accessory minerals from the Lutomia granitic pegmatite, situated in the Góry Sowie Mountains, Bohemian Massif (Poland). The dissertation is relatively extensive (232 pages) and it is written in Polish language. The first part of the dissertation is devoted to detailed descriptionn of regional geology with focus on the Góry Sowie Mts., including basic petrographic, tectonic and paleogeographic informations of the surrounding metamorphic and magmatic rocks. The Methods chapter characterises mainly analytical conditions of the electron-probe microanalysis, the most employed microanalytical method of the study as well as calculation routines for all analysed minerals.

The dominant part of the reviewed dissertation (130 pages) is devoted to the Results: detailed textural and compositional description of the pegmatite minerals. The Discussion chapter evaluates mainly an evolution of phosphate minerals during pegmatite formation, from primary magmatic, through high-temperature metasomatic and hydrothermal, to low-temperature hydrothermal and weathering genetic stage. Author describes 48 phosphate phases, including some unique minerals. The last chapter represents a voluminous References (27 pages) with relevant recent as well as historical citations of Polish and international authors.

Generally, the reviewed doctoral dissertation is well and clearly written, by advanced scientific style. The division of chapters, their extent and sentencies of the text are adequate

and logical, without redundant or replicate parts and logical discrepancies. Moreover, the text is completed by numerous suitable figures (optical and BSE photomicrographs, mineral diagrams) and tables of mineral compositions including their formulae calculations.

The topic of the dissertation (complex study of phosphate mineralization in pegmatite from magmatic to low-temperature stage) is highly actual. Evolution of phosphate-rich, geochemically evolved granite-pegmatite magmatic systems and their subsolidus overprint represents a complex and important problem in petrological and mineralogical science, investigated by many recent authors, as it is documented in the manuscript. In my opinion, the most important scientific results of the dissertation of A. Włodek are following:

(1) Documentation of primary phosphate nodules rich in Fe, Mn, Mg, Ca and Li, exsolved from dominant alumo-silicate melt during magmatic stage of the relatively primitive anatectic pegmatite system. Consequently, precipitation of Li-bearing, primary magmatic phosphate minerals (triphylite group) together with graftonite and sarcopside members is possible also in such relatively barren granitic pegmatite populations (without Be, Cs and with scarce Nb-Ta and REE minerals).

(2) Characterization of several stages of subsolidus alteration and overprint of the primary magmatic phosphate mineral assemblage by metasomatic to hydrothermal (high- to low-temperature) fluids as well as near-surface weathering. Interaction of several primary phosphate phases of single usually anhydrous composition with the subsolidus fluids led to crystallization of numerous new and more complex phosphate phases. Therefore, the Lutomia pegmatite is an excellent example of strong prograde mineral diversification of phosphate phases due to fluid-mediated overprint of single magmatic phosphate assemblage in the world scale (such as Hagendorf, Palermo, Karibib, etc.).

(3) Identification and description of some unique and very rare minerals, especially Zr-bearing phosphate phases: zigrasite, malhmoodite and Ca-dominant analogue of zigrasite (a potentially new mineral species). The presence of apparently low-temperature Zr-phosphates (together with several documented locations of these minerals in the world) reveals a relatively high mobility of Zr^{4+} also in near-surface environment and it brings a new view into geochemical behaviour of zirconium as "nominally resistant" element.

Critical and problematic points, questions

The reviewed dissertation contains also some deficiences, errors and questionable points. I select some of them in the following items:

(1) Page 22: Author cited the „Map 1“ in the text but the map is not included in the dissertation.

(2) Some pegmatites mentioned in the Góry Sowie Mts. contain kyanite. Generally, this high-pressure mineral is not typical for granitic pegmatites. How is author opinion about kyanite origin in such pegmatites; primary mineral or product of pegmatite metamorphic overprint?

(3) A relatively lot of citations noted in the text are missing in the References (e.g., Pieczka et al. 2015b; Szełęg et al. 2017; Tichomirova et al. 2002; Słaby and Martin 2008; Dathe 1887; Pieczka 1997; Ercit 2005; Moore 1972; Hughes et al. 2008; Cámara et al. 2015; Gomes et al. 2009; Cassait and Orlandi 1989; Quensel 1937; Dill 2015; Ruslan et al. 2001; Veksler and Thomas 2002). Some citations in References are not in alphabetical order (e.g., reference Hwang et al. 2019 is situated between Matsubara et al. 2001 and Mazur and Puziewicz 1995), some references are not complete (e.g., Žáček is without year of publication; Beutell 1884: citation without pages, etc.).

(4) Geological description of the Lutomia pegmatite, including host-rock petrography, pegmatite to host-rock relationships, photographs or schematic cross-section of the pegmatite illustrating its zoning, etc. is absent.

(5) How is difference between marićite and karenwebberite? Are sicklerite and ferrisicklerite different mineral species with clear end-member formulae or are they only intermediate members between triphylite and heterosite or between lithiophyllite and purpurite, respectively?

(6) Tripyline crystals show a strong chemical zoning between triphylite I and II (Fig. 17A-B). How are main differences in Mg, Fe and Mn contents between both triphylite generations? It is not explained in the text. Consequently, the average formula of triphylite is not illustrative. The triphylite I and triphylite II analyses are not distinguished in the Table 8.

(7) The compositions classified as hedegaardite and “Fe-hedegaardite“ could be rather classified as merrillite and ferromerrillite. They have <1 Na apfu, $(OH)_{calc.} < 0.5$ and $(Ca+Mn)^{2+} \sim 9$. However, the compositions are very similar.

(8) It is not possible to distinguish between high-temperature hydrothermal-metasomatic and low-temperature hydrothermal minerals on the basis of textural relationships in some cases.

(9) It is better to use Fe^{2+} – Mg – Mn^{2+} (not Fe_{total} – ...) triangular diagram for whitmoreite and earlshanonite (Fig. 55).

(10) There are two different compositional varietes of Ca-analogue of zigrasite (Fig. 65): Fe-Mg-rich and Mg-Fe-poor (near end-member). Consequently, it is not illustrative to use one average formula for the both varietes (page 161).

(11) Some type errors occur, e.g.: hagendorfite (not hegendorfite); Přibyslavic (not Přibilsavic); New Hampshire (not N. Hemsphire); beraunite (not braunite), hedegaardite (not hadegaardite), bradaczekite (not brodaczekite), etc.

However, all these (and some another) problematic points and errors are not essential.

Conclusion

The reviewed doctoral dissertation of mgr. inż. Adam Włodek represents a very valuable scientific work which contains a lot of original results concerning mineralogy of phosphate-rich granitic pegmatites in worldwide meaning. The dissertation is fully suitable for the doctoral thesis defense and I recommend to award a title PhD to A. Włodek.

Bratislava, September 16, 2020

Pavel Uher, PhD
Professor of Mineralogy
Department of Mineralogy and Petrology

Faculty of Natural Science, Comenius University
Ilkovičova 6
842 15 Bratislava, Slovakia