THE SOWIE MTS. PEGMATITES (LOWER SILESIA, SW POLAND): A CURRENT KNOWLEDGE

PIECZKA, A.[1]*, ŁODZIŃSKI, M.[2], SZEŁĘG, E.[3], ILNICKI, S.S.[4], NEJBERT, K.[4], SZUSZKIEWICZ, A.[5], TURNIAK, K.[5], BANACH, M.[6], MICHAŁOWSKI, P.[6] & RÓŻNIAK, R.[6]

[1] Department of Mineralogy, Petrography and Geochemistry, AGH – University of Science and Technology, Mickiewicza 30, 30-059 Kraków, Poland

[2] Department of General Geology, Environmental Protection and Geotourism, AGH – University of Science and Technology, Mickiewicza 30, 30-059 Kraków, Poland

[3] Dept. of Geochemistry, Mineralogy and Petrography, University of Silesia, Będzińska 60, 41-200 Sosnowiec, Poland

[4] Inst. of Geochemistry, Mineralogy and Petrology, Univ. of Warsaw, Żwirki and Wigury 93, 02-089 Warszawa, Poland

[5] Institute of Geological Sciences, University of Wrocław, Cybulskiego 30, 50-205 Wrocław, Poland

[6] DSS S.A. Company, Piława Górna Quarry, Sienkiewicza 96, 58-240 Piława Górna, Poland

* E-mail: pieczka@agh.edu.pl

Pegmatites of the Sowie Mts. gneissic block are known for at least 150–200 years. In the 19th century, they were mined out in numerous localities, *e.g*. Owiesno, Różana, Piława, Bielawa, Kamionki, mainly as a feldspar raw material. Most data pertinent to the mineralogy of the pegmatites date back to that period. In the pegmatite of Michałkowa (*type locality*), WEBSKY (1868) described a new phosphate mineral, sarcopside, $(Fe,Mn,Mg)_3(PO4)_2$, accompanied by huréaulite and vivianite (fide LIS & SYLWESTRZAK, 1986). Another phosphate, triplite, $(Fe^{2+},Mn)_2PO_4F$, was reported in a railway crosscut northwards of Piława Górna (FIEDLER, 1863; DATHE & FINCKH, 1924; HINTZE, 1933; LIS & SYLWESTRZAK, 1986), while a mineral representing the columbite group, $(Fe,Mn)\ (Nb,Ta)_2O_6$, in form of plates up to 5 mm in diameter, was found in a pegmatite occurring also nearby Piława Górna (ROMER, 1864; ROTH, 1867; TRAUBE, 1888; HINTZE, 1933; LIS & SYLWESTRZAK, 1986). MIKUSZEWSKI *et al.* (1976), based on geochemical investigations about of 100 surface-available pegmatite bodies, concluded that the Sowie Mts. metamorphism (*ca*. 380–370 Ma) was not sufficient for the formation of zoned pegmatite bodies enriched in trace elements. However, PIECZKA *et al.* (2003, 2004) gave first indications on Li-bearing mineralization in pegmatites of the region. These are the presence of ferrisicklerite, $Li_{1-x}(Fe,Mn)PO_4$, forming lamellar intergrowths with graftonite, sarcopside, Ca-beusite, staněkite, alluaudite and numerous others phosphates in a pegmatite from Lutomia, as well as green elbaite found in the vicinity of Gilów. Moreover, the occurrences of columbite-(Fe) and Pb-bearing microlite, in the form of inclusions in beryl crystals, were reported by ŁODZIŃSKI & PIECZKA (2008) from the region Owiesno–Kietlice. It was more and more evident that at least some of the Sowie Mts pegmatites represent transitional varieties between the MS and REL classes in the pegmatite classification by ČERNY & ERCIT (2005). NOVÁK (2005), who characterized pegmatites in the Bohemian Massif, preclassified Sowie Mts. pegmatites as LCT, beryl pegmatites.

Six-year period of mining activity of the Company *Dolnośląskie Surowce Skalne S.A.* at Piława Górna, a supplier of crushed aggregates for the largest national infrastructure projects including first of all the construction of express roads and motorways, with an output of 20–25 million tons of various metamorphic rocks, resulted in formation of an immense open pit enabling viewing down to 100 m of the massif. The metamorphic rocks are frequently cut with pegmatite veins, especially of dyke nature (*Julianna-2008, Subtrio-2009, Lithium-2010*) reaching vertically to 30–40 m, horizontally to 80–100 m, in thickness to 4–6 m, with the tonnage reaching 40.000–50.000 tons, showing distinct zoning (border zone, graphic zone, massive feldspars zone, quartz nucleus). Such big pegmatite bodies have not been hitherto known. Beforehand, a vein-and-lens pegmatite system from Lutomia, approx. 20 m long, was considered as the biggest pegmatite in the Sowie Mts. region.

The pegmatites from Piława Górna exhibit diversified states of geochemical evolution, from almost completely barren, through poorly to highly evolved, with local concentrations of Li, Cs, Be, B, Nb, Ta and REE-bearing mineralization. They can be classified as LCT, MS-REL to REL pegmatites. The basic minerals are typical of pegmatite: quartz, microcline, albite, biotite, muscovite, frequently black tourmaline (schorl), garnet evolving from almost $Alm_{50}Spe_{50}$ in veins of poorly-evolved pegmatite to $Spe_{97}Alm_3$ in the most evolved Li-bearing pegmatite representing the albite-spodumene class. The mineral of **beryl**, $Be_3Al_2[Si_6O_{18}]$, the main carrier of **Be**, occurs in all pegmatite bodies, although in various forms and colours (greenish, yellowish, white, pinkish, bluish). In the most evolved Li- and Cs-bearing pegmatite *Lithium-2010*, it evolved into a composition typical for **pezzottaite**, $CsBe_2LiAl_2[Si_6O_{18}]$. Beryl is usually accompanied by small quantities of **bavenite**, $Ca_4Be_2Al_2Si_9O_{26}(OH)_2$ and **bityite**, $CaLiAl_2Si_2BeAlO_{10}(OH)_2$. **Phenakite**, $Be_2[SiO_4]$, **helvite**, $Mn_4Be_3Si_3O_{12}S$, and probably **liberite,** Li_2BeSiO_4, so far have been encountered only as accessory minerals. Beryl is not distributed uniformly in veins; apart from a pegmatite relatively poor in this mineral (*Julianna-2008* type), there was also exposed a big pegmatite vein (*Subtrio-*

2009 type, approx. 10,000–15,000 m^3 rock), in which the contact between the feldspar zone and the quartz nucleus was almost completely grown with crystals of this mineral.

In poorly evolved pegmatite, type *Julianna-2008,* **Nb** and **Ta** mineralization is encountered in the form of **columbite-(Fe)**, evolving toward **columbite-(Mn)**, **tantalite-(Fe)** and further toward **ixiolite** overgrown with Nb- and Ta-bearing **cassiterite**, and **titanian ixiolite**. Relics of the last phase were found in minerals of the samarskite group: prevailing **ishikawaite** and **samarskite-(Y)** in minor amounts. Grains of those minerals are usually overgrown with **polycrase-(Y)** and various minerals belonging to the **pyrochlore** and **betafite** groups of the pyrochlore supergroup (**pyrochlore**, **yttropyrochlore**, **uranpyrochlore**, **betafite** and **yttrobetafite**). In addition, the contents of Nb and Ta reach more than 5 wt% Ta and 3 wt% Nb in **cassiterite** and more than 4.0 wt% Ta and 3.0 wt% Nb in **titanite**. Columbite grain sizes are diversified. The largest crystal of columbite-(Fe) reached 6 cm; but usually crystals of the mineral are considerably finer. Grains of the samarskite-group minerals reach even 2 cm in size, but in most cases are smaller. Ixiolite is rather fine. The Li- and Cs-bearing pegmatite, type *Lithium-2010*, also contains **columbite-(Mn)** that evolves towards **tantalite-(Mn)**, forming plates and needle-shaped crystals, up to 2 cm in length, sometimes altered into **microlite**, **plumbomicrolite**, and **bismutomicrolite** (all of them belonging to the pyrochlore supergroup), Nb- and Ta-enriched **rutile** and **ilmenite** containing up to a dozen or so wt% Nb or Ta, **wodginite**, as well as Ta-rich members of the **roméite** group.

Carriers of alkali metals (**Li**, **Rb**, and **Cs**) are only connected with moderately and highly fractionated pegmatites (types *Subtrio-2009* and *Lithium-2010*). **Lepidolite** (pink mica) and **spodumene,** $LiAlSi_2O_6$, as well as coloured tourmalines (mainly **elbaite** to **olenite**, with **rossmanite and liddicoatite** domains) are main carriers of Li. Others, already aforementioned Li-bearing phases are represented by **bityite** (*Subtrio-2009*), **lithiophilite** and the most probably **liberite,** Li_2BeSiO_4 and **eucryptite**, $LiAlSiO_4$ (*Lithium-2010*). Rubidium is concentrated in feldspars (0.4–0.5 wt% Rb) and micas, especially of the highly fractionated *Lithium-2010* pegmatite because of its substitution for K. Cesium mineralization has been recognized in blocks of the Li-bearing pegmatite as separate nests of **pollucite**, $(Cs,Na)_2Al_2Si_4O_{12} \cdot H_2O$, reaching up to 30 cm in length. In the outermost parts of beryl crystals, coming from *Lithium-2010* pegmatite, there was diagnosed a zone containing up to 15 wt% Cs, whose composition corresponds to Cs-bearing variety of beryl named **pezzottaite**. Other beryl crystals contain up to 7 wt% Cs, but Cs is negligible in crystals coming from *Julianna-2008* and *Subtrio-2009* pegmatites. In addition, Cs was identified as an important substituent in K-feldspars (to 0.2 wt%) and in some dark micas (up to 18 wt% Cs), in which it prevails over K.

Rare earth elements, including Sc and Y, concentrate mainly in poorly fractionated pegmatites, type *Julianna-2008*, in which REE-containing phases are sometimes disseminated mainly around the border between the graphic zone and massive feldspar zones. The phases are represented mainly by **fluorapatite**, minerals of the **samarskite** group, containing from around 2 to more than 6 wt% Y and 4 wt% of other lanthanides. Lower REE contents correspond to **ishikawaite**, higher to **samarskite-(Y)**. **Polycrase-(Y)** that co-occurs with samarskite contains around 10.0–13.0 wt% Y and 7–8 wt% of other rare earth elements. Similar contents of REE are recorded in **yttropyrochlore** and **yttrobetafite**. Apart from the mentioned phases, REE are main components in **monazite,** $(Ce,Nd,Sm,La)PO_4$, and **xenotime,** $(Y,Yb,Er,Dy,Ga)PO_4$; while in **thorite** detected were approx. 3 wt% Y and 2–4 wt% LREE.

In the pegmatites, as well as in the surrounding amphibolite have been recognized trace sulfide mineralization including Ni-bearing pyrrhotite, pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, bismuthinite and a still unrecognized Ag-Bi-sulfosalt, as well as bismutite and native Bi. This type of mineralization may be related to the hydrothermal stage, which had formed many small ore deposits mined within the Block area before many years ago.

The presented draw on the current knowledge of mineralogy of the Sowie Mts. pegmatites indicates that the bodies may be quite exceptional even in the scale of whole Bohemian Massif. Large dimensions of the bodies arise a question about economic significance of the pegmatites as K-feldspar raw material or as a potential source of some critical elements. The described pegmatites *Julianna-2008*, *Subtrio-2009* and *Lithium-2010* have been completely excavated during winning of migmatite and amphibolite rocks.

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