Ph.D. dissertation

MINERALOGICAL STUDY OF PHOSPHATE-BEARING PEGMATITE FROM LUTOMIA

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Abstract

The aim of the doctoral dissertation was the mineralogical characterization of the anatectic granite pegmatite from Lutomia in the Góry Sowie Block (Świdnica commune, Dolnośląskie voivodship). The pegmatite from Lutomia belongs to primitive LCT pegmatites, the formation of which was associated with the consolidation of anatectic granitic magmas during the exhumation of the Góry Sowie metamorphic complex. These processes took place at the stage of metamorphism under amphibolite facies, dated to 380-370 Ma. The mineralogical characterization focuses on the description of pegmatite zones with emphasis on phase recognition and description of the textual and chemical variability of minerals building individual pegmatite zones. Four zones have been distinguished within the body: (1) border/wall zone; (2) graphic zone; (3) blocky feldspar zone, and (4) albite zone. In the border and wall zones (1) major minerals are albite, orthoclase, quartz and biotite forming intergrowths with randomly dispersed crystals of accompanying minerals such as fluorapatite, muscovite, prehnite, monazite-(Ce), xenotime-(Y) and zircon. The graphic zone (2) is dominated by strongly altered albite and K-feldspar occurring as pure orthoclase as well as orthoclase perthite. Accompanying minerals in this zone are subhedral crystals of quartz, muscovite aggregates and irregular accumulations of fluorapatite crystals. The blocky-feldspar zone (3) consists mainly of two feldspars: albite (with almost extreme composition $Ab_{0.99}Or_{0.01}An_{<0.01}$) and orthoclase co-occurring with muscovite and chloritized biotite packages, crystals of black tourmaline and rare, scattered nodular aggregates of phosphate minerals. The albite zone (4) consists mainly of large Na-feldspar crystals coexisting with muscovite, quartz, schorl and phosphate minerals forming nodular accumulations. The mineralogical characterization of phosphate phases is the most important part of the doctoral dissertation due to rarity of these minerals and their importance in the genesis of the Lutomia granite pegmatite. Phosphate phases from the nodular accumulations are divided in three different genetic groups: (1) high-temperature magmatic phosphates; (2) metasomatic minerals of the high-temperature hydrothermal stage; (3) secondary minerals of low-temperature hydrothermal stage and hyperergenic weathering stage.

The minerals of the first group include graftonite-(Mn) evolving into graftonite-(Ca), sarcopside, triphylite, wolfeite-(I), monazite-(Ce) and xenotime-(Y). Metasomatic phosphates are a large genetic group including graftonite-(Ca)-beusite-(Ca) solid solution series, phosphates of the wolfeite-(II)-tryploidite series, minerals of the alluaudite, arrojadite and whitlockite groups, samuelsonite, kryzhanovskite-(I) and fluorapatite. Weathering and low-temperature hydrothermal minerals are represented by ferrisicklerite and heterosite, phosphoferrite, kryzhanovskite-(II), ludlamite, vivianite, minerals of the earlshannonite-whitmoreite series, strunzite, ferrostrunzite, beraunite, dufrénite, landesite, fairfieldite, and also zigrazite-malhmoodite-“Ca-analog of zigrasite” series. Among these phosphate minerals, more than 50 individual phases have been described, of which such as 'dickinsonite-(KNa)', 'dickinsonite-(BaMn)', 'jahnsite-(CaFeFe)', 'Fe-hedegaardite' and the calcium analogue of zigrazite have been described for the first time in nature and are potentially new minerals. In addition, minerals such as 'dickinsonite-(BaNa)', arrojadite- (BaNa), arrojadite-(BaFe) as well as zigrazite and malhmoodite are phosphate phases extremely rare found.

An important aspect of this work is the analysis of the chemical and textural variability of primary igneous phosphates indicating a trend of the geochemical fractionation in the Fe-Mn-Mg system during pegmatite consolidation. This is reflected both by the chemical compositions of mineral components from one pegmatite body as well as is visible in the geochemical maturity of various pegmatites that are part of an individual pegmatite-forming environment.

The doctoral dissertation also highlighted the chemical variability of (REE)-carrier minerals (monazite-(Ce) and xenotime-(Y)), which has implications in trends of geochemical fractionation of the light and heavy REEs, as well as uranium and thorium at various stages of solidification of a single pegmatitic body.