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THE EASTERN ERZGEBIRGE GRANITE PLUTON: FROM MANTLED FELDSPARS TO SNOWBALL QUARTZES

INTRODUCTION

In this study we discuss the textural results of ongoing petrogenetic and metallogenetic research that has the aim to characterize the late Variscan evolution of the Eastern Erzgebirge granite pluton as part of the Erzgebirge/Krusne hory granite batholith (situated across the border of Saxony and Bohemia). The study includes

- the postkinematic Namurian age Older Intrusive Complex (OIC) *granites of the Niederbobritzsch massif* ("Gebirgsgranite" of pre-caldera stage),
- the Westphalian age volcanic to subvolcanic rocks of the Altenberg-Teplice caldera s.s. (ATC, with *Teplice rhyolite*, *rapakivi-textured porphyritic microgranite of Altenberg-Frauenstein*), and
- the Stefanian age Younger Intrusive Complex (YIC) topaz-bearing rare metal granites ("Erzgebirgsgranite", post-caldera stage) that are represented by the *Schellerhau granite complex*.

Similarities shared among these rocks give proof of an at least partially common crystallization history before the melt pulses were intruded or erupted, respectively.

GEOLOGICAL SETTING

The Eastern Erzgebirge is the most eastern part of the Fichtelgebirge-Erzgebirge anticline where late- to post-orogenic Variscan uplift and exhumation processes were accompanied by intense felsic (rhyolitic and granitic) magmatism controlled by brittle fracture tectonics. The orogenic collapse of the Saxothuringian zone contributed in marginal and central parts of the Erzgebirge to the formation of volcano-tectonic intramontane depressions (Olbernhau and Schönfeld depressions) and strike-slip related pull-apart basins (Erzgebirge and Döhlen basins). Caldera complexes developed in the Altenblock block (ATC) and in the Tharandter Wald. The caldera formations are used as time markers because by field evidence from the ATC they are subsequent to the I-type biotite granites of the OIC but were intruded in result of the ATC collapse by highly evolved topaz-bearing granites of the YIC. The latter exhibit S-type characteristics with A-type tendency.

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PLAGIOCLASE-MANTLED K-FELDSPAR

Rapakivi-textured feldspars (Fig. 1) were found in the porphyritic feldspar-quartz *microgranite of Altenberg-Frauenstein* (GP I with fine-grained matrix), and in the porphyritic quartz-feldspar-hornblende microgranite (GP II with graphophyric matrix and mafic schlieren), but not in the mid- to coarse-grained microgranite (GP III with phenocryst-free miarolithic dykes). Beside the plagioclase-mantled K-feldspar the occurrence of dendritic plagioclase and resorpted quartz crystals mantled by microcrystalline mafic minerals indicates a textural adjustment of pre-existing crystals which are suddenly placed in an environment in which they are out of equilibrium. Nests of mafic minerals which are not in equilibrium with the silicic host are a textural pointer for magma mixing. For that reason we explain the formation of plagioclase-mantled K-feldspar by the fact that K-feldspar phenocrysts from felsic magma were introduced into mafic magma, causing local undercooling in the portion of magma surrounding the crystals resulting in the growth of a plagioclase mantle in a thermally and compositionally equilibrating system. The mixing-mingling stage first causes the resorption (rounding) of pre-mixing crystals, and second, the formation of new crystals due to equilibration. Some of these new crystals mantled the pre-mixing crystals. The formation of dendritic plagioclase phenocrysts can be explained as a result of rapid textural adjustment in the contact of silicic and mafic magmas causing a strong local undercooling. We interpret the intrusion sequence forming the ATC rocks as caused by non-continuous deflation of the magma chamber from the middle extending to the bottom and then to the top. The GP rock sequence shows some geochemical tendencies similar to the Niederbobritzsch OIC granites, and also few zircon ages from GP samples (possibly inherited from the OIC magma or protolith) hint for existence of a petrogenetic link prior to the suggested felsic-mafic magma mixing. These ages are in contrast to clear field evidence where the GP intrudes in fact the Teplice rhyolite (the latter dated as Westphalian).

SNOWBALL QUARTZ

Snowball-textured quartz phenoblasts (Fig. 2) were found in the highly evolved *Schellerhau granites*. They are magmatic-hydrothermal fluid saturation textures and are characterized by zonal arrangement of entrapped matrix minerals (albite, K-feldspar, mica) alternating with inclusion-free zones. Our case studies showed a crystallization sequence albite – K-feldspar – Li-mica – snowball quartz. If the growth velocity increased rapidly, beside silicate melt drops also predating and simultanously formed matrix minerals were overgrown and trapped in the quartz. Cathodoluminescence and growth zoning studies indicate a kinetically caused increase of the growth velocity with crystal size in a nearly non-convecting crystal mush. Wavy zones of snowball quartz are interpreted as products of small scale diffusion fronts which lead to changing CL properties developed during the crystal growth caused by rapid variation (like periodic degassing) of melt conditions.

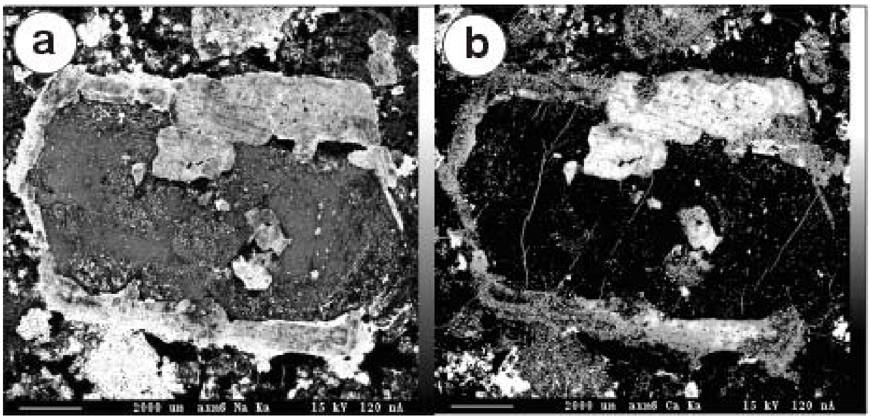

Fig. 1 Element maps of mantled K-feldspar for Na (a) and Ca (b) from the porphyritic microgranite of Altenberg. The Ca image shows the oligoclase mantle around K-feldspar, the Na image shows albitization starting at the rim and overprints older magmatic zoning.

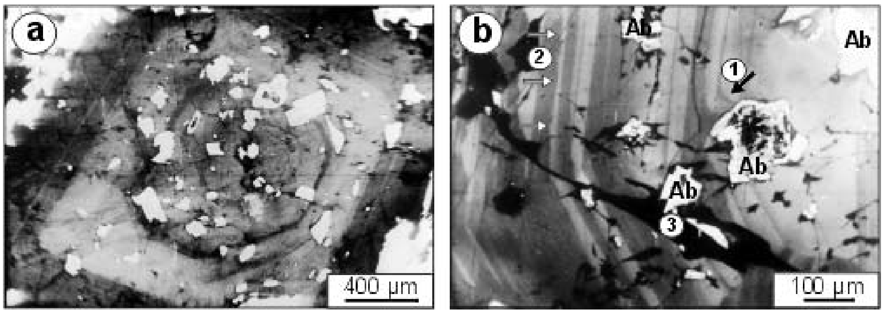

Fig. 2 SEM-CL images of snowball quartz of the Schellerhau SG3 alkali feldspar - topaz granite. a) Snowball quartz with a large number of albite inclusions (white); b) Detail of a snowball quartz showing growth impediments around albite (Ab) inclusions (1), wavy zoning (2), and stress-induced recrystallized quartz (black) around mineral inclusions (3).

CONCLUSIONS

Quartz CL and microanalytical studies of quartz and feldspar textures are based on crystal size, crystal habit, and growth texture correlation of phenocrysts. Mantled K-feldspars as magma chamber disequilibrium feature, and snowball quartz indicating fluid-saturation in periodically degassing shallow system are both extrema. Complimentary to geochemical and mineralogical evidence, the results support a model of the complex evolution and cooling history of granitic magmas in the study region. These were generated from variable protolith compositions, ascended and emplaced at changing p-T conditions during different stages of late-Variscan crustal decompression, were affected partially by some mafic-felsic magma interaction, and finally fractionation and fluid-rock interaction took place.

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