Application of cathodoluminescence (CL) and LA–ICP–MS to study quartz grains

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Quartz is a relatively stable mineral, commonly found in granitic rocks, and it typically contains elements that were incorporated upon primary growth in the melt. The LA–ICP–MS technique enables us to study such minor and trace elements present in the quartz lattice. In CL images we can observe internal textures, and a combination of the two techniques makes it possible to study how each element influences the CL characteristics.

The samples investigated in this study came from the Altenberg-Teplice Caldera (ATC). The late-Variscan ATC is situated in the Eastern Krušné Hory Mts. (Erzgebirge) on both sides of the Czech-German border. According to field relations, vertical sections trough deep boreholes and chemical composition, following intrusive-effusive phases can be distinguished within the caldera (Breiter et al., 2001; Müller et al., 2005; see also Breiter et al., 2012): basal rhyolite tuffs and ash flows (BR); dacitic tuffs and ignimbrites (DC); Teplice rhyolite tuffs and ignimbrites (TR1); air fallen Teplice rhyolite tuffs with lava clots (TR2); crystal-rich Teplice rhyolite ignimbrites (TR3); dykes of granite porphyry related to caldera collapse (GP); intrusion of post-caldera biotite granites (plutons of Schellerhau and Preiselberg, BiG); intrusion of post-caldera zinnwaldite granites (plutons of Krupka, Cínovec/Zinnwald, Altenberg, Sadisdorf, ZiG).

Geochemically, the older BR and DC-units are peraluminous S-type granitoids of calc-alkaline character. The younger units (TR, GP, BiG, ZiG) are only slightly peraluminous, high-K, P-poor, and Zr, Th, Y, and HREE-enriched granitoids of A-type (Breiter, 2012). The youngest zinnwaldite granite is highly fractionated, F, Li, Rb, Sn, W, Nb, Ta, and Sc-enriched granite hosting Sn-W mineralization.

Internal textures of quartz grains were studied using a HC 2 hot-cathode CL system, a CAMECA SX100 electron probe micro-analyser equipped with a panchromatic scanning system, a Tescan colour scanning luminescence system, and a Thermo-Finnigan Element 2 sector field ICP–MS coupled with 213 nm NdYAG laser (New Wave Research UP-213).

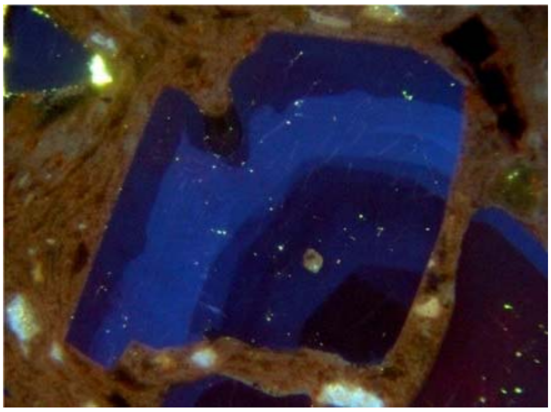

Fig. 1. *CL image (width 2 mm) of a fractured, zoned quartz grain from a rhyolite (TR3 unit) in the Altenberg-Teplice Caldera, showing pronounced internal zoning.*

Quartz grains from the ATC generally show intensive zoning (Fig. 1). Basal rhyolites are characterised by round and cracked quartz grains with darker, nearly violet luminescent cores and lighter blue rims. Scarce quartz grains in dacites are round and show homogenous blue luminescence. Quartz grains from all TR units are cracked and partly dissolved with dark cores and slightly brighter rims (Fig.1). As far as the colours and zonality concerned, the CL of quartz grains from the GP unit is widely similar to those from the TR units. Both rhyolitic and granitic porphyry quartz grains exhibit zonal textures. Core is rich in Al (200-350 ppp) and poor in Ti (5-30 ppm), while rim is depleted in Al (80–130 ppm) and enriched in Ti (40–100 ppm). The Ti content shows a positive correlation with the CL intensity.

Quartz grains from BiG and ZiG units are either nearly non-luminescent or show very weak, dark blue CL. No zonality has been observed. Quartz from the older biotite granite is similar to the cores of quartz from TR containing 100-150 ppm Al and 15-40 ppm Ti. Quartz from the younger zinnwaldite granite contains 150-300 ppm Al and max. 10 ppm Ti.

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