Imaging of spatial trace-element distribution in apatite using various X-ray based and spectral analytical methods

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Magmatic apatites formed in a composite granitoid pluton usually exhibit distinct zonation patterns caused by changes in trace-element composition, such as REEs and Y. Such compositional variations can be used to describe various petrological and geochemical processes, e.g. mixing of magmas of different composition. Apatites from Karkonosze Massif of Poland were studied using various X-ray-based and spectral analytical methods: FE-EPMA – Field Emission Electron Microprobe (including BSE images), PIXE/PIGE – Particle Induced X-ray/Gamma Emission and CL – Cathodoluminescence. Each method was employed to visualize (mappings) and quantify (spot analyses, line profiles) trace-element distribution patterns in single apatite grains. Slightly different suites of trace elements possessing various detection limits were analyzed with each method, with the largest number of elements measured by EPMA and the lowest detection limits achieved by PIXE. PIGE was proved to be most sensitive for analyzing light elements, such as F and Cl. Cathodoluminescence turned out to be the method best suited for visualizing zonation patterns with subtle, very thin zones not seen either on BSE images or X-ray maps. Because each method has advantages and limitations, their combined application is required to best visualize trace-element variations in apatite, which then can be used for modelling magma- differentiation processes.

Evolution of rhyolite magmas in the Halle Volcanic Complex – A record from Hf and O isotope and Hf concentrations in zircon

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The Halle Volcanic Complex (HVC) is located in the northeastern Saale Basin in NE Germany. The region is underlain by the Mid – German Crystalline Zone. The HVC is dominated by rhyolitic rocks (c. 200 km^3), which were mainly emplaced as large laccoliths. The U/Pb age of zircons ranges from 289 to 301 Ma, inherited zircons are scarce [1].

We have chosen four localities within the HVC for detailed isotopic and chemical analyses of magmatic zircon: Spitzberg, Wettin, 1044 and 1390 [1]. εHf, $\delta^{18}O$ and elemental concentrations of Zr, Hf have been measured in previously dated zircons from these localities. On the basis of Hf content we divided zircon in two groups: zoned grains with low Hf core (8 - 9000 ppm) and high Hf rim (10 - 12000 ppm) and unzoned grains with constant low Hf concentration through grains (6 - 9000 ppm). High Hf rims occur also as magmatic overgrowths on inherited cores. Most of high Hf zircon fragments are also characterized by higher εHf compared to low Hf zircon. The diversity in $\delta^{18}O$ (6.3 - 8.1 ‰) does not correlate with Hf concentration and εHf.

Generally, the isotope and chemical characteristic of zircon grains is similar between localities and suggest an input of higher εHf magma towards the late stage of magma evolution, probably shortly prior to the final emplacement. Lack of correlation between εHf and $\delta^{18}O$ implies that at least three sources contributed material [2] to the ca. 300 Ma magmatism contrary to the simple two source contribution observed for the NE German Basin [3].

[1] Breitkreuz *et al.* (2009), Z. Dt. Ges. Geowiss. 160:173-190. [2] Romer *et al.* (2001), CMP, 141:201-221. [3] Pietranik *et al.* (2013), J. Petrol – in press

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