Tracing element enrichment processes using fluid and melt inclusions and μ-fluorescence spectroscopy

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Natural melt and fluid inclusions may conserve the composition of melts and fluids present during mineral formation and thus may allow to study element enrichment processes in the upper crust. In the last two decades, synchrotron radiation (SR) has become an essential tool for studying fluid and melt inclusions using X-ray spectroscopic techniques. In this contribution, applications of micro-fluorescence spectroscopy are presented to study element enrichment processes in magmatic systems.

One application of μ-fluorescence spectroscopy is single inclusion trace element analysis. Depending on the matrix of the inclusion and excitation conditions, elements with Z between 19 and 92 may be detected in parallel and detection limits in the ppm range may be reached [1]. By analysing a sequence of fluid and/or melt inclusions, trace element enrichment processes may be directly observed. Due to the non-destructiveness of the photon beam and the achievable small focus, elemental maps may be achieved of fluid and melt inclusions and elemental distribution between vapour, liquid and daughter crystals can be detected. This enables daughter crystals to be identified and thus allows to conclude on elemental complexes during fluid transport processes. μ-fluorescence X-ray absorption spectroscopy can be used to determine the chemical speciation of high Z (> 29) trace elements in fluid inclusions at *in situ* conditions up to 700 °C [e.g. 2]. Three-dimensional information on elemental distribution in an inclusion may either be retrieved by confocal μ-fluorescence analysis by analysing 10 μm thick layers of the sample or - at a better spatial resolution of a few μm - by helical fluorescence tomography [4].

Current developments in SR μ-fluorescence spectroscopy include a reduction of spot sizes below 1 μm and an improvement of detection limits by application of wavelength dispersive fluorescence analysis.

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S-type granites and crustal growth? Low $\delta^{18}O$ source components revealed in Scottish Caledonian S-type granites

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The complex compositional nature of I-type granites, which can be derived through mixing of mantle, infra- and/or supracrustal sources, results in a continuing debate over the relationship between granitic magmatism and crustal growth. In order to characterize the nature and proportion of the supracrustal end-member source that may have contributed to the Scottish late Caledonian (~430-400 Ma) I-type granites, this preliminary study investigates three Caledonian (~460 Ma) S-type granites from northeast Scotland by integrated O, U-Pb and Hf isotope analyses of magmatic and premagmatic inherited zircon.

On the basis of field, whole-rock geochemical and isotopic data the Kemnay, Cove and Nigg Bay granites experienced a simple petrogenetic evolution and were generated by melting their Dalradian Supergroup metasedimentary country rocks. For the Kemnay and Cove granites this hypothesis is further supported by crustal Hf and oxygen isotope signatures in magmatic zircon, and good agreement between U-Pb age data of inherited zircon and those determined in a detrital zircon study of the Dalradian Supergroup. In contrast, magmatic zircons of the Nigg Bay Granite show much lower oxygen isotope values, similar to those observed in I-type granites. Hence, the Nigg Bay Granite can be interpreted to contain different sources, despite whole-rock and zircon geochemical and isotopic data suggesting the same source material for all three S-type granites. Further work is required to determine the nature of the low-$\delta^{18}O$ material, but it most likely represents a hydrothermally altered supracrustal or infracrustal source. Nevertheless, this study clearly demonstrates the necessity of integrating zircon oxygen and Hf isotopes with whole-rock data to reveal the complex nature of I-type as well as S-type granites.