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Efficient search for accessory phases and chemical characterisation of major rock forming minerals for petrologic applications by combining Electron Probe Microanalysis and SEM automated mineralogy

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Many applications in modern petrology require the assignment of qualitative and quantitative mineral chemical data to the textural position in thin section samples. We present a novel approach that combines scanning electron microscope (SEM)-based automated mineralogy and electron probe microanalysis (EPMA). As a case study, both methods are combined in order to constrain the pressure-temperature-time (P-T-t) paths of micaschists and gneisses in the Saxothuringian Zone of the Variscan fold belt in Germany.

After selection of samples, polished thin sections are prepared. In a first step SEM-based automated mineralogy (Mineral Liberation Analyser, MLA) is used in the grain X-ray mapping (GXMAP) mode which records a back scattered electron (BSE) image of the sample to identify areas with a homogeneous BSE grey level, followed by the analysis of these areas with an energy dispersive x-ray (EDX) spectrometer to determine the spatial distribution of rock forming minerals, in this specific case garnet. Careful classification of the EDX spectra allows the identification of garnets with different zonation patterns within a sample [1]. The quantitative chemical composition of garnet is then determined by EPMA.

The U-Th-Pb age of monazite is determined by EPMA in order to assess the temporal evolution of the studied samples. The identification of monazite in typical metamorphic rocks by light microscopy is a cumbersome and time-consuming procedure. Due to the typically small grain size of monazite, the search by optical microscopy bears in addition the risk to systematically overlook small grains or monazites in specific textural positions. Therefore, MLA is used to identify and locate monazite grains in the sample and to assess their textural position. The coordinates of the monazites are then transferred to the EPMA using a pointlogging system [2]. The U-Th-Pb ages along with the chemical composition of 50-100 monazites per sample are then determined with EPMA.

Combining SEM-Based automated mineralogy with EPMA provides a robust and accurate procedure for localization, identification and quantitative chemical analysis of accessory and rock-forming minerals with many potential applications on petrological problems. Furthermore chemical information can be linked to textural and structural data. In addition precious measurement time on the EPMA can be saved.

References:

[1] Schulz B et al. (2014) German J Geosci 85: 614

[2] Osbahr I et al. (2015) Microsc Microanal 21(5): 1080-1095