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Trace-element variation in metamorphic apatite

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Apatite is a common accessory mineral in igneous, sedimentary and metamorphic rocks. It can host a variety of trace elements in its crystal structure and provide reliable U-Pb and low-temperature thermochronological age information, while its trace-element partition coefficients are sensitive to changes in magma composition. Apatite also has strong potential as a provenance tool in sedimentary studies. However, the trace-element variations encountered in metamorphic apatite are still poorly understood. Apatite is commonly found in metamorphic rocks of different compositions (pelitic, carbonate, basaltic and ultramafic protoliths) and from different grades from transitional diagenetic environments to the granulite- and eclogite-facies.

For this study, apatite grains of 23 metamorphic samples of different grades (greenschist facies to granulite facies) and different protoliths (pelites and metabasites) were analysed by LA-ICP-MS for trace (e.g. Mn, Y, Sr, As, Pb, Th, U) and rare-earth elements contents. The data are plotted on chondrite-normalized element plots, whole-rock normalized element plots and on discriminant element diagrams. The data are also compared with magmatic apatite trace element data from the literature, and show that some trace elements in metamorphic apatite (Th, LREE) are significantly depleted compared to magmatic apatite. These data also demonstrate that apatite trace element composition is an effective tool in provenance studies as apatite composition can be used to distinguish between metamorphic and magmatic sources.

Distinguishing between apatites from the two different metamorphic protoliths is more challenging. The variable REE contents in several of the metamorphic samples (attributed to competing growth of monazite in pelites and epidote/allanite in metabasites) means the REE in metamorphic apatite are not always suitable for discriminating between pelitic *versus* metabasite protoliths.

The most diagnostic discriminant diagram for distinguishing between different metamorphic protoliths is a graph of U vs As. U seems to be less affected by competing growth of monazite or epidote/allanite, while As can be incorporated into apatite as replacement of P^{5+} by As^{5+}, as silicate minerals can only incorporate minor amounts of As^{3+} into their crystal structure. The U and As budget of apatite more likely reflect the bulk whole-rock composition, and both elements are significantly enriched in pelites/shales. Principal component analysis will be undertaken on the trace element dataset to further discriminate between apatite from different protoliths (e.g. pelites *versus* metabasites).