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Texture, chemistry and age of monazite and allanite in the northern Central Alps

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The Central Alps is one of the best-known orogens, presenting a well established metamorphic transect between the Helvetic Prealps and the northern Lepontine dome. With conditions documented from diagenetic to lower amphibolite facies, it offers an incomparable opportunity to study the evolution of the texture, chemistry and phase relationship of accessory minerals in such a Barrovian field gradient. Here, we report on the distribution of Rare Earth Elements (REE) and the significance of U-Th-Pb ages in metapelites from the North Central Alps. Our strategy is to characterize the REE-minerals texturally and chemically, document their assemblages, and deduce mineral reactions along the metamorphic field gradient. The most promising REE-minerals are then dated with SHRIMP and LA-ICPMS.

The sequence of REE minerals reveals a series of reactions among silicates and phosphates. At diagenetic grade, roundish detrital monazite (Variscan based on chemical U-Th-Pb dating) contain the LREE; at lowest metamorphic grade, minor Alpine monazite formed in metasediments. Upon the appearance of chloritoid (T$\sim$400°C), monazite vanished, and LREE were taken up in allanite. Previously to garnet growth, allanite acquired two successive rims: the first one rich in HREE, the second containing almost no REE. Following garnet growth at the "chloritoid-out" zone boundary (T$\sim$570°C), allanite and its rims were partially replaced by monazite and xenotime, both associated with plagioclase, biotite and/or staurolite. In these samples, the presence of epidote relics, which preserve their characteristic chemical and textural zoning, indicates that they did not experience reequilibration following their prograde formation. Hence the partial in-situ breakdown of allanite to monazite offers the unique possibility to obtain ages representative of two distinct crystallization stages. SHRIMP

Th-Pb and U-Pb dating on allanite and monazite yields ages of 31.5±1.3 Ma and 18.0±0.1 Ma, respectively. Considering that the difference of 13.5 Ma between the two ages represents the time elapsed between 400˚C and 570˚C, an average heating rate of 12-13˚C/Ma is proposed for the regional Barrovian metamorphism in the northern Lepontine Alps. Given the tectonic complexity of the area, the interpretation of this low heating rate remains to be investigated.