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Monazite chemical age and composition correlations, an insight in the Palaeozoic evolution of the Leaota Massif, South Carpathians

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Notwithstanding remarkable advantages of monazite microprobe U-Th-PbT geochronology of metamorphic formations, such as the direct investigation of a metamorphic mineral in a truly in situ setting, unequalled spatial resolution, and cost-effective analyses, it essentially remains affected by indeterminations as regards the accuracy and the representativity of the results. Besides the experimental hurdles related to trace element analyses with the microprobe (sensitivity, background and overlap effects) the method faces two main biases, firstly its inherently blind status emerging from the aprioric assumption of isotopic equilibrium, and secondly the marked susceptibility of monazite to fluid-stimulated chemical recrystallization and compositional resetting (e. g. Kelly et al. 2012).
Age spectra obtained from individual sampled habitually display a significant scatter of calculated age data, in such a way that the separation of coherent and geologically relevant populations may often represent a substantial challenge. The interpretation of the results greatly benefits from the qualitative analysis of the textural and paragenetic setting or a trial-and error quantitative statistical assessment of distinct age clusters (Montel et al., 1996), though still maintaining a variable degree of subjectivity, as in any interpretative process not fully sustained by quantitative analysis.
Additional dependable support can be gained from further qualitative parameters characterizing, besides the distribution of individual age data, also the global chemical composition of the analysed monazite grains, as well as the relationship to the corresponding metamorphic assemblages (Săbău & Negulescu, 2013). The quantitative assessment of the age patterns of individual samples can be achieved by plotting the normalized age gradient from the sorted age pattern, allowing distinction of quasi-gaussian distribution domains likely to correspond to coherent age clusters of geologic significance. On the other hand, the chemical variability of the monazite grains enables separation of discrete populations, which cluster in ternary chemical plots (LREE – Y+Nd+MREE – U+Th+Ca, LREE – Nd+MREE – Y) and display similar chondrite-normalized lanthanide patterns, quantitatively evaluated by ratios such as (La/Nd)CN, (Nd/Gd)CN, (Gd/Y)CN, (U/Th)CN, (Y/Y*)CN, and (Eu/Eu*)CN. The correspondence between age and chemical clusters endorses their geological relevance and make a case for geunuine tectonothermal events.
Distinct compositional domains corresponding to well-defined age clusters have been identified in gneissic rocks of the Leaota Massif, South Carpathians, highlighting the lower Paleozoic evolution of a crustal fragment detached during the Cambrian from northern Gondwana. Relict ages of Panafrican affinity of around 530 Ma are heavily overprinted by Lower Ordovician crustal thickening followed by tectonic relaxation coeval with granitization (around 470 Ma), followed in turn by high-pressure metamorphism at the Ordovician-Silurian boundary (Negulescu et al., 2015) and final tectonic stacking associated to Variscan docking to Laurussia + Avalonia, reflected in a high-pressure overprint at 350-325 Ma.

References

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