Combining Atom Probe Tomography and Transmission Electron Microscopy in monazite reveals grain-scale-closed systems reset at nano-scale: toward nano-geochronology.

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Combined Atom Probe Tomography (APT) and Transmission Electron Microscope (TEM) nano-characterizations of monazite crystals from a ~1 Ga, ultrahigh temperature granulite from Rogaland, Norway (Laurent et al., 2016; Seydoux-Guillaume et al., 2018) reveal phase separation led to the isolation of two different Pb* reservoirs at the nanoscale. The S-rich core of these monazite crystals contains Ca-S-rich clusters, 5-10 nm in size, homogenously distributed within the monazite matrix with a mean inter-particle distance of 40-60 nm. The clusters acted as a sink for radiogenic Pb (Pb*) produced in the monazite matrix, which was reset at the nanoscale via Pb diffusion while the grain remained closed at the micro-scale. Compared to the concordant ages given by conventional micro-scale dating of the grain, the apparent nano-scale age of the monazite matrix in between clusters is about 100 Myr younger, which compares remarkably well to the duration of the metamorphic event. This study highlights the capabilities of combined APT-TEM nano-structural and nano-isotopic characterizations in dating and timing of geological events, allowing the detection of processes unaffordable with conventional dating methods.

References:

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