Th–U distribution in the crust: outcrop and grain scale approaches

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Monazite is one of the most widely used geochronometers for high temperature processes. Additionally, monazite is a major host of Thorium (Th) and Uranium (U) in Earth's crust. Monazite composition may change across metamorphic grades and rock types according to Pressure–Temperature, rock composition (*P*–*T*–*X*) and coexisting assemblage. Together with melt production and migration, these factors largely control the transport and distribution of Th in Earth's crust. Despite the vital importance of age data from monazite for understanding the rates and timing of tectonic processes, there has been only limited effort to systematically understand the growth behaviour and compositional changes of monazite and associated REE–Th–U minerals as a function of *P*–*T*–*X* in compositionally homogeneous suites of natural rocks. That is the focus of this study.

We present new data from two compositionally homogenous suites of progressively metamorphosed metasediments, Mount Stafford, central Australia and the Ivrea–Verbano Zone, Italy. We integrate in-field gamma ray spectrometry data on bulk Th–U and compare it to monazite compositional data to explore Th and U behaviour. Typically, GRS data show that Th concentration increases in rocks that underwent partial melting with respect to their lower grade counterparts, resulting in increased heat production at higher grade. Conversely, monazite grown at granulite facies conditions is typically lower in Th than that growing at the amphibolite facies, but much of the monazite in granulite facies rocks may be residual from growth along the prograde path. We argue that a mineral scale approach to understanding Th behaviour must be complemented by bulk field geochemistry in order to understand changes to heat production as a consequence of melting processes.