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U-Th-Pb isotope behaviour in zircon, monazite, apatite, allanite, xenotime, titanite and rutile: deciphering high-temperature poly-metamorphism by *in situ* LA-SF-ICP-MS dating of accessory minerals

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In-situ U-Pb geochronology is a powerful tool to link mineral textural information with age data. Recent advances in LA-ICP-MS dating techniques are allowing for the affordable and routine dating of metamorphically useful accessory phases at high spatial resolution. In this study we performed systematic, *in situ* U-Pb dating of metamorphic zircon, monazite, apatite, allanite, xenotime, titanite and rutile from poly-metamorphosed, metasedimentary granulites of the Archaean Ancient Gneiss Complex (AGC) in Swaziland.

All minerals record variable, complex and protracted histories of growth/re-crystallisation in response to (at least) four distinct thermal episodes, i.e. at 3.43–3.40, 3.24–3.18, 3.15–3.03 and 2.73 Ga. The combined data demonstrate protracted, episodic heating (with little cooling) of the AGC crust during the Paleoarchean to Neoarchaean. Zircon and monazite inclusions in peritectic garnet date the thermal peak of the terrane, between 3.15 and 3.03 Ga. This is interpreted to represent the dominant 830–875 °C, ≥ 6.5–7.6 kbar granulite facies partial melting event. However, relic crystals/domains in zircon, monazite, and large allanite grains clearly survived anatexis. Matrix apatite, xenotime and allanite associated with garnet and monazite breakdown, indicate an amphibolite-facies re-hydration event at 2.8– 2.7 Ga.

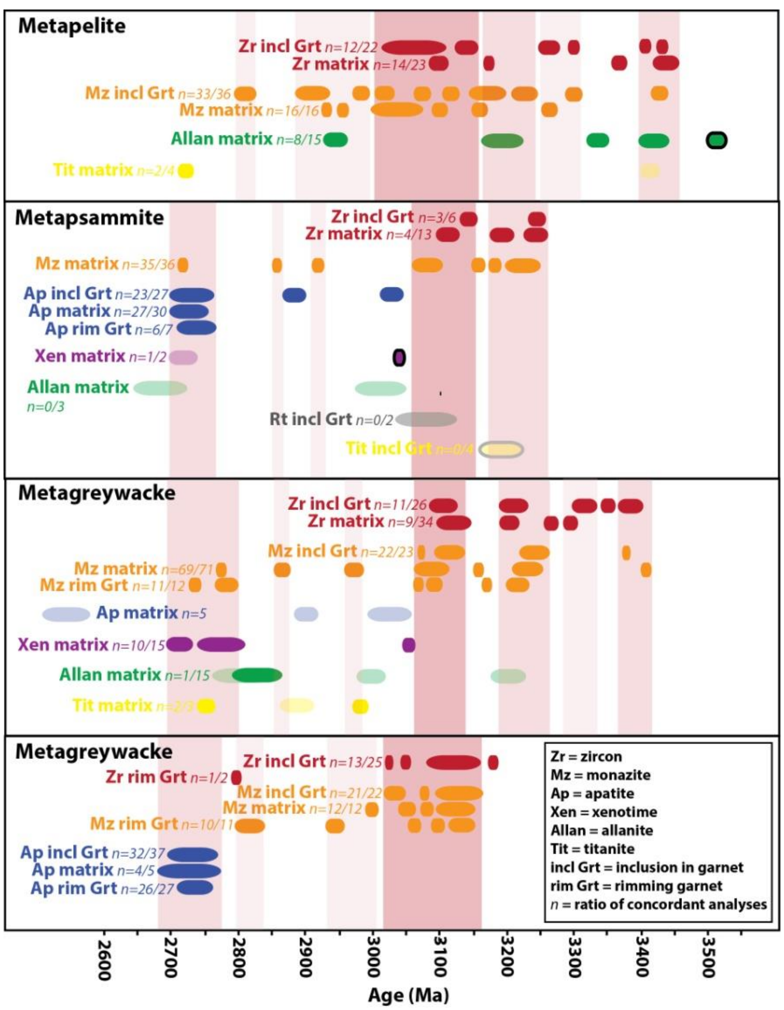

Figure 1: Summery of in situ U-Pb data from four metasedimentary granulite samples

Significantly, all apatite inclusions in garnet record identical ages of 2.73 Ga, similar to apatite in the matrix. This suggests complete re-setting of the U-Th-Pb isotope system in apatite during the most recent amphibolite-facies overprint; even those ‘armoured’ as inclusions in the cores of 3.15–3.03 Ga peritectic garnet.

The results of this study have bearing on: (1) the pitfalls of interpreting U-Pb age data from inclusion suites in garnet; and (2) the complex behaviour of accessory phases (e.g. monazite, allanite and apatite) during granulite-facies metamorphism, and its potential for surviving partial melting.