# Archean extreme metamorphism

CHRIS CLARK[1]*, RICHARD J.M. TAYLOR[2], ANDREW KYLANDER-CLARK[3], BRADLEY R. HACKER[3]

[1]School of Earth & Planetary Sciecnes, Curtin University
[2]Department of Earth Sciences, University of Cambridge
[3]Earth Science, University of California, Santa Barbara
*Correspondence: c.clark@curtin.edu.au

The end of the Archean represents a period of significant transition in the history of the Earth. A modern Earth-like plate tectonic regime had recently been established, land surfaces were beginnning to emerge from the oceans and the first collsions between supercratons were occuring. In this context one of Earth's largest exposures of crustal ultrahigh temperature (UHT) metamorphism, the Napier Complex in east Antarctica, was formed. The Napier Complex preserves a record of sustained (>130 Myr) high-thermal gradients (>35°C/km; crustal temperatures of >1,100°C) followed by exhumation and protracted, near isobaric cooling over a spatial extent of >90,000 km$^2$. The period of crustal thickening, exhumation and isobaric cooling recorded in these rocks is an extreme end-member of endogenic crustal metamorphism and its development has been proposed to be related to the development of one of Earth's earliest orogenic plateaus.

To test the idea that the extreme thermal conditions are the result of orogenic plateau formation at the end of the Archean a range of geochemical, geochronological and petrological data have been collected to constrain; (1) crustal evolution (U–Pb, Lu–Hf, O isotopes in zircon); (2) thermal evolution (4$^+$ cation thermometry of zircon, rutile and quartz); (3) durations (U–Pb +REE in zircon, rutile and monazite) and integrated with forward modeling of metamorphic assemblages (*P–T* pseudosections) from ~20 locations across the Napier Complex.

The constraints from this dataset have been used to develop numerical models that also incorporate Archean thermal regimes associated with higher rates of radiogenic heat production and mantle temperatures. Using these inputs the models are able to replicate the metamorphic conditions and durations across the Napier Complex. However, the modelling also predicts Moho temperatures approaching 1,200°C. The elevated thermal graidents and resulting temperatures will have a significant impact on the rheological profile of the Archean crust, its ability to support an orogenic plateau and it's subsequent evolution. Integration of all available data with models allows a refined view of how one of Earths earliest orogenic plateaus may have formed and decayed.