AN INSIGHT INTO THE LOW-TEMPERATURE THERMAL EVOLUTION OF THE COVERED EASTERN GAWLER CRATON MARGIN: THE STUART SHELF BASEMENT

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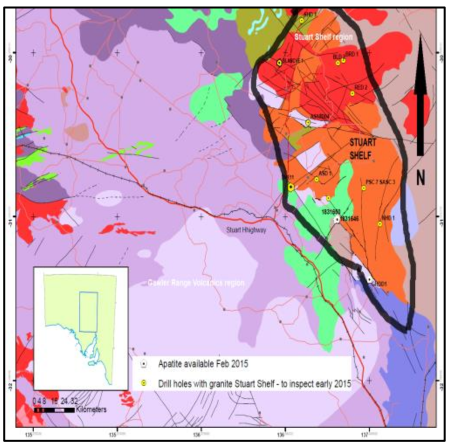
No previous AFT study on the Eastern Gawler Craton covered by the Stuart Shelf.. Previous work in surrounding areas suggests exhumation events to have occurred as a result of the Delamerian and Alice Springs Orogenies . Were the Delamerian and Alice Springs Orogenies the main exhumation mechanisms in the Eastern Gawler Craton?

The Stuart Shelf is defined by 1420 Ma Pandurra formation, overlain by a platform of undeformed Neoproterozoic to lower Cambrian sedimentary sequence of Adelaide Rift System equivalents (840-560Ma) that overly and define the EGC boundary. The basement is dominated by 1950–1850 Ma Hutchison Group, ~1850 Ma Donington Suite, 1595-1575 Ma Hiltaba Suite intruvsives, and Gawler Range Volanics ~1500Ma.

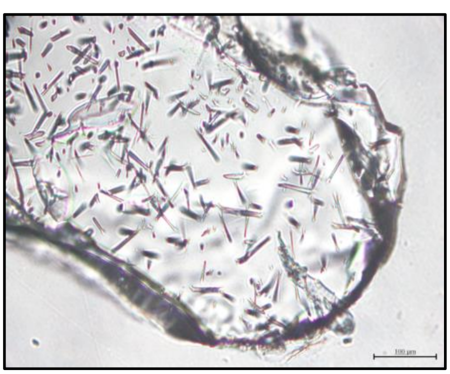
The two major tectonic events within the region are the ~1850 Ma Kimban and ~500 Ma Delamerian Orogenies

Fourteen samples were obtained from drill cores following a NS transect, taken from the granitic basement of the eastern Gawler Craton below the Pandurra unconformity underneath the Stuart Shelf platform. The majority of the northern samples are located around Olympic Dam and the southern most of the samples were taken near Carrapateena and Punt Hill.



Primarily Apatite Fission Track dating (60-120 °C). Additional Apatite Helium (45-75 °C) and Zircon Helium (~170-200 °C) analysis.

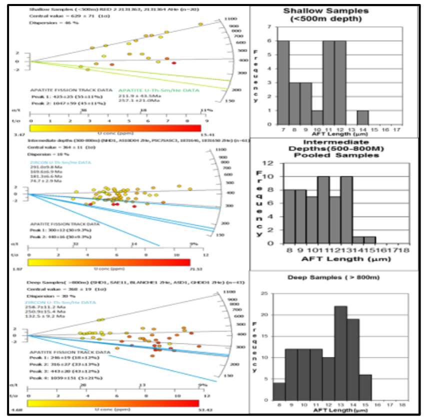
Apatite Fission Track Thermochronology is based on the spontaneous fission decay of ^{238}U which produces fission tracks in the crystal lattice. Fission track age is derived from the number of spontaneous fission tracks and associated ^{238}U conc^n. this represents timing of cooling through the PAZ. The rate of cooling through the PAZ is given by the amount of fission track shortening measured by confined fission track length distribution. From this we can infer the low temperature thermal evolution of an area.



Apatite and zircon U-Th-Sm/He thermochronology

Based on the temperature dependant diffusivity of radiogenic ^{4}He through the crystal lattice. It records the timing of cooling through lower temperatures (~45-75°C) for apatite and higher temperatures (~180-200°C) for zircon.

AFT results based on depth



Differences observed at different sample depths..

Shallow samples record a clear Mesoproterozoic event and a Silurian peak..AHe shows two Triassic peaks. As multiple thermochrons missing for peaks more data is needed. .Large scatter in AHe may be due to partial He loss thus is poorly constrained.

Intermediate samples show 2 AFT peaks. A Silurian-Devonian and carboniferous-Permian event. Oldest ZHe peak confirms C-P event while 3 youngest may be episodes of partial He loss.

Deep samples 3 well defined AFT peaks

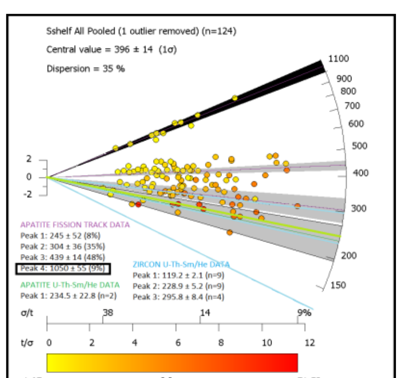
Late Silurian-early Devonian, late Carboniferous-early Permian and late Permian- early Triassic peaks. Mesoproterozoic peak similar to shallow samples is constrained from 2 grains. Two zircon (U-Th-Sm)/ He peaks confirm the Permian-Triassic peak, with a third likely affected by partial He loss.

Modelled data from Apatite Fission Track (AFT) analysis identifies four time periods where the eastern Gawler Craton basement experienced cooling into AFT closure temperatures (~60-120°C):

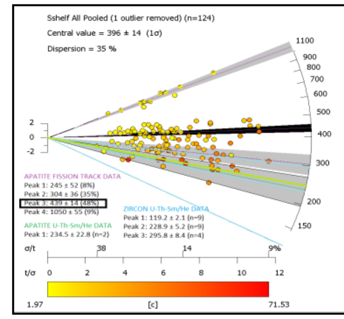
- 1050 ± 55 Ma (Mesoproterozoic)
- 439 ± 14 Ma (late Ordovician-Silurian)
- 304 ±36 Ma (Carboniferous- Permian)
- 245 ± 52 Ma (Triassic)

In addition, the Carboniferous and Triassic peaks are supported by zircon (ZHe) and apatite (AHe) (U-Th-Sm)/ He results.

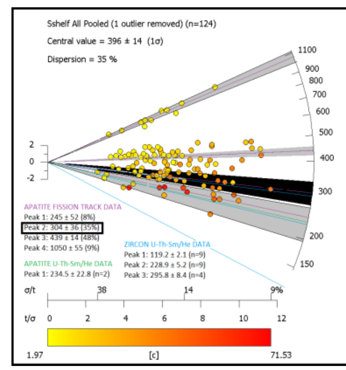
- 1050 ± 55 Ma (Mesoproterozoic)
- The preserved Mesoproterozoic event presents new AFT data in the area and coincides with some recent studies. However, it occurs only in samples obtained from the Gawler Range Volcanics and more prominent in core depth shallower than 500m (RED 2). But one
- likely related to the final pulses of the Musgravian Orogeny (~1230 – 1150 Ma; Wade *et al.,* 2008)
- Keeling et al (2007) gives an age of~1100 Ma for hydrothermal alteration of dicktite to illite in the base of the Pandurra Formation. This alteration requires localised fluid flow at temperatures > 150 °C, above the apatite PAZ.



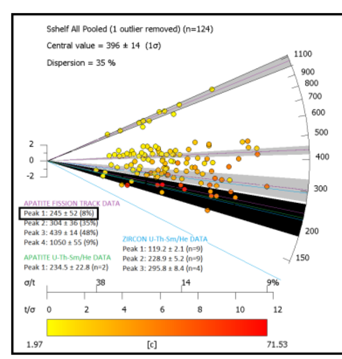
- 439 ± 14 Ma (late Ordovician-Silurian)
- The large spread of single grain ages (~500 - 400 Ma) associated with this peak indicates mixing between the Delamerian Orogeny (514 – 490 Ma; Foden *et al.,* 2006), represented by the oldest AFT ages (480 Ma) with partial resetting of AFT ages by the first pulse of the Alice Springs Orogeny (ASO).
- This pulse has been reported in surrounding areas.



304 ±36 Ma (Carboniferous- Permian)..There are no other thermochronological constraints in the Stuart Shelf supporting a thermal event in the Carboniferous however, several AFT studies in surrounding areas such as the Gawler Craton (Gleadow *et al.,* 2002, Boone *et al.,* 2013, Reddy Hons Thesis 2014); the Adelaide Fold Belt (Gibson and Stüwe *et al.,* 2000) and the Flinders Ranges (Weisheit *et al.,* 2014) also show evidence of Carboniferous exhumation linked to widespread crustal thickening throughout South Australia resulting from final stages of the ASO (Ballèvre *et al.,* 2000)



245 ± 52 Ma (Triassic). A Triassic (246 ± 19 Ma) AFT age is preserved in samples from depths greater than 800m only. However shallow samples preserve a similar AHe age (234.5 ± 22.8 Ma) and similar ZHe ages (~240 Ma) are preserved in intermediate and deep samples. Weisheit et al (2014) accounts for an event of localised Triassic-Jurassic hydrothermal resetting in the flinders ranges. This study shows that this event may be more regional than previously thought.



Conclusions

Four cooling episodes during the Mesoproterozoic, Ordovician , late Carboniferous–Permian and Triassic. The mesoproterozoic event is an outlier being confined to one sample location but is clearly defined, and more research around this sample location may to constrain its boundaries. No AFT events were constrained to the Cretaceous making the EGC different from studies in the surrounding areas, however Most of the thermal history of the eastern Gawler Craton matches that observed in regions surrounding the Start Shelf, South Australia.

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