Exhumation of the Peake and Denison Ranges; Insights from low-temperature thermochronlogy

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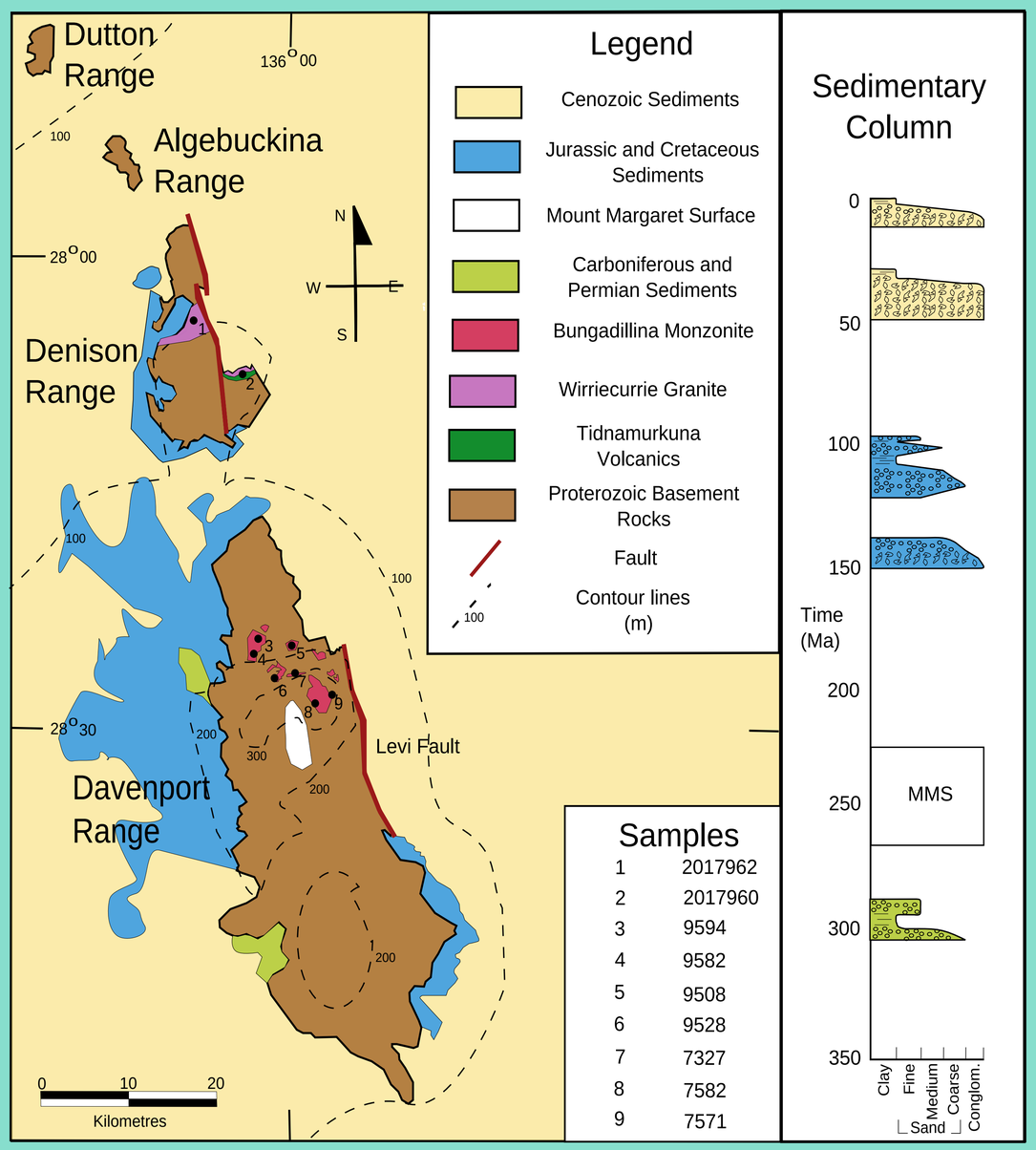

Figure 1, Simplified geological map and stratigraphic column of thePeake and Denison Ranges, indicating the relationship between and ages of different geological units, the location of major faults, topographic contour lines and sample localities. Map modified after Hopper (2001).

Figure 2, Radial plots of AFT ages from study region, n indicates number of grains measured, Central Value indicates the central age of the sample and the colour difference indicates the different D_{Par} (etch pit) lengths for each grain. Where more than one population of ages is present, the central age is split into peaks (indicated by gray bars). To the right of each radial plot is the accomanying AFT length frequency histogram for each sample. On each histogram, AFT legnth is in µm, n indicates the number of tracks measured, l_m is average track length and σ is the Standard deviation of the sample. Radial plots were constructed using *Radial Plotter* (Vermeesch 2009).

Introduction and Methodology

The Peake and Denison Ranges are located in the north eastern region of the Gawler Craton. They are dominated by proterozoic sedimentary and metamorphic rocks with abundant Palaeoproterozoic to Ordovician igneous intrusive and extrusive rocks (Ambrose et al. 1981). There are three significant igneous bodies in the Ranges: The Tidnamurkuna Volcanics, the Wirriecurrie Granite and the Bungadillina Monzonite (Hopper 2001).

To date, no comprehensive low-temperature thermochronological study has been conducted to determine the timing of exhumation to shallow crustal levels. However, previous work suggests the exhumation may have taken place during the Permian, Cretaceous or Miocene and Pliestocene (Wopfner 1968; Radke 1973; Twidale 1994; Kohn et al. 2002; MacDonald et al. 2013).

Granitoid rocks samples were collected from the igneous outcrops at the Peake and Denison Ranges (Fig. 1) by Morrison (1989) and by researchers of the Geological Survey of South Australia (Fanning et al. 2007). Apatite Fission Track (AFT), Apatite Helium (AHe) and Zircon Helium (ZHe) methods were conducted on the samples to constrain periods and rates of cooling within the region. Afterwhich, the data was modelled to recreate the entire low-temperature thermal history of the region.

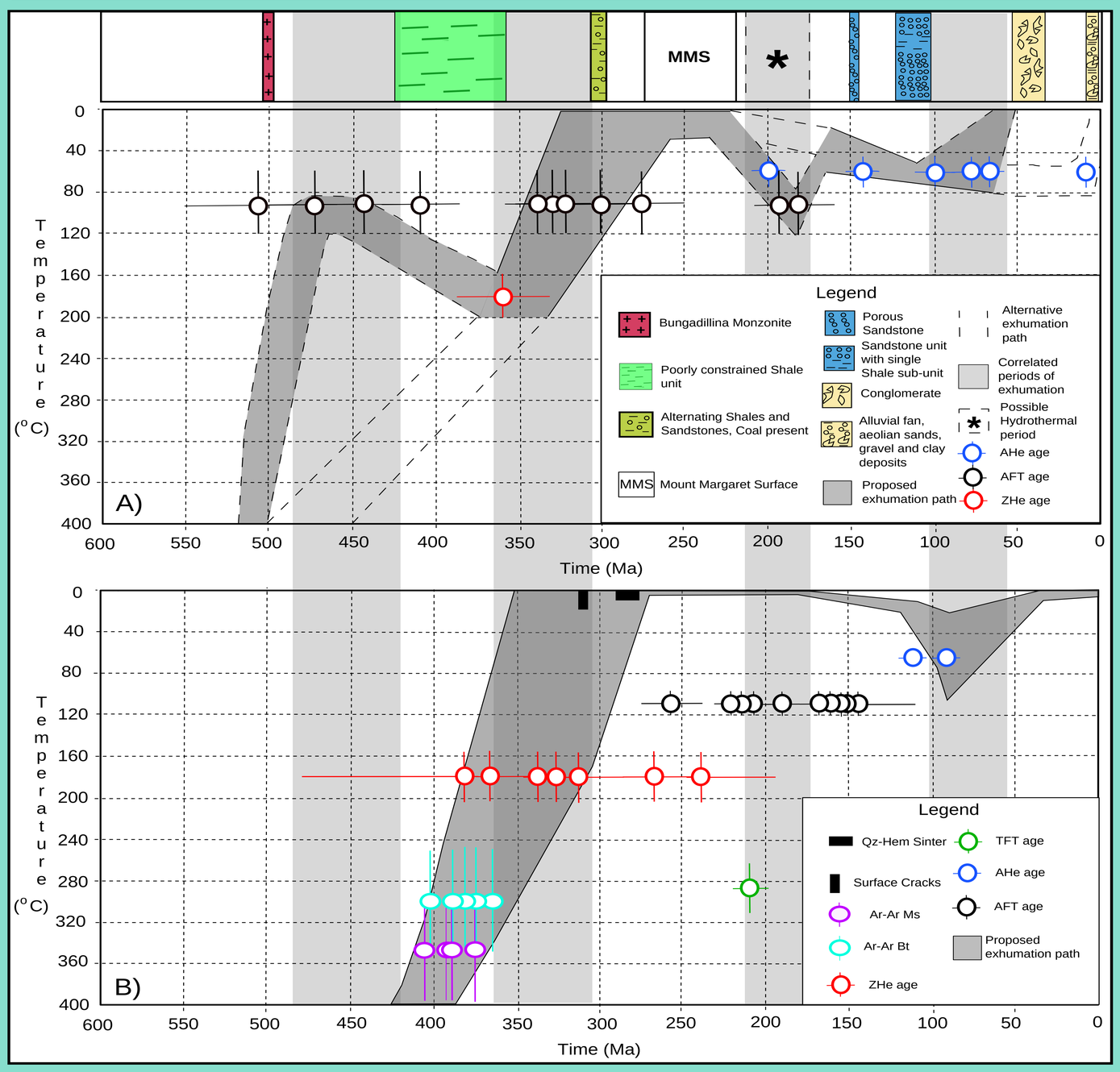

Figure 3, the proposed exhumation path of the Peake and Denison Ranges through time-temperature space (Panel a) with inclusion of sedimentary constraints and compared to the exhumation history model of the Arkaroola region (Panel b; Weisheit et al. 2014). A best-fit exhumation model was constructed which matches all data and is indicated by the gray path, alternative paths are indicated by the dashed lines. Arkaroola region time-temperature graph was adapted from Weisheit et al. (2014) and contains compiled data from Krieg et al. (1995); McLaren et al. (2002); Mitchell et al. (2002).

Major thermal events:

Ordovician (~470-420 Ma):
The Ordovician cooling event occured within samples from the Davenport Range and is interpreted as the cooling of the Bungadillina Monzonite in shallow crustal levels as a result of the Delamerian Orogeny (Morrison 1989).

Late Carboniferous-Permian (~360-300 Ma):
The Late Carboniferous-Permian event is prevailent within a majority of the samples and is interpreted as regional exhumation caused by the end of the Alice Springs Orogeny.

Late Triassic-Jurassic (~210-170 Ma):
The late Triassic-Jurassic event is only witnessed within samples 9528 and 2017962. This thermal event is likely the result of the Ranges reaching AFT temperatures due to burial, however, the lack of sedimentary rocks of this age within the sedimentary record disputes this. Therefore, we propose this is actually a period of increased hydro-thermal activity.

Upper Cretaceous (~100-60 Ma):
The Cretaceous thermal event is witnessed by AHe ages and is interpreted to be exhumation to the surface from shallow crustal levels caused by the widespread Cretaceous exhumation throughout the Gawler Craton (Twidale 1994; Kohn et al 2002).

Discussion

The results from previous studies contain a high degree of consistancy with the work conducted in this study. The Permian tectonic event (Radke 1973) is correlated with the end of the Late Carboniferous-Permian thermal event while the widespread Upper Cretaceous exhumation is evidenced by the AHe results. The Miocene and Pliestocene fault movement suggested by Wopfner (1968) is also present, however, it is only evidenced by one AHe age (Fig. 3).

The model presented in this study was compared to a thermal history model for Arkaroola, put forward by Weisheit et al. (2014; Fig. 3 panel b). Upon comparison, three thermal periods within the Peake and Denison Ranges are also seen within Arkaroola and the period of proposed hydro-thermal activity within Peake and Denison correlates well with the period of known hydrothermal activity within Arkaroola. This indicates that both regions shared a similar exhumation history.

Many regions throughout South Australia shared components of the Peake and Denison thermal history. The Adelaide Fold Belt experienced Cretaceous exhumation (Gibson and stuwe 2000) while regional South Australian studies produced ages similar to the Carboniferous-Permian population (Gleadrow et al. 2002; Kohn et al. 2002)

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