INTRODUCTION

Multi-method thermochronologic data are presented for Neoproterozoic granitoid samples from the eastern Musgrave Province, South Australia. Interpretation of these data with the aid of time-temperature modeling allows inference of multi-stage cooling histories.

The results obtained in this study will test the hypothesis that the Petermann and Alice Springs orogenies were the main causes for Phanerozoic exhumation in the region, and will determine if any later thermal events occurred.

The high sample density across the structural architecture of the study area furthermore reveals patterns of differential exhumation and preservation of the thermal record. The observed differential exhumation patterns match with a model of an inverted graben system, demonstrating how low temperature thermochronologic techniques can reveal fault reaction patterns.

The results highlight that the eastern Musgraves record a complex Phanerozoic low-temperature thermal history revealing the poorly appreciated tectonic evolution of inland Australia.

METHODS

• Apatite fission track (AFT) analyses of all samples, using the laser-ablation inductively-coupled-plasma mass-spectrometry (LA-ICP-MS) method, to determine the timing of the rocks cooling through AFT closure temperatures (220–60°C).

• Apatite (Ape) and Zircon (Zir) (U-Th-Sm)/He analyses of representative samples from different regions across the study area, to determine the timing of cooling through Ahe (75–45°C) and Zir (200–130°C) closure temperatures.

• He/Ne (Kasten 1993) time-temperature modeling conducted for the 3 regionally representative samples to determine the relative rates of cooling between ~200°C and surface outcrop temperatures.

MIDDLE REGION

![Image of radial plots for the middle region of the study area](Image 1)

Figure 3: Radial plots for the middle region of the study area. The gray zones highlight the AFT age peaks and their error range. A pattern of increasing exhumation northwards towards the Marjuy Fault is seen throughout samples 06-09-03, then sample 05 north of the fault shows a shift back to a shallower level of exhumation.

CONCLUSIONS

Multi-method low-temperature thermochronology reveals a complex and structurally influenced upper crustal thermal and exhumation history of the eastern Musgrave Province throughout the Phanerozoic.

• Four main thermal events identified. The oldest AFT age (Neoproterozoic–Cambrian) in the central study regions is interpreted as exhumation triggered by the widespread Petermann orogeny. Silurian–Devonian and Carboniferous–Early Permian AFT age clusters indicate two distinct episodes, during the early and late stages of the Alice Springs Orogeny.

• A subsequent Triassic–Jurassic shallow reheating evidenced across all sample regions, suggesting an elevated geothermal gradient may have affected central and southern Australia extensively at this time.

• Differential AFT age preservation and exhumation patterns are revealed across the sampled transect relative to the major E-W structural architecture, proposing shallow exhumation levels in the centre and deeper exhumation towards the margins.

• As shown visually in Figures 5 & 8, the regional exhumation profile best fits a deformed inverted graben model, and modelling this data in time-temperature space reveals two distinct pathways through the upper crust dependent on level of exhumation.

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