Introduction & Aim

The location of the boundary between the Gawler Craton and Musgrave Province is currently inferred from magnetic and gravity anomalies, yet the nature of this boundary is poorly understood. Thick overlying Arckaringa and Officer Basin sediments restrict outcropping basement, and the number of basalts-intersecting drill holes across the northern Gawler is limited. This region is critical to understanding drill hole data for constraining the boundary from Gawler Craton crust into Musgrave crust at depth.

This study presents 15 new heat flow estimates from the Gawler Craton and one new value from the Musgrave Province with the aim of characterising changes in basement lithology corresponding to changes in observed heat flow.

This new dataset provides data to a region with no published heat flow data to date. This data will contribute a substantial addition of heat flow values into the Australian continental heat flow dataset.

These new heat flow values are also complemented by a magnetotelluric dataset transecting the study region. This dataset allows for the imaging of resistive bodies beneath the crust to a depth of 300 km.

Methods

Heat flow is calculated from the following equation:

\[ Q_h = \frac{\Delta T}{z_g} \times \Delta z \]

Heat flow is the product of thermal conductivities of lithologies and the thermal gradient at depth; thermal gradients are sourced as single value Bottom Hole Temperature (BHT) extrapolated at the well to determine gradient, or from continuous temperature logs.

Thermal conductivities of lithologies firstly requires loans of samples from the South Australian Drill Core Reference Library. These core samples are scanned using a Thermal Optical Scanner, which applies a heat source to the core sample and measures its response, giving a single representative value of thermal conductivity per sample of core.

Results

Heat flow values range from continental average (58-68 mWm\(^{-2}\)) to high in the south to low in the north (93-112 mWm\(^{-2}\) Karkaro-1, CHDCu001 and Mount Willoughby-1), transitioning to high heat flow in the south of the study region (93-112 mWm\(^{-2}\) Karkaro-1, CHDCu001 and Mount Willoughby-1).

The first heat flow value observed in the Musgrave Province was calculated at 70 mWm\(^{-2}\) (CHDCL013).

Magnetotellurics data reveal a region of resistive bodies located between two conductive bodies, corresponding to the location where heat flow values transition from above average (68-89 mWm\(^{-2}\)) to high (93-112 mWm\(^{-2}\) )

Discussion

There are a number of reasons that may explain a change in heat flow signatures and resistivity values, however the most likely explanation is a change in the nature of basement lithology. The nature and location of the boundary between the Musgrave Province and Gawler Craton (which is currently poorly understood) the new heat flow and magnetotelluric datasets presented in the study suggest that it most likely corresponds to a structural feature located within the transitional heat flow zone.

To allow higher resolution delineation of this boundary and to further constrain the thermal characteristics of this region, further work collecting more robust temperature and thermal conductivity datasets is necessary to allow for additional heat flow estimates overlying the transitional zone identified in this study.

Conclusions & Further Work

There are a number of reasons that may explain a change in heat flow signatures and resistivity signals, however the most likely explanation is a change in the nature of basement lithology.

The nature and location of the boundary between the Musgrave Province and Gawler Craton (which is currently poorly understood) the new heat flow and magnetotelluric datasets presented in the study suggest that it most likely corresponds to a structural feature located within the transitional heat flow zone.

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