Application of open-source software and high-resolution geophysical images to explore the plate tectonic evolution of Australia

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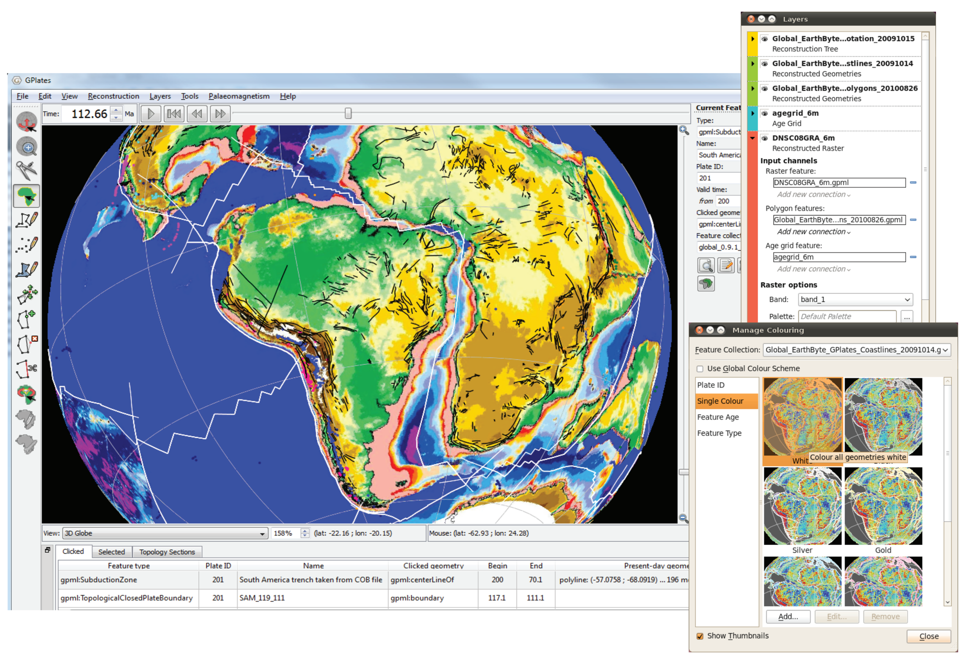
INTRODUCING GPLATES

GPlates is a free, open-source, cross-platform desktop application offering state-of-the-art palaeo-GIS functionality

- smooth, multiple-frame-per-second animation of reconstructions.
- interactive graphical manipulation of reconstructions, with continuous real-time feedback.
- temporally aware information model.
- seamless interoperability with standard GIS data types, including raster data on the surface of the globe, and geoscientific XML-based technologies such as GPML and GeoSciML.
- tool for attaching arbitrary data to tectonic plates
- Time-derivative information such as plate-motion velocity fields and flow-lines calculated on-the-fly.
- Export reconstructions as instantaneous data snapshots or as 2-D vector-graphics in SVG format.



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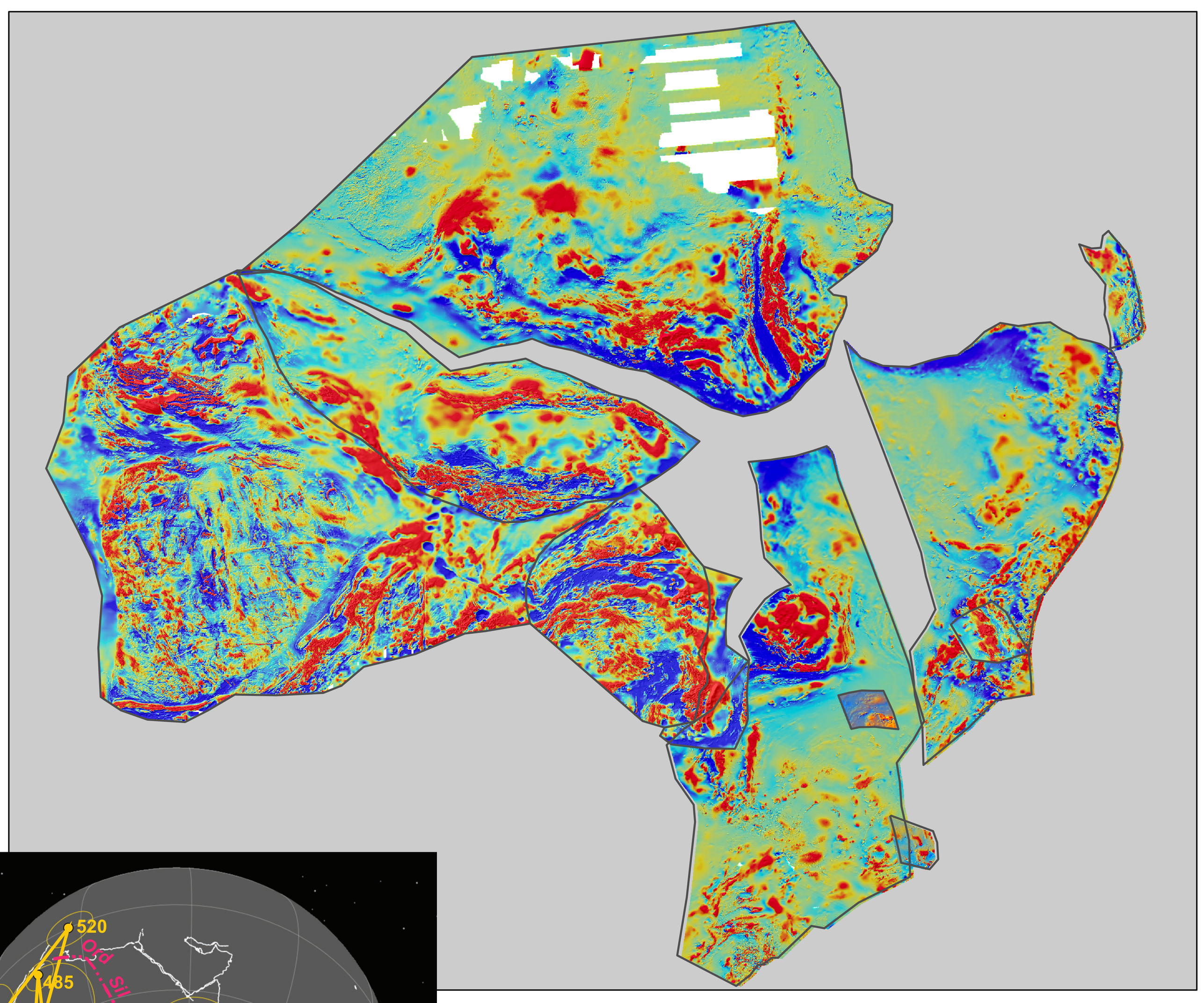
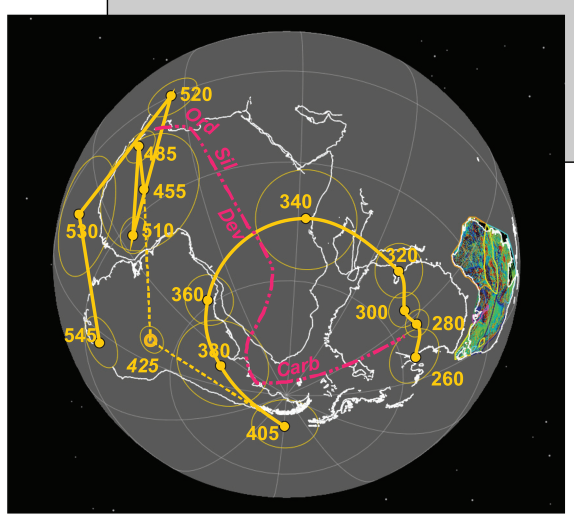
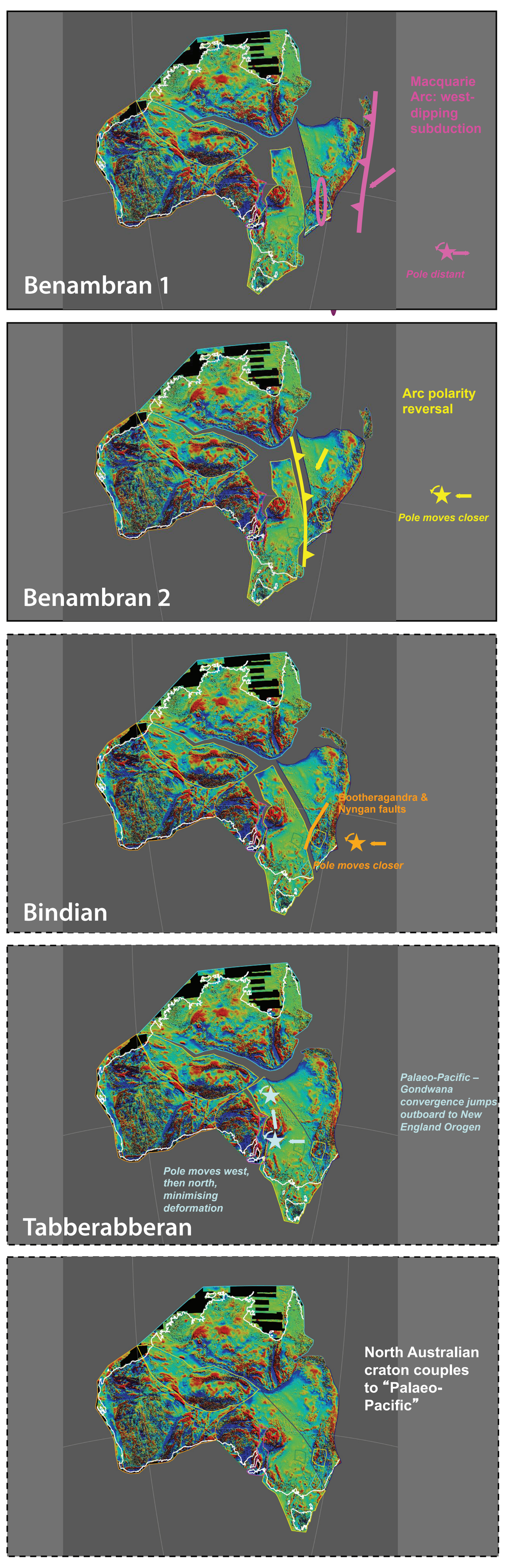
APPLICATION 1: EASTERN AUSTRALIA DURING THE PALAEOZOIC



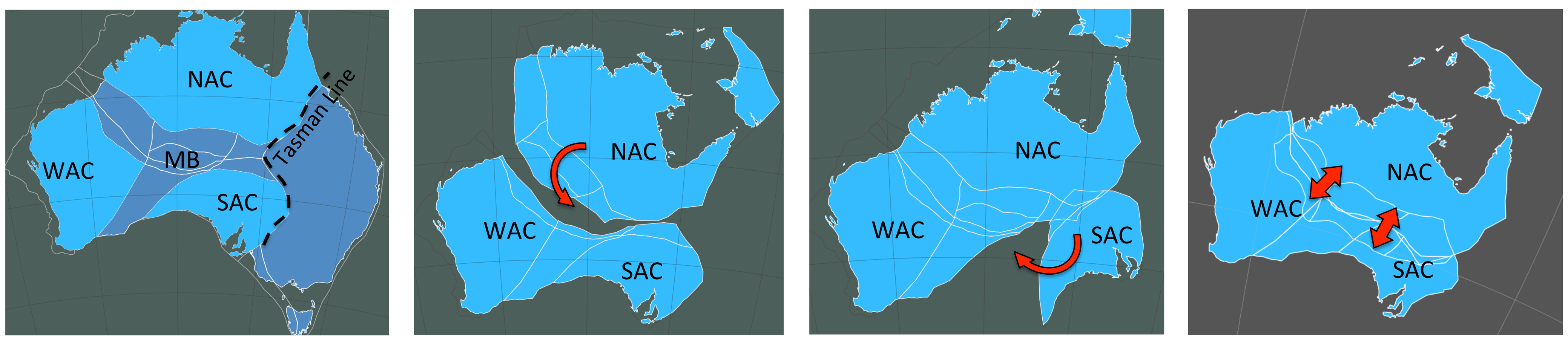


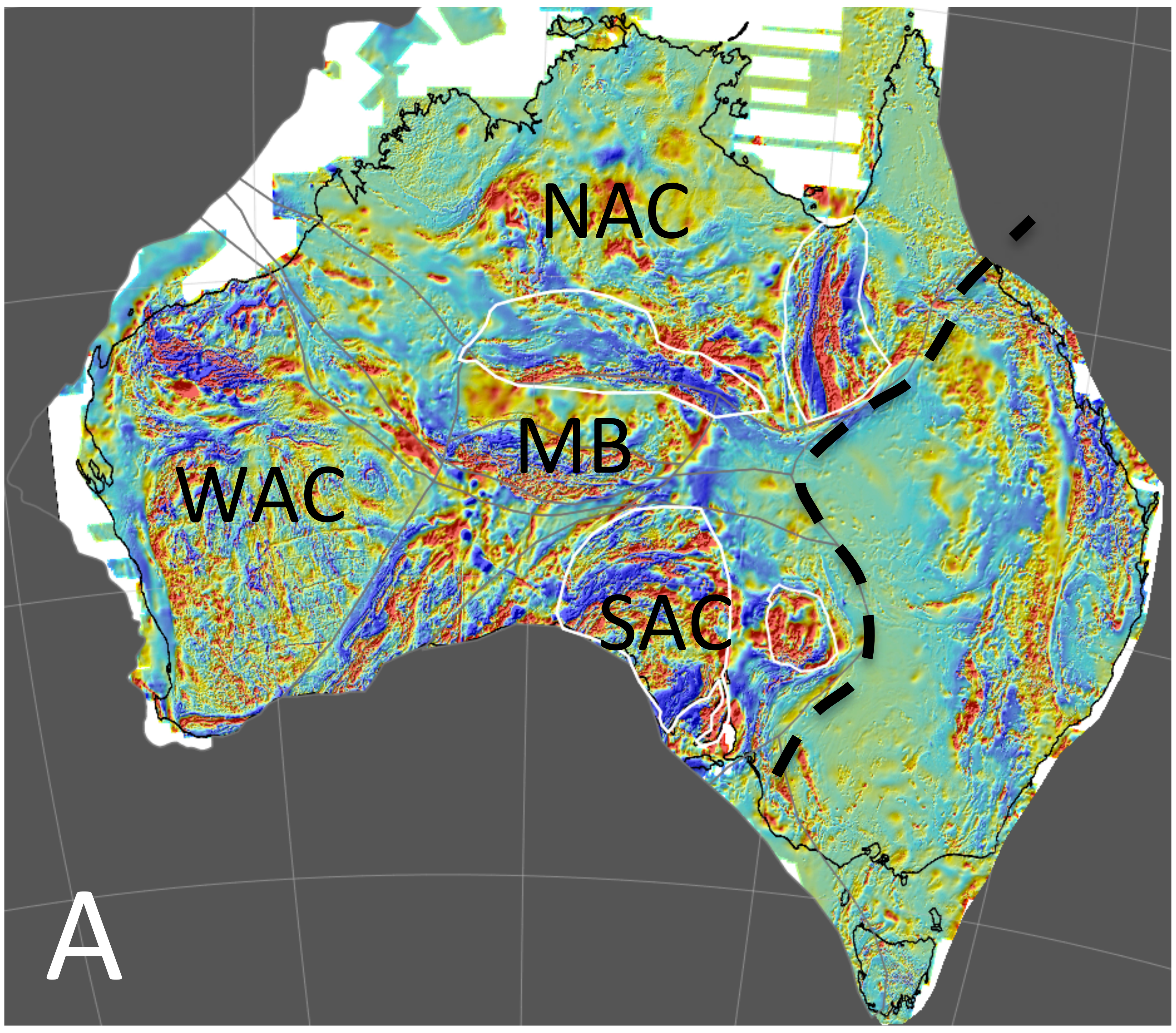
The geology of Eastern Australia records a series of orogenic events along the margin of the supercontinent Gondwana. Musgrave and Cayley [3] used GPlates to develop a new model for the tectonic evolution of this area during the Silurian-Devonian. Magnetic anomaly maps [4] help to define the major Paleozoic-age geological provinces and the shear zones that disrupt them – reconstructions are constrained by bringing the anomalies that define these provinces into their original alignment.

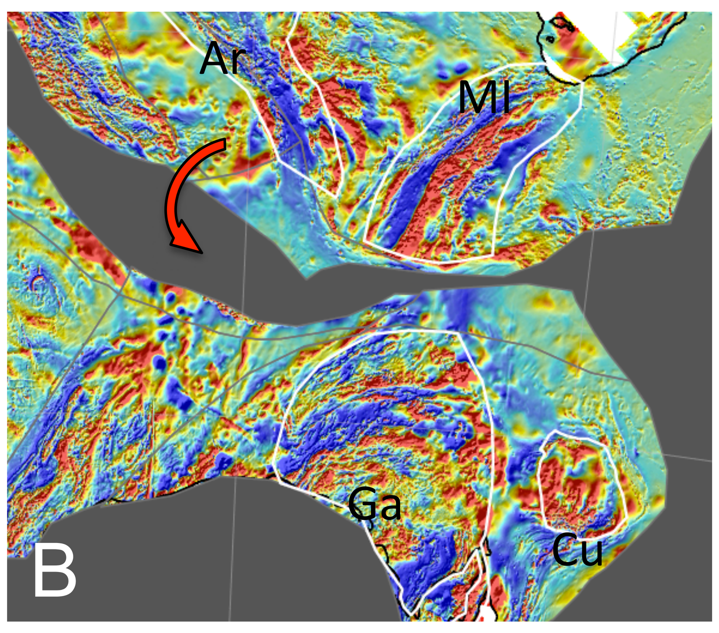
Previous Apparent Polar Wander Paths (APWPs) for Gondwana during the mid-Paleozoic have relied on paleomagnetic data from the tectonically active parts of Eastern Australia. By incorporating available paleomagnetic data into the GPlates reconstruction, Musgrave and Cayley (2011) revised this APWP taking these tectonic motions into account.

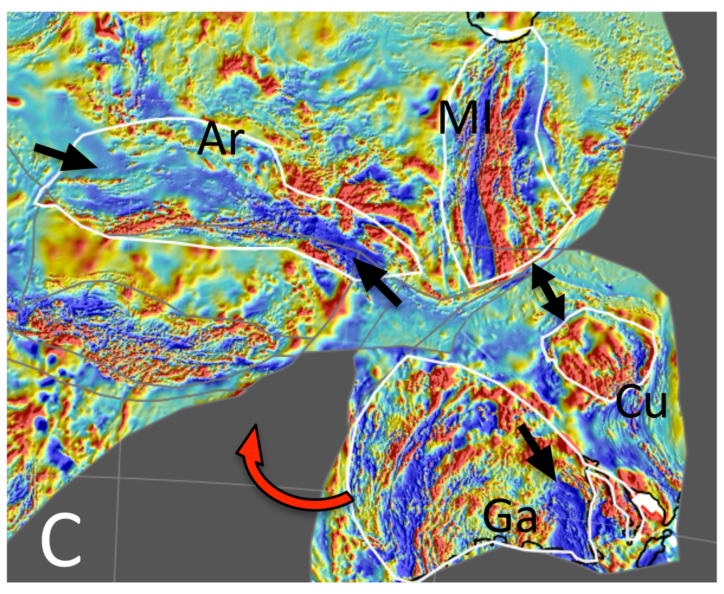


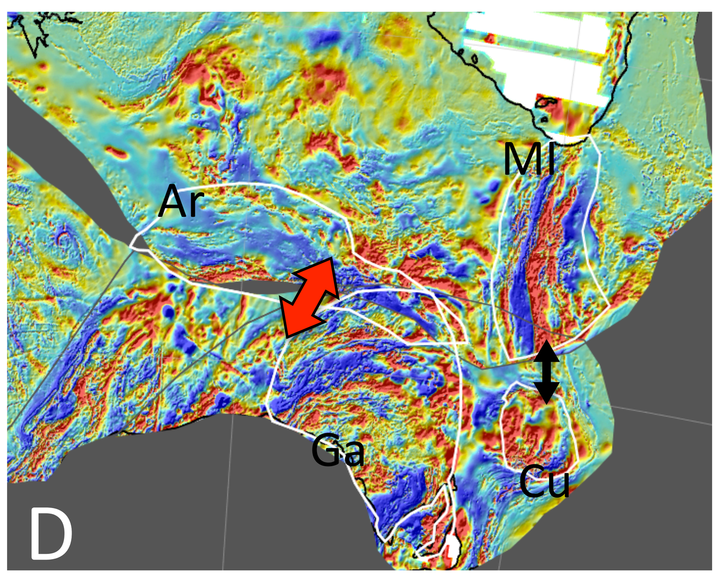
APPLICATION 2: PROTEROZOIC MOTIONS BETWEEN AUSTRALIAN CRATONS











The older parts of Australia are generally described in terms of three 'cratons', the North, West and South Australian Cratons [5], from here on abbreviated to NAC, WAC and SAC respectively. Various authors have proposed large relative motions between these cratons during the Proterozoic (>542 Ma ago), drawing evidence from paleomagnetic data and mapped geology. For example, Li and Evans [6] recently proposed a 40˚ rotation of the NAC relative to SAC and WAC took place around 600 Ma, while Giles et al [7] suggested an alternative scenario where the available observations were best explained by a large rotation of the SAC relative to the NAC around 1300 Ma.
The main panel (A) shows the magnetic anomaly map for Australia [4], reconstructed using the different proposed reconstruction scenarios for Proterozoic Australia. The reconstructed configuration of Giles et al [7] bring into closer juxtaposition the distinctive anomaly patterns in the regions of the Mount Isa and Curnamona Provinces. The Li and Evans [6] model (Panel B) leaves Mount Isa and Curnamona widely separated. The magnetic anomalies also reveal the structural grain within the Gawler Craton and Arunta Inlier. Giles et al [7] argue that these two provinces formed a continuous orogenic belt along Australia's southern margin during the late Paleoproterozoic. Panel C illustrates how the rotation of the South Australian Craton yields continuity in the grain of the magnetic anomalies between the Gawler (Ga) and Arunta (Ar) provinces.

Modelling the Proterozoic tectonic evolution of Australia has important implications for the juxtaposition of the Mount Isa (MI) and Curnamona (Cu) regions, located on the NAC and SAC respectively. Today, these regions lie far apart, but a number of authors have emphasized the similarities in the age and geochemical compositions, suggesting that the rock units (and mineral deposits) within both regions formed at a time when the regions were much closer together. GPlates combines tools for the reconstructing high resolution imagery and vector data with data-mining functionality that allows us to explore spatio-temporal relationships between the present-day distribution of mineral deposits and the geodynamic processes through which they formed.

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