Potential field modelling of proposed land seismic transects in the Northern Territory

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Four land seismic surveys have been proposed over the Northern Territory (Figure 1):

- Southern McArthur Basin, crossing the Batten Trough.
- The Tanami region and north-western Arunta.
- Central Arunta, extending the existing BMR seismic line north-easterly across the Wiso Basin, the Tennant Creek Province and the Georgina Basin.
- Two north trending transects in the Eastern Arunta, beginning in the Amadeus Basin, crossing the Arunta and terminating in the Georgina Basin.

Prior to seismic acquisition, potential field modelling was conducted to refine existing geological models. Analysis of the magnetic and gravity fields help to define a number of variables including; the dip of structures and geological contacts, the depths to the tops of bodies, the depth extent of bodies and, the shape and orientation of bodies.

The inherent non-uniqueness of potential field modelling, i.e. a single anomaly maybe produced by an infinite number of differing source bodies, requires geological input to ensure that the results are realistic. The widely spaced gravity stations, up to 11 km, result in the loss of the high frequency component of the gravity field. It is impossible therefore, to model the near surface geology based on the gravity. Near surface geology can, however, be modelled in more detail using the magnetic data, as the sample spacing, along line, is typically 7 m and 400 m line spacing.

The proposed seismic transect in the southern McArthur Basin, starts in the Bauhinia Shelf in the west, crosses the Batten Fault Zone and finishes, in the east, on the Wearyan Shelf (Figure 2). The McArthur Basin consists of a thick platform of Middle Proterozoic, unmetamorphosed and relatively undeformed sediments. The basal unit comprises the Tawallah Group, a laterally consistent unit, comprising primarily sandstone and minor volcanics. Separated by regional unconformities are the overlying rift related McArthur and Nathan Group carbonates, which are themselves overlain by clastics of the Roper Group. The Batten Fault Zone coincides with the position of the former Batten Trough. Inversion of the trough has stripped the overlying Nathan and Roper Groups, exposing the McArthur Group sediments.

The results of the potential field modelling (Figure 3) of a section closely following the seismic transect comprises a geological model for which the computed gravity response matches the observed data. Thick sections of dense McArthur Group carbonates produce a broad gravity high over the Batten Fault Zone. Gravity lows over the Bauhinnia shelf are modelled with thick sections of up to 5 km of low density Roper Group clastics directly overlying Tawallah Group. The lower gravity field over the Wearyan Shelf, is modelled by thin sections of Roper Group and McArthur Group sections overlying the Tawallah Group. The magnetic field consists of two broad anomalies, which can not be reproduced by modelling the known volcanics in the McArthur Basin sediments. These volcanics are thin plate bodies and will not produce the observed broad anomalies. Modelling suggests that the source of these anomalies, with depths to the top of the bodies of over 8 km, occur within the McArthur Basin basement. Due to the high densities and magnetic susceptibilities, these bodies are probably of mafic composition.

In the Tanami Region two proposed seismic transects extend in a north-westerly and northerly trend. Four potential field modelled sections were produced for the Tanami Region. One section was located to follow the north-westerly trending seismic transect, while the other three were located to cross major structures and regions of interest (Figure 4).

Results of the modelling show that the granites of the Coomarie and Frankenia domes have large depth extents (approximately 8 km) and form a single pluton at depth (Figure 5). These granitoids do not appear to have vertical dipping contacts, they widen at the base, with dips up to 45^{o}. Thick sequences of dense, magnetic MacFarlane Peak Group sediments sit in a synform with a basal contact at about 5 km depth between the two granitic domes. A fault-bounded wedge of dense, magnetic Mount Charles Formation is located within the synform. The north-west bounding Black Peak Fault dips sub-vertically, while the other bounding fault dips at 60^{o} to the north-west. On the southern edge of the Browns Range Dome (Figure 6), the Browns Range Shear Zone is modelled with a southerly dip of approximately 70^{o}. The granitic dome extends to approximately 8 km depth and is a composite pluton consisting of granitic bodies with differing density and magnetic susceptibilities. To the south of the Browns Range Zone thick sections of dense McFarlane Peak Group are modelled beneath approximately 2.5 km of Birrindudu Sediments. Late stage north-westerly trending structures (Figure 7), including the Tanami and Mongrel Faults dip steeply (~70^{o}) to the southwest, while other northwest trending structures dip steeply to the north-east.

The eastern Arunta line transects the Harts Range region of the Eastern Arunta Province (Figure 8). It extends from the Georgina Basin in the north across the Harts Range Metamorphic Complex and into the Amadeus Basin in the south. The line was designed to model the geometry of a proposed Cambrian intraplate rift-fill sequence (Irindina Supracrustal Assemblage - ISA) overlying basement of the Palaeoproterozoic Strangways Metamorphic Complex (SMC). The transect cross-cuts a regional low magnetisation corridor that extends northwest across northern Australia which may be the geophysical expression of the proposed rift.

Modelling suggests (Figure 9) that the ISA comprises a very thin veneer over SMC basement in the Harts Range. This veneer is an order of magnitude thicker to the north, coincident with an area of extremely low magnetisation. Major block boundaries typically dip towards this area and are consistent with a modified rift, centred south of the Delny-Mt Sainthill Shear Zone. The Illogwa Shear Zone which bounds the ISA to the south appears to be a major north-dipping crustal structure.

Figure 1. Regional geology of the Northern Territory including locations of the proposed seismic surveys shown in red. The white line shows the position of an existing BMR seismic transect.

Figure 2. Image of the Bouguer Gravity Field over the Batten Trough region showing locations of the proposed seismic transect (purple) and the modelled section (blue).

Figure 3. Potential field model over the Batten Trough. TG – Tawallah Group, TV – Tawallah Group Volcanics, MG – McArthur Group, NG – Nathan Group & RG – Roper Group. MF – Mallapunyah Fault, TF – Tawallah Fault & EF – Emu Fault.

Figure 4. Image of the Bouguer Gravity field over the Tanami Region showing the positions of the modelled sections.

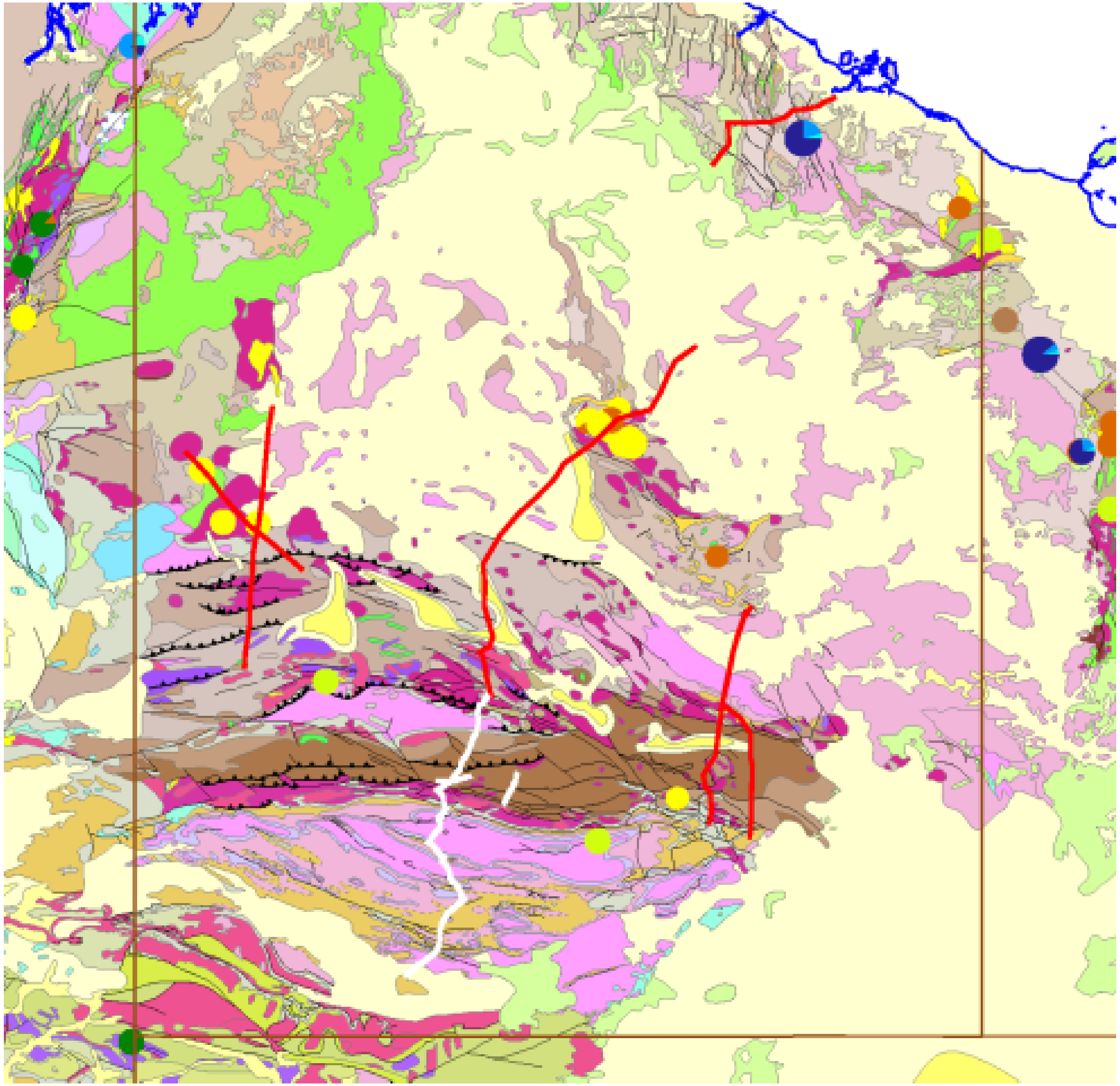
Figure 5. Potential field model along section 3 (Figure 4). Mc-A, Mc-S & Mc-U: McFarlane Peak Group, amphibolite, sediment & undivided; Ta – Tanami Group, mC - Mount Charles Formation. BPF – Black Peak Fault. Densities (g/cm^3) are shown for all units. Susceptibilities (SI) are only given for non-zero values.

Figure 6. Potential field model along section 1 (Figure 4). Mc-A, Mc-S & Mc-U: McFarlane Peak Group, amphibolite, sediment & undivided; Ta – Tanami Group. BRS – Browns Range Shear Zone. Densities (g/cm^3) are shown for all units. Susceptibilities (SI) are only given for non-zero values.

Figure 7. Potential field model along section 4 (Figure 4). Mc-U – Undivided McFarlane Peak Group, Ta – Tanami Group & G – Undivided granites. MF – Mongrel Fault & TF – Tanami Fault. Densities (g/cm^3) are shown for all units. Susceptibilities (SI) are only given for non-zero values.

Figure 8. Image of the total magnetic intensity (reduced to pole) over the Eastern Arunta. The position of the proposed land seismic transects (black dashed line) and the modelled section (white line) are shown.

Figure 9. Potential field model across the Eastern Arunta. EPSZ – Entire Point Shear Zone & DSZ – Delny Shear Zone. Densities (g/cm^3) are shown for all units. Susceptibilities (SI) are only given for non-zero values.



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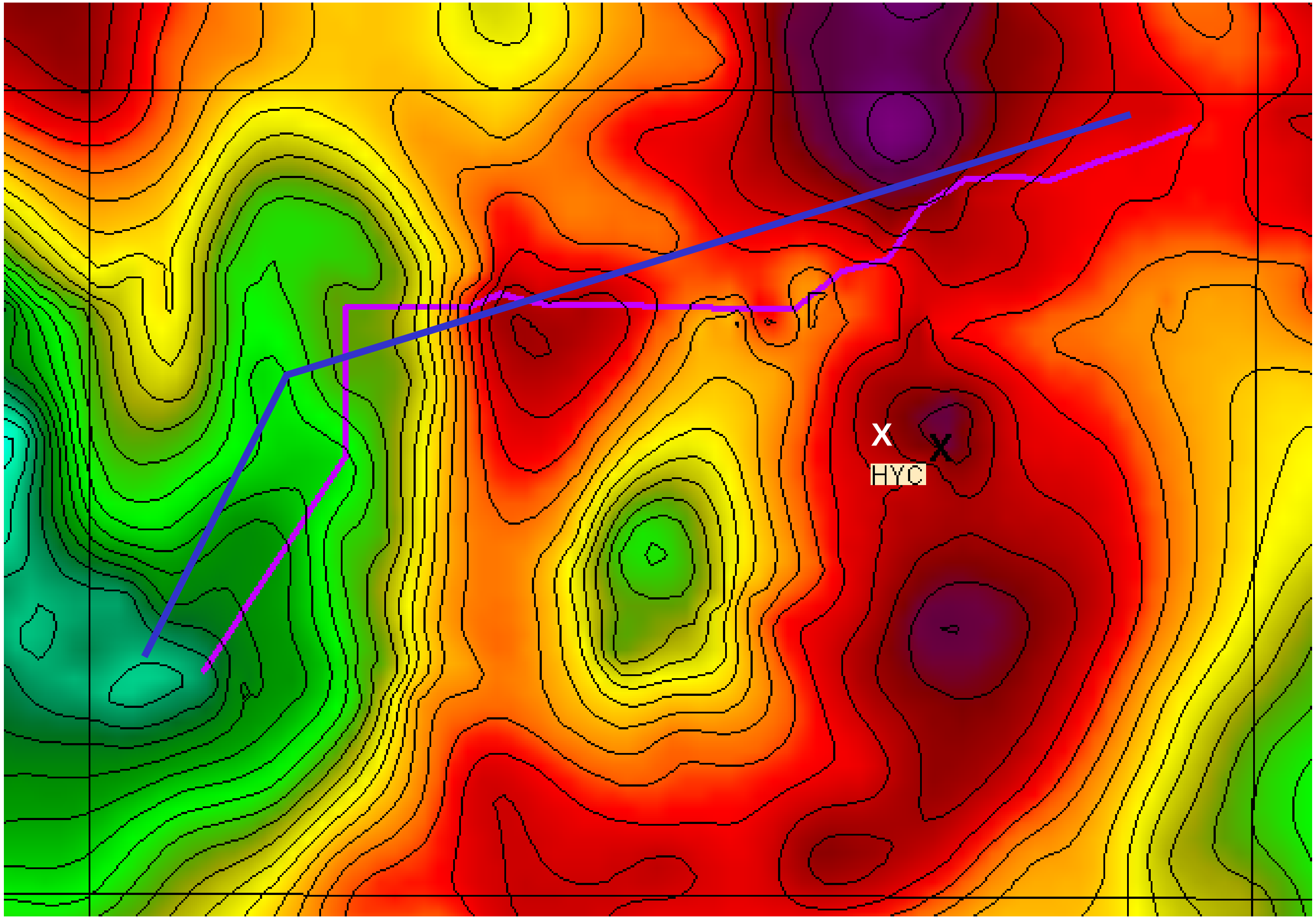

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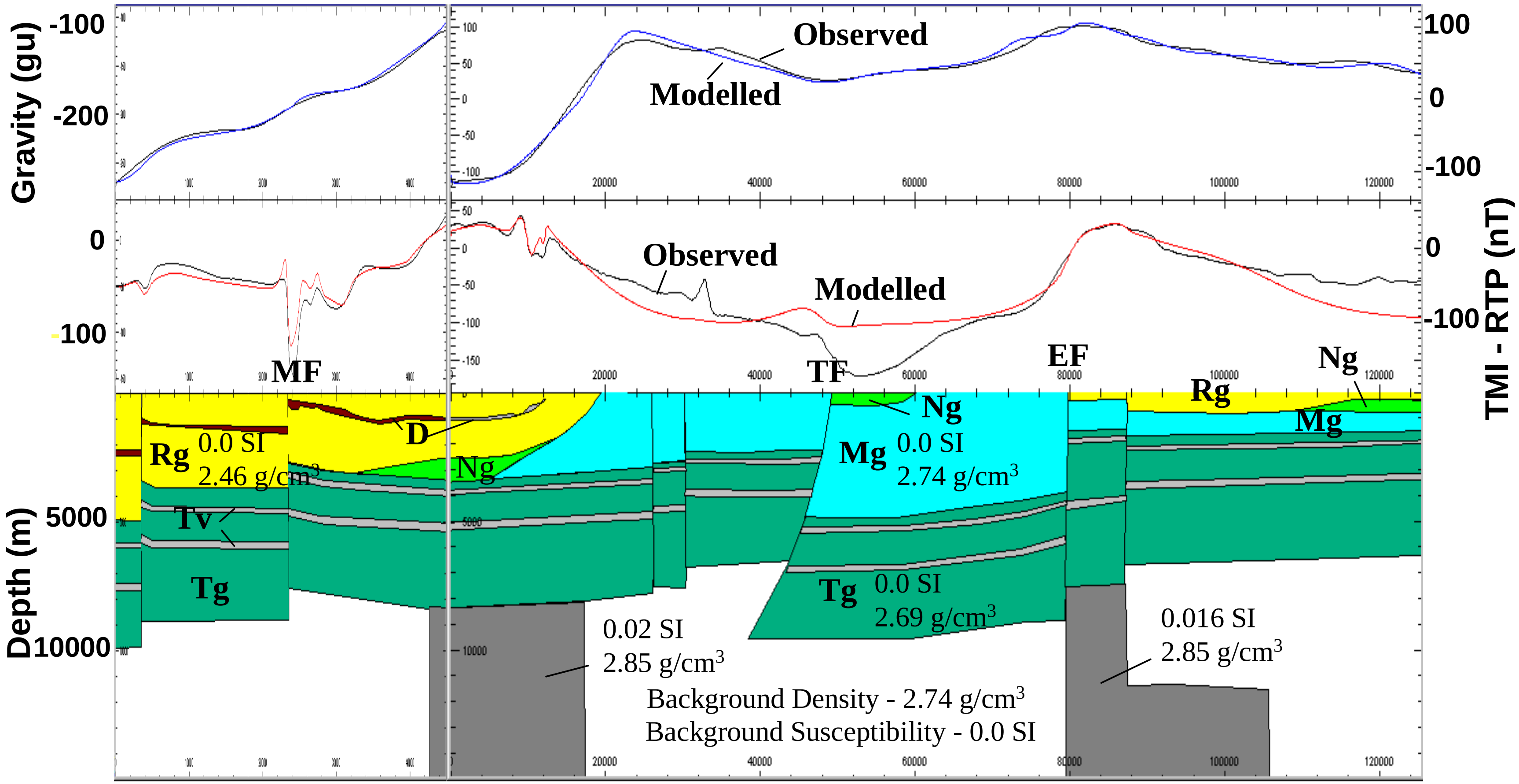

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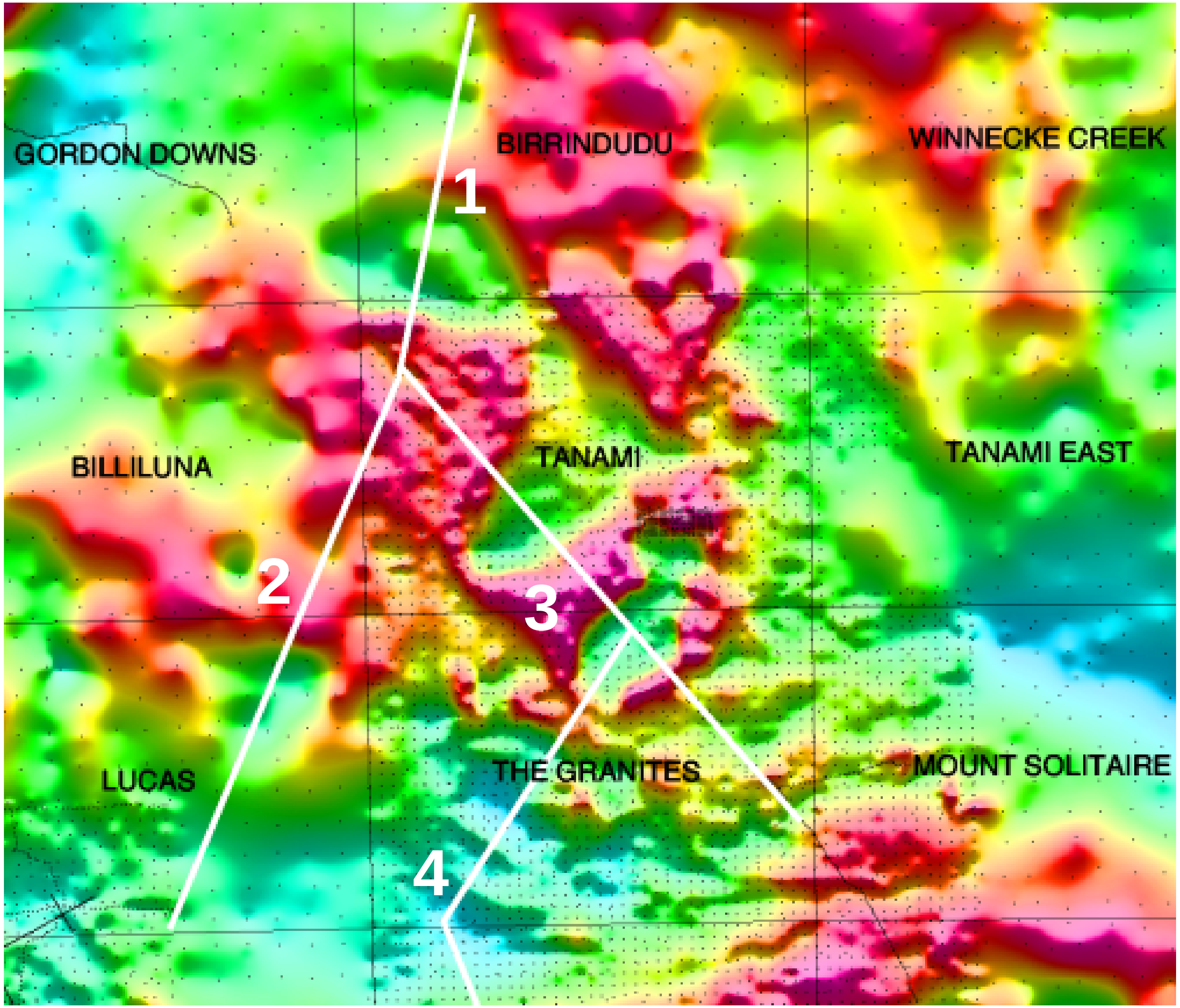

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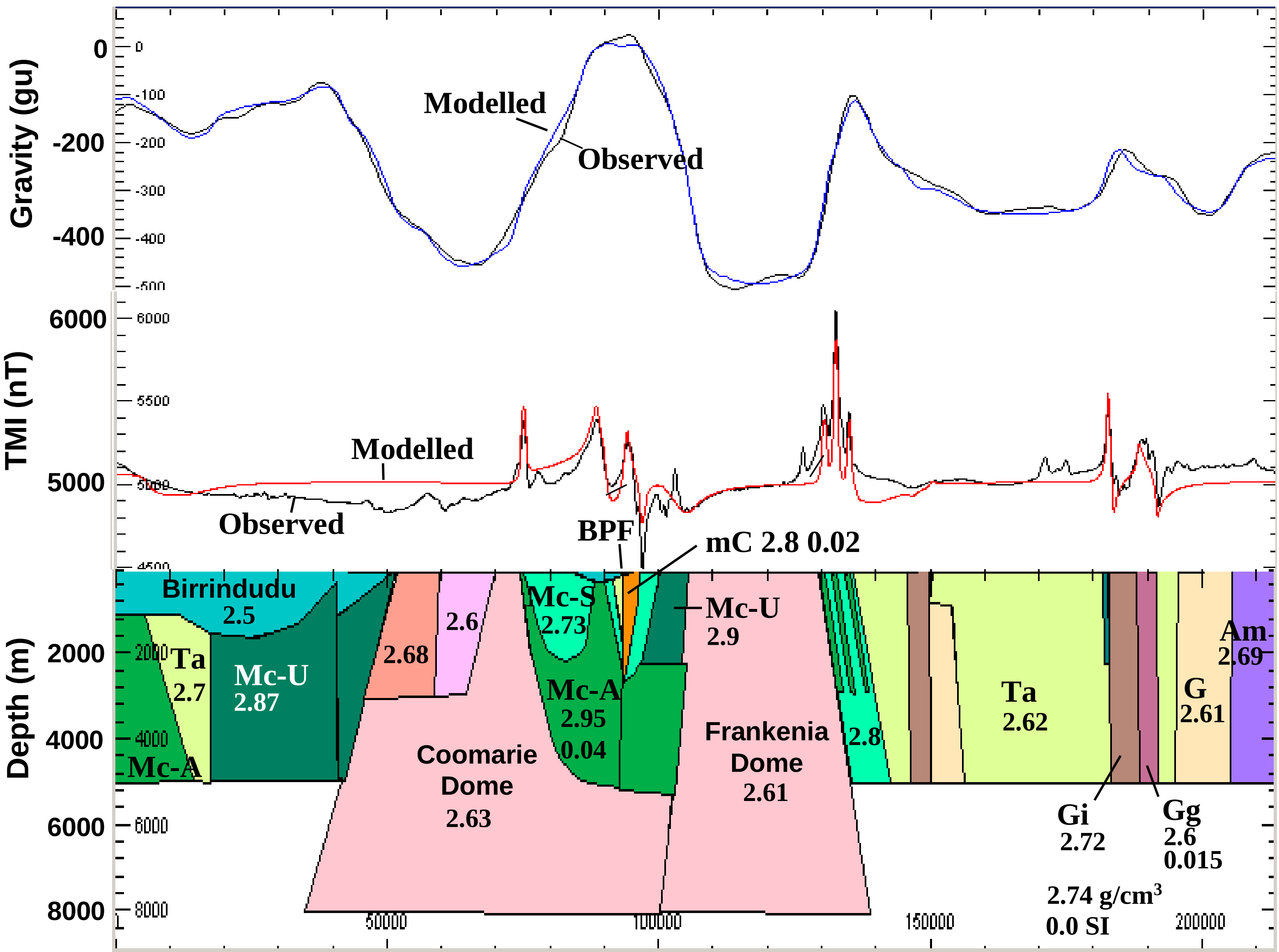

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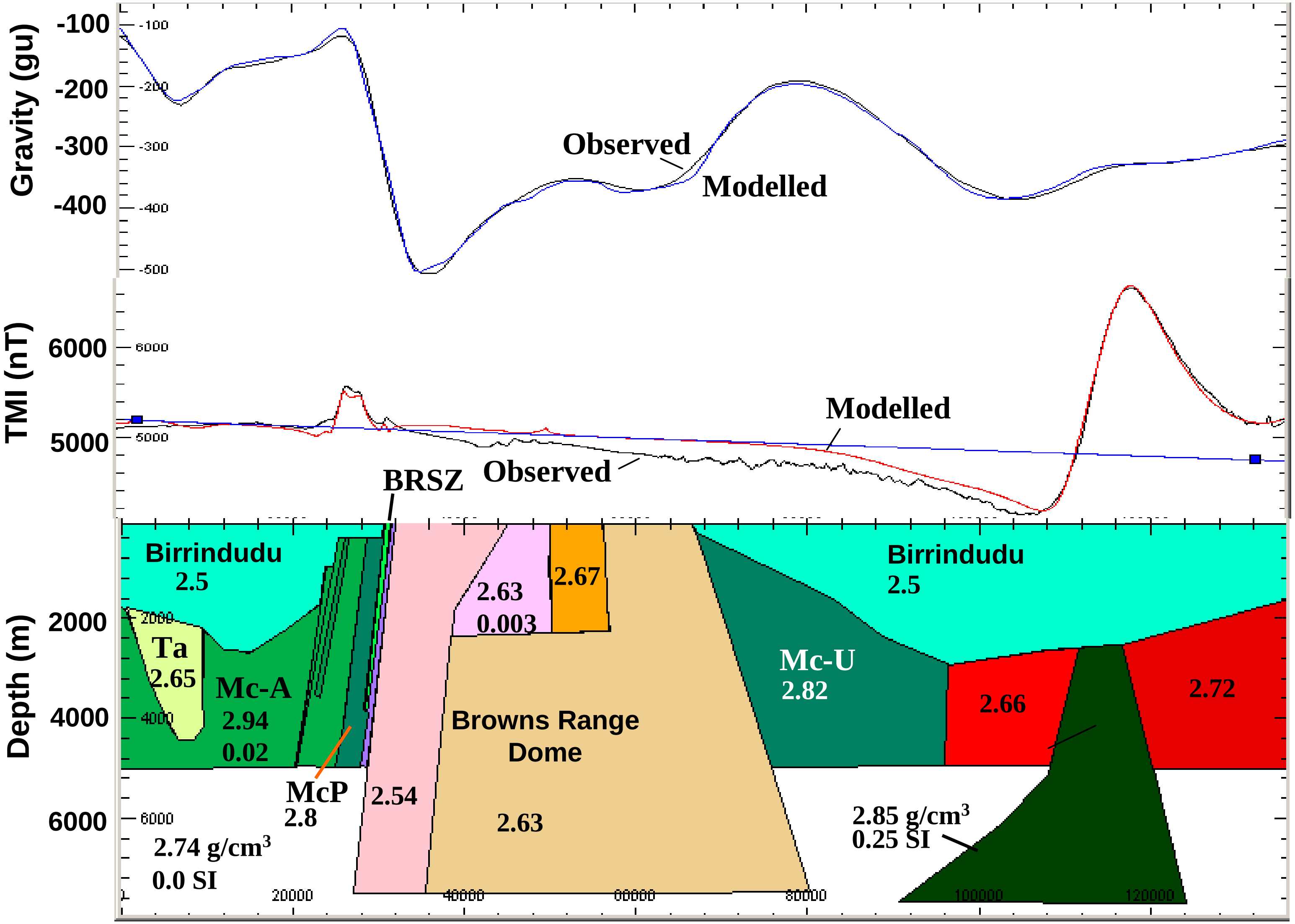

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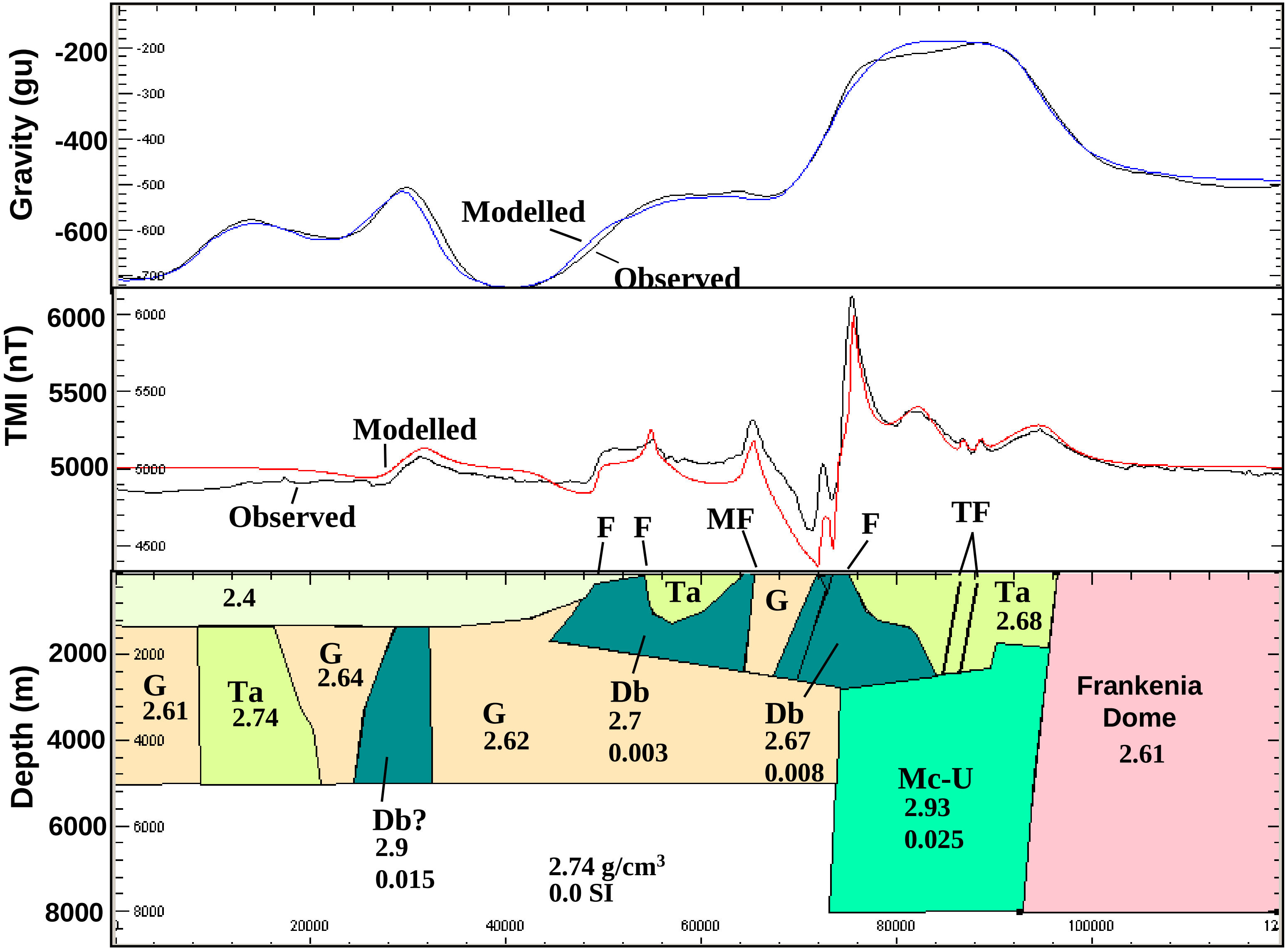

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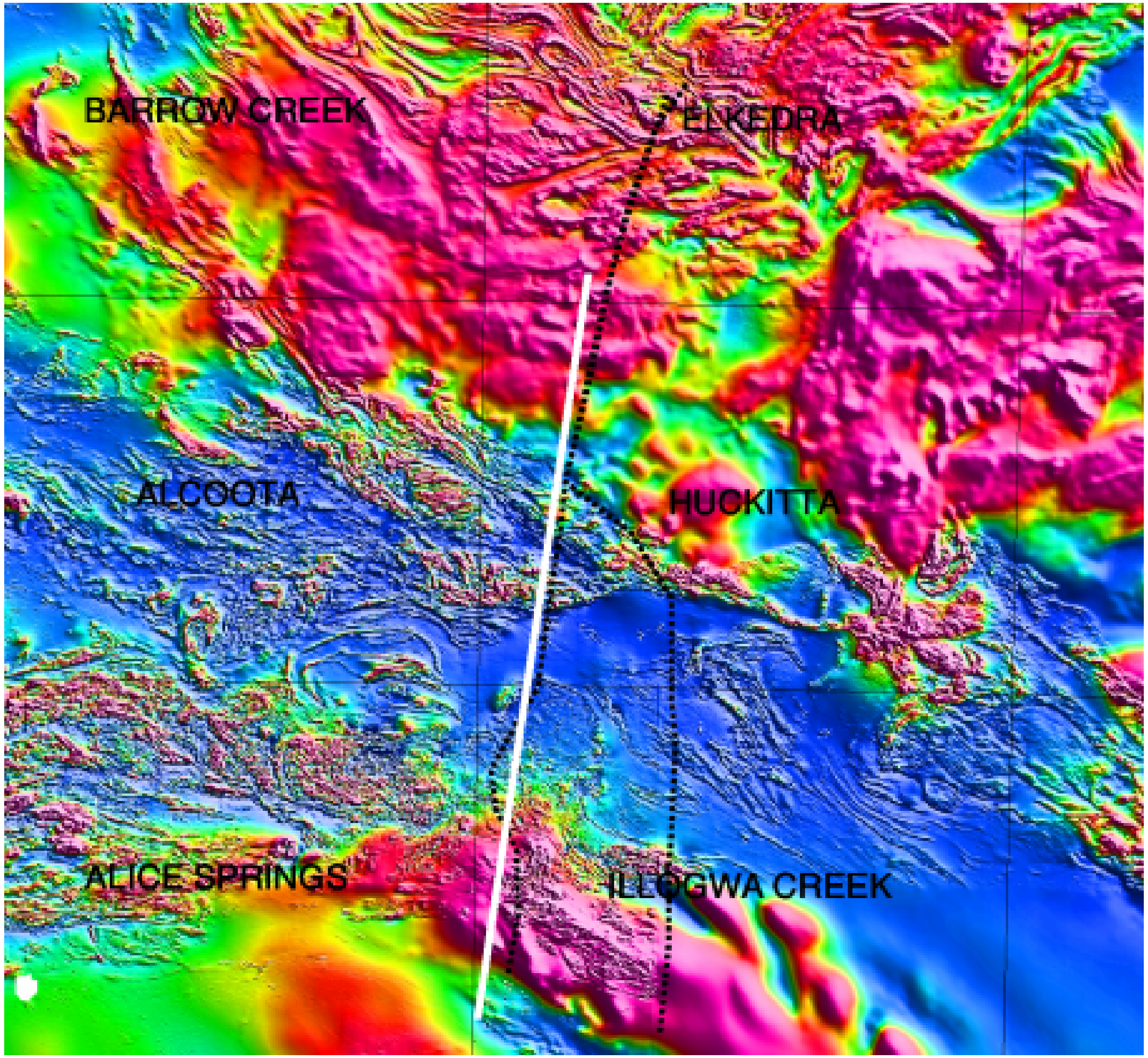

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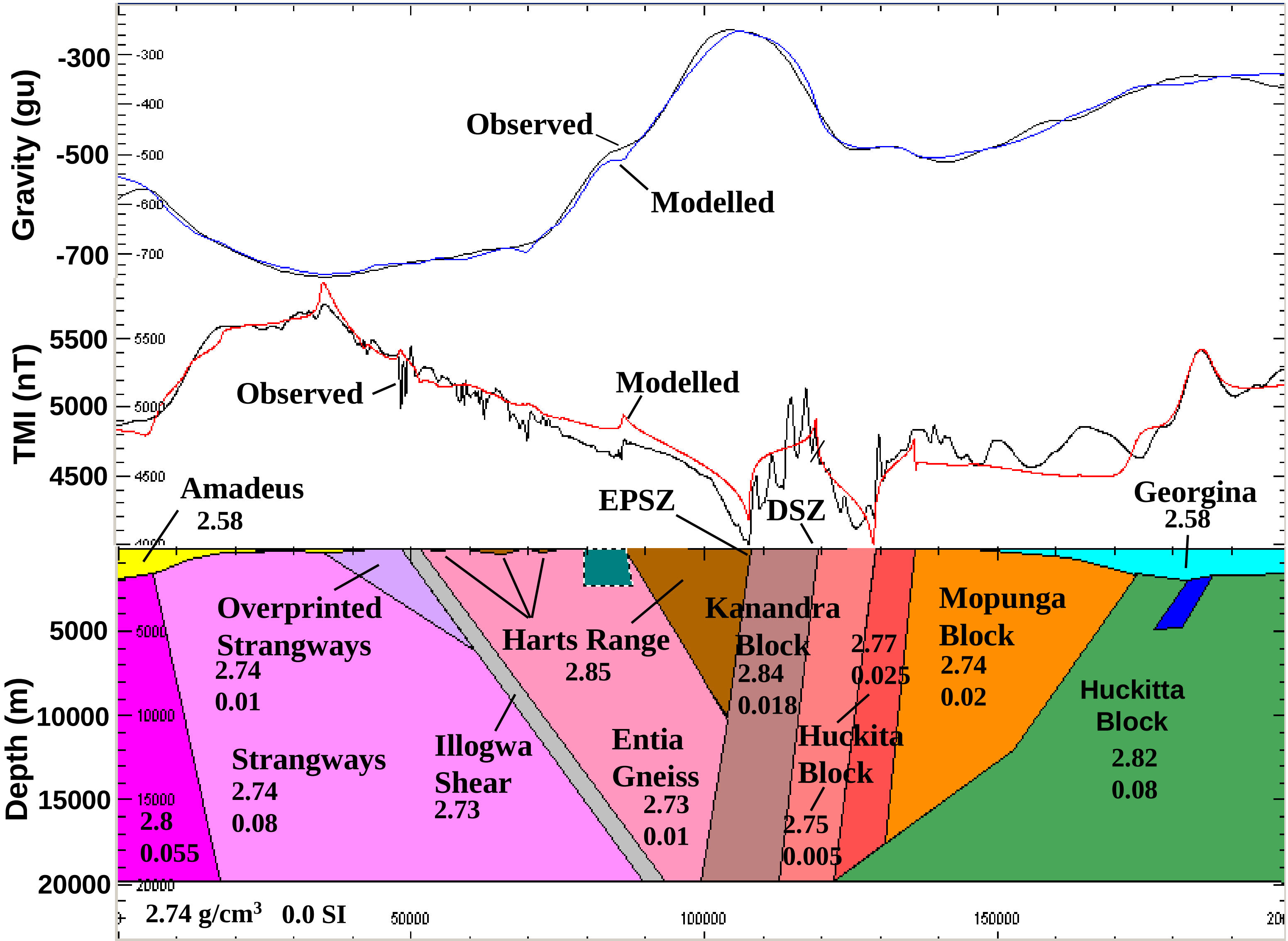

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