Preliminary interpretations from the 2015 Coompana aeromagnetic survey

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SUMMARY

The Coompana airborne survey is a large-scale pre-competitive aeromagnetic and radiometric survey in western South Australia flown in 2015. The survey was undertaken in order to provide greater geological controls on the basement geology in this area, which lies beneath the cover sequences of the Eucla, Bight, Denman and Officer Basins. This survey covers much of the South Australian part of the Coompana Province, which includes the Coompana Magnetic Anomaly. In this preliminary interpretation of the aeromagnetic survey, we have distinguished five basement domains based on the magnetic data and attempted to differentiate where domain boundaries are structural or intrusive. Integrating the aeromagnetic interpretation with existing drillhole and outcrop constraints suggests that the western part of South Australia had a long-lived, dynamic geological history with at least four major rock-forming events identified in the Coompana Province: c. 1610 Ma, c. 1500 Ma, c. 1180 Ma and c. 860 Ma.
Detailed interpretation of the 200 m line-spaced infill region has enabled contact and relative age relationships of the intrusive bodies causing the Coompana Magnetic Anomaly. We suggest a multi-phase intrusive complex, with an early deep disc-like intrusion, followed by pipe-like satellite bodies intruding higher into the crust. The relative age of this intrusive complex is interpreted to be between c. 1120 Ma and c. 860 Ma.

Key words: Coompana, Aeromagnetics, Basement, Domains, Intrusions

INTRODUCTION

The Geological Survey of South Australia recently began a campaign of geophysical and geochemical pre-competitive data collection in the Coompana region of western South Australia in an effort to elucidate the geological history and mineral potential of the region. The program of data collection was initiated in 2013 with the collection of the Eucla-Gawler deep crustal seismic reflection profile 13GA-EG1, the first results of which were released in December 2015 (Dutch, Pawley and Wise, 2015), and the Coompana section results are to be released at the 2016 Australian Earth Sciences Convention in June 2016 in Adelaide. Additionally, a biogeochemical survey following the same transect as the seismic line, with additional lines over the Coompana Magnetic Anomaly, was completed in 2013 (Dunn and Waldron, 2014). The Coompana airborne survey, completed in December 2015, has collected over 250,000 line kilometers of magnetic and radiometric data at 400 m line spacing in the western part of the State, with 200 m infill over the Coompana Magnetic Anomaly (Figure 1).
This contribution provides a preliminary interpretation of the Coompana aeromagnetic survey (Figure 1). We present initial observations about the magnetic character of the basement domains, and discuss where existing drillhole and geochronological constraints have aided interpretation. We then place basement domains and other interpreted features into a tentative geological framework.

Observations and Interpretations

Basement domains

We interpret five broad basement domains based on magnetic character (Figure 1). From cross-cutting relations, it is possible to construct a probable chronological sequence. From oldest to youngest, the domains are:

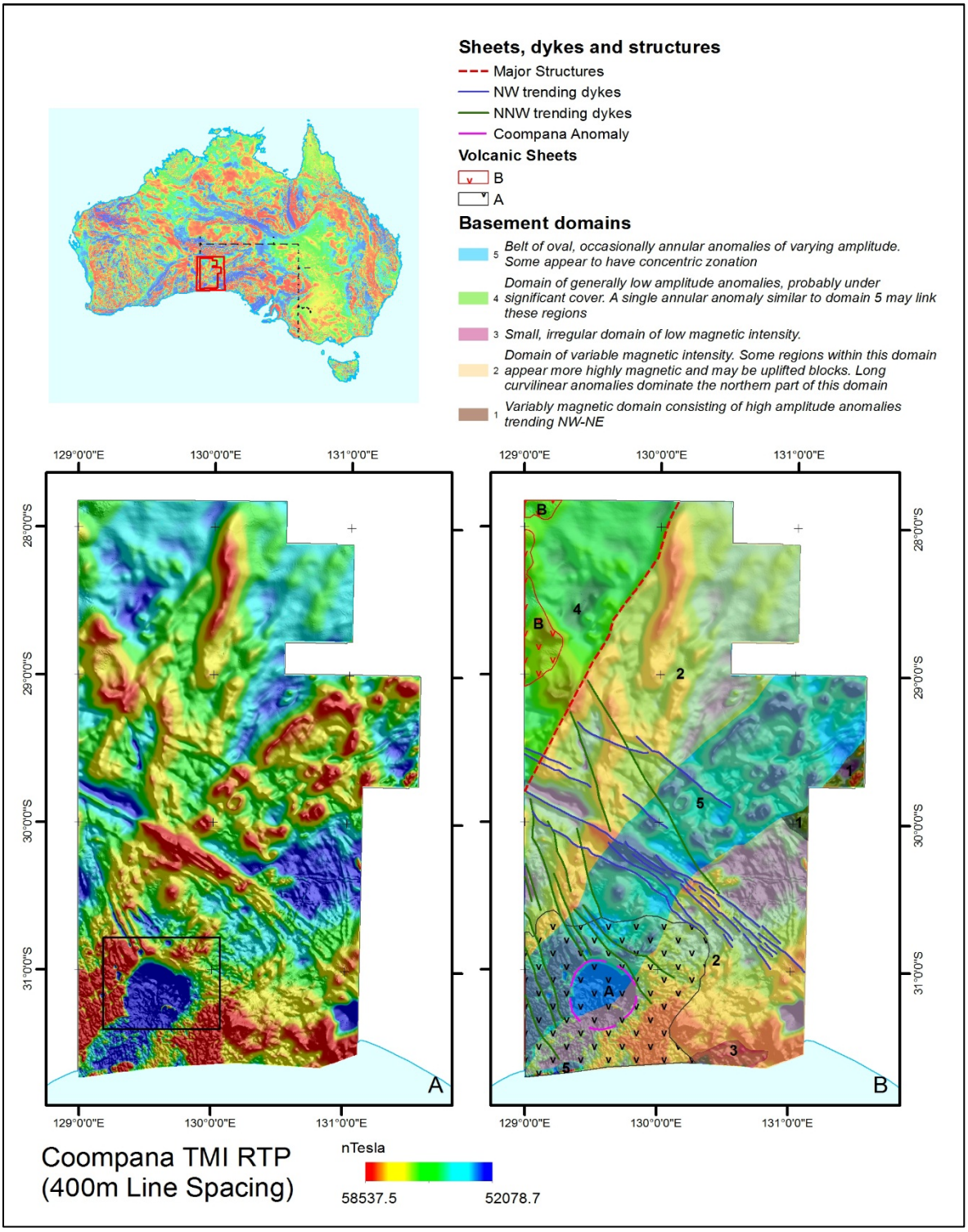

Figure 1; Coompana aeromagnetics. Uninterpreted 400 m line-spaced image (left) and interpreted basement domains, volcanic sheets and dykes (right). 200 m line-spaced infill region shown by black box (shown in Figure 2).

Domain 1. This is a variably magnetic domain in the central-eastern part of the survey that comprises high amplitude northwest- and northeast-trending anomalies. This domain appears to be the extension of magnetic marker horizons associated with 1740-1720 Ma magnetite-rich Moondrah Gneiss intersected in Ooldea 1, 2 and 3 drillholes (Payne et al., 2006), as well as metasedimentary rocks from drillhole Lake Maurice East, and would correspond to the western Nawa Domain. Dutch et al., (2015) interpret the Nawa Domain to be the Gawler Craton footwall over which the younger Coompana Province has been thrust along the Jindarnga Shear Zone.

Domain 2. This is a domain of variable magnetic intensity that appears to be intruded by rocks of domains 3 and 5. Drillholes Kutjara 1, Guinewarra Bore, Alballa-Karoo and Nullarbor Plains 6 intersected granitic basement rocks in domain 2,

though other lithologies may be present but not represented in drillholes. The western boundary of domain 2 is north-northeast striking and appears to continue into Western Australia, where it marks the change between c. 1610 Ma Toolgana Supersuite-aged rocks to the east, and younger rocks of the 1505-1487 Ma Undawidgi and 1195-1175 Ma Moodini supersuites to the west (Wingate et al., 2015). This boundary is possibly a major fault structure, as it is defined by a sharp change in amplitude of the magnetic anomalies, from higher to the east in domain 2 to generally lower in domain 4 to the west (Figure 1). This domain boundary is a major structure that either juxtaposes basement rocks with different magnetic character, or represents a change in cover thickness over the same basement rocks.

Domain 3. This is a small, irregular domain in the southern part of the survey that is characterised by low magnetic intensity. The basement rocks of this domain have been intersected by drillhole Mallabie 1, with a sample of granodioritic gneiss dated at 1505±7 Ma (Wade et al., 2007). This domain possibly represents a single intrusive body or may be much more extensive than this single pluton, possibly representing a corellative of the 1505-1487 Ma Undawidgi Supersuite, recognised in drillholes FOR010-012 in the western part of the Coompana Province (Wingate et al., 2015).

Domain 4. This domain occurs in the northwestern corner of the project area, where it has a sharp north-northeast-striking contact with domain 2 to the southeast. Domain 4 is characterised by generally low amplitude, long wavelength magnetic anomalies. Petroleum exploration well Mulyawara 1 intersected granitic rocks in this domain, with a magmatic crystallisation age of c. 1170 Ma (Neumann and Korsch, 2014). Domain 4 is also the along-strike extension of magmatic rocks of the Moodini Supersuite dated at 1195-1175 Ma and found to be intruding Undawidgi Supersuite in drillholes FOR010 to FOR012 (Wingate et al., 2015) similar in age to the c. 1220-1120 Ma Pitjantjatjara Supersuite of the Musgrave Province (Edgoose et al 2004; Smithies et al 2011; Jagodzinski and Dutch, 2013).A single annular anomaly within domain 4 is visually similar in size and amplitude to numerous features observed in domain 5.

Domain 5. This is a north-northeast-striking linear belt characterised by prominent elliptical and occasionally annular or zoned anomalies. Drillhole Eucla 1 penetrated the southwesterly extension of this belt on the West Australian side of the border. The magnetic character surrounding Eucla 1 is dominated by discrete oval to annular anomalies that are interpreted to represent individual plutons, displaying a sharp intrusive contact with a weakly magnetic host. A granite sample from Eucla 1 was dated at 1140 ±8 Ma and correlated with the Moodini Supersuite (Wingate et al., 2015). Due to the spatial partitioning of 1195-1175Ma rocks of the Moodini Supersuite in domain 4, and the slightly younger (i.e. c. 1140 Ma) rocks in domain 5, it is possible that distinct magmatic events are recorded in each domain. The age of the rocks from domain 5 are similar to the latter stages of the Musgravian Orogeny and Pitjantjatjara Supersuite (Smithies et al 2011; Jagodzinski and Dutch, 2013; Walsh et al 2015; Tucker et al, 2015, Howard et al 2015). Domain 5 appears to continue to the north east and abuts the margin of the Gawler Craton. It is unclear whether the belt of plutons intrudes the Gawler Craton, or whether there was a structural juxtaposition of the northern Coompana Province against the Gawler margin, similar to that seen at the Jindarnga shear zone (Dutch et al., 2015).

Dykes and volcanic rocks

Two sets of thin, continuous magnetic features, one northwest trending and the other north-northwest trending, are observed within this area (Figure 1). A cross-cutting relationship is visible, with the northwest trending set appearing to cross-cut, and therefore post-date, the north-northwest trending set. These features are interpreted as steeply-dipping dykes.

Two regions of stippled high-frequency magnetic anomalism can be observed, and are interpreted to be sub-horizontal sheets of volcanic rock (Figure 1). Sheet A, in the south west corner of the survey covers a large region, and is interpreted to overlie granitic basement, and be overlain by sedimentary cover rocks. The northwest trending dykes are possible feeders to this volcanic sheet. Sheet A may extend further east than is interpreted in Figure 1, although it may be difficult to detect due to increasing cover thickness which may be masking the magnetic signal.

Sheet B is in the northwest of the survey region, abutting the West Australian border. Sheet B appears to comprise several zones of very high frequency magnetic signal. The high frequency signal indicates that the magnetic source is shallow and is therefore interpreted to be a volcanic succession overlying significant sedimentary cover. Sheet B is interpreted to be related to the north-northwest dyke swarm.

Two distinct phases of dyke intrusion and volcanism can therefore be recognised in the aeromagnetic survey. The older magmatic phase is north-northwest-striking dykes, which are interpreted to be correlatives of the widespread c. 825 Ma Gairdner–Amata dolerite suite that intruded the Musgrave Province and Gawler Craton (Crawford and Hilyard 1990; Werner et al. 2014; Wingate et al. 1998; Zhao and McCulloch 1993; Zhao, McCulloch and Korsch 1994). This phase also includes the mafic volcanic rocks intersected in drillholes CD 1, BN 1–2, KN 1 and Mallabie 1 in the southern part of the Coompana Province (i.e. volcanic sheet A; Fig. 1) that were recently dated at 859 ± 66 Ma in CD 1 (Travers 2015).

The younger magmatic phase includes the northwest-striking dykes and volcanic sheet B. These are possibly equivalent in age to the Cambrian Table Hill Volcanics that are exposed to the north, and part of the wider Kalkarindji Large Igneous Province (Cowley 2009).

Coompana Magnetic Anomaly

The Coompana Magnetic Anomaly is located in the south western corner of the survey and is a prominent circular, reversely polarised anomaly (Figure 1). More detailed imaging of this region is provided by the increased resolution of magnetic data acquired at 200m line-spacing over the Coompana Magnetic Anomaly (Figure 1, 2). Additional interpretations at a smaller scale are provided in figure 4 and discussed here.

Several smaller, and also reversely magnetized, satellite bodies are visible within and surrounding the main anomaly (Figure 2). The causative body of the Coompana Magnetic Anomaly appears to intrude the boundary between basement domains 2 and 5 (Figure 1). The ovoid and jointed high-frequency magnetic character of a Moodini Supersuite pluton within domain 5 appears not to be overprinted by the longer-wavelength Coompana Magnetic Anomaly, suggesting the reversely magnetized anomaly is from a deeper source Similarly, the stippled magnetic signature of the Neoproterozoic volcanic sheet A are likewise apparently not destroyed by the

intrusive body causing the longer-wavelength Coompana Magnetic Anomaly. These observations suggest that the Coompana Magnetic Anomaly is caused by a circular, disc-like intrusive body at depth.
Several satellite bodies appear to be associated with the main Coompana anomaly. In at least four cases, these satellite bodies overprint the Moodini Supersuite plutons. In addition, these satellite bodies also appear to intrude the causative body of the main anomaly. This suggests that these satellite bodies intruded subsequent to the large intrusive body. Further, the circular or cigar-shape, and the high definition of the magnetic response, of these satellite bodies probably indicates that these bodies are probably pipe-like satellites that intruded to higher levels in the crust than the intrusion that caused main Coompana Magnetic Anomaly (Figure 2). From the aforementioned relationships, it is possible to estimate the age of the intrusions producing the Coompana Magnetic Anomaly to between ~1120 Ma (post-dating the Moodini Supersuite) and ~860 Ma (pre-dating the Neoproterozoic volcanic sheet).

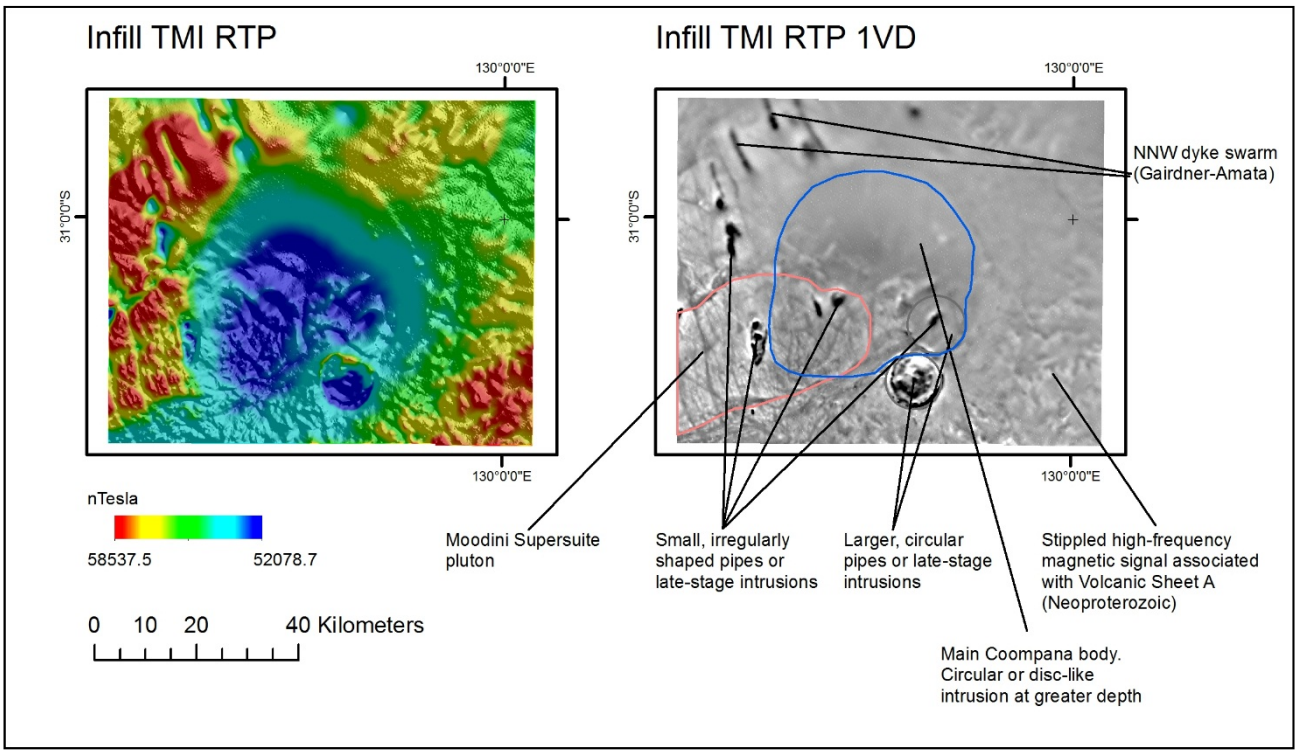

Figure 2; 200 m line-spaced infill of the region surrounding the Coompana Magnetic Anomaly. Simple interpretation of TMI RTP 1VD image (right).

CONCLUSIONS

This preliminary interpretation of the aeromagnetic survey has distinguished basement five domains based on the magnetic data, and identified episodes of volcanism and dyke emplacement. We have used existing geological constraints to suggest a likely basement lithology for each domain and age relationships between domains and magmatic events.
Detailed interpretation of the high resolution infill survey over the enigmatic Coompana Magnetic Anomaly has elucidated contact relationships between the main intrusive body, numerous satellites, and the host rocks. The defined contact relationships constrain an intrusive age to between c. 1120 Ma and c. 860 Ma.

This early work will form the basis for a series of activities that will aid the geological understanding of this region:

- This will start with a detailed interpretation of the aeromagnetic survey, which will further examine the hypotheses presented here.
- This more advanced interpretation will be done in parallel with interpretation of the Coompana Province section of the Eucla-Gawler seismic line, thereby allowing the development of a model consistent across all data sets.
- A planned 1 and 2 km spaced gravity survey south of the trans-Australian railway line will be conducted in 2016, providing significantly better resolution gravity data in the area.
- Gravity and magnetic inversions and forward modelling along the seismic section and across the Coompana magnetic anomaly will provide an indication of the distribution and structural geometries of the basement units across the province.
- Collection of the AusLAMP magnetotelluric survey has been completed in the west of the state. This data will be processed and modelled during 2016.
- Finally, the results of these interpretations, in conjunction with new gravity data and modelling, will help to determine locations for a planned regional drilling program in the Coompana Province commencing in early 2017, funded through the PACE Copper initiative.

By integrating the above datasets together with new constraints on the geology from regional drilling and re-sampling of existing drill holes, an interpretation of the geometry and geodynamic history of the Coompana Province will be constructed. This data and synthesis will help the development of an evolving geological framework for the region, and therefore inform explorers in opening up a new mineral exploration province in South Australia.

ACKNOWLEDGMENTS

The Coompana magnetic survey was funded by the South Australian Government through the PACE Frontiers initiative. Geoscience Australia are acknowledged for their project management and QA/QC of the aeromagnetic survey and acquired data.

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