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SUBMISSION TO NORTHERN TERRITORY GEOLOGICAL SURVEY (NTGS)

NORTH ARUNTA PROJECT,
BONITA SUB-PROJECT

Airborne Electro Magnetic data acquisition and processing

FINAL REPORT

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Distribution

❑ Northern Territory Geological Survey – digital
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1. Summary

The objective of the proposed geophysical program is to increase interest in the underexplored Northern Arunta area by means of generating target areas and aid geological interpretation work using geophysical techniques not previously employed in the area.

EM work is new to the area. Historically, EM work has generally only been used to delineate highly conductive bodies at depth, which are generally massive sulphide targets. ABM Resources is of the opinion that EM would also be successful in defining regional structures, bodies of increased disseminated sulphides, and variations in regolith depth, especially in areas where the surrounding stratigraphy is extremely resistive, to aid mapping of geology and further targeting for mineralised structures.

Airborne EM over the Bonita project highlighted a previously unidentified regional structure, as well as thick transported cover and deep weathering in the majority of the ABM tenure. Data integration with other geophysical datasets and geochemical sampling will aid target generation and geological interpretation in the area, with further proposed work including EM data processing to remove the effects of overburden from the dataset, to help identify features in the EM data below cover.
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3. Introduction

The North Arunta project is located directly north of Alice Springs, with the majority of ABM’s tenements accessible from the Stuart Highway or via the Tanami Highway. The Barrow Creek subproject is approximately 300km north of Alice Springs along the Stuart Highway and stretches west for 85km. The Reynolds Range subproject tenements are accessible via the track to the Coniston station; 150km north of Alice Springs and between 60km and 120km from the Stuart Highway. The Bonita tenements lie directly to the west-northwest of Reynolds Range, but are best accessed following small regional tracks directly north of Yuendumu, off the Tanami Highway. Most of these tenements have had little exploration and vehicle access is difficult.

In April 2012, an airborne Electro Magnetic (EM) geophysical survey commenced by Fugro Airborne Surveys for ABM Resources over the three project areas of Barrow Creek, Reynolds Range and Bonita tenements (Figure 1). The Bonita EM survey met the minimum requirements to qualify for the Northern Territory Geological Survey collaborations grant and is highlighted in this report.

The Bonita survey comprises a total of 1,229 line kilometres over EL 23926 and EL 29368, with 1,000m line spacing and a line direction of 42 degrees. The nominal terrain clearance was 120m. The Bonita portion of the survey flights experienced some maintenance related delays and commenced on the 21st of June 2012. Fugro’s acquisition and processing report is included in Appendix A, and covers the three survey areas.

Fathom Geophysics Pty Ltd., Perth, processed and interpreted the data for ABM in view of exploration aspects. Due to the favourable EM response over the Barrow Creek project, the majority of interpretation work has focused on this area. Further details on interpretation work are covered in section 8. Fathom’s ‘Stage 1’ interpretation and plate modeling report is included in Appendix B. Further stages of interpretation have not yet been completed but may include forward modeling of conductive plates and removal of transported / weathered material from the raw data response to enhance or highlight buried conductors, and data integration between EM and magnetic datasets.
4. Regional Context

a. Regional Geology

The oldest exposed basement in Central Australia comprises metamorphic and igneous rocks of the Arunta Inlier (Haines et al., 1991). Rocks of the Arunta Inlier are interpreted as being at least partly correlative with sedimentary and volcanic sequences of the adjacent Tennant Creek and Granites - Tanami Inliers.

The Arunta Inlier (Early-Middle Proterozoic) is characterised by metamorphosed sedimentary and igneous rocks of low to medium pressure facies. Deformation and regional metamorphism to upper green schist facies took place between 1810-1750 Ma (Black, 1981). Shaw and Stewart (1975) established three broad stratigraphic subdivisions based on facies assemblages and lithological correlations. From oldest to youngest, these subdivisions are named Division 1, 2 and 3. Using this model defined by Shaw and Stewart (1975), the orthogneiss east of Osborne Range, the calc-silicate rocks west of Crawford Range and the Bullion Schist would be included in Division 2, and the Ledan Schist in Division 3 of the Arunta Inlier.

Unconformably overlying these rocks are the Hatches Creek Group sediments and volcanics. Blake et al. (1987) formally subdivided the Group into the Ooradidgee, Wauchope and Hanlon Subgroups, comprising a total of 20 Formations and two Members. The Hatches Creek Group is a folded sequence of shallow-water sediments with interbedded volcanic units which reach thicknesses of at least 10,000 metres.
The sediments include ridge-forming quartzites, felspathic, lithic and minor conglomeratic arenites and friable arenite, siltstone, shale and carbonate. The Ooradidgee Subgroup consists mainly of fluvial sediments and sub-aerial volcanics which partly interfinger. The Wauchope Subgroup is characterised by large volumes of volcanics and sediments probably both marine and fluvial in origin. The Hanlon Subgroup may be entirely marine and lacks volcanics (Blake et al., 1987).

Deformation and regional metamorphism took place between 1810-1750 Ma (Black, 1981). Folding was about NW trending axes while metamorphism to upper greenschist facies took place. Later intrusion of both the Arunta basement and the Hatches Creek Group by granitoids of the Barrow Creek Granitic Complex took place around 1660 Ma (Blake et al., 1987). Contact metamorphism and metasomatism are often observed.

Sedimentation associated with the Georgina Basin commenced during the Late Proterozoic with the Amesbury Quartzite and was terminated during the Early Devonian after deposition of the Dulcie Sandstone. The Georgina Basin sequence was mildly affected by the Carboniferous Alice Springs Orogeny. A long erosional period followed with subsequent deep weathering during the Tertiary produced silcrete and ferricrete horizons. A veneer of Quaternary sands and soils overlays much of the area, except where recent and active alluvial sedimentation is present.

### b. Mineralisation

Most of the gold mineralisation in the Barrow Creek and Reynolds Range areas appears to be concentrated along a relatively narrow corridor of greenschist facies Lander Rock Formation meta-turbidites. Where there is good exposure in the central part of the belt at Reynolds Range, folding in the Lander beds has northwest-striking axes, plunge towards the southeast and verges towards the southwest with steep southwestern limbs and gently dipping northeastern limbs (English, 2006). The mineralisation at Barrow Creek has very limited outcrop.

Widespread gold anomaly was identified within greenschist-facies metasediments along the eastern side of the Reynolds Range in the early 1990’s. Gold is hosted by sulphidic quartz veins and has been interpreted to broadly correlate with gold mineralisation in the Tanami region.

The highest grade gold mineralisation at Reynolds Range is at the Sabre and Falchion prospects. High grade intercepts occur in rocks of higher metamorphic grade, such as the Black Knight Prospect, but more commonly it appears to be associated with retrograde greenschist facies metamorphism. Gold mineralisation occurs in a number of different geological settings and with a number of different metal associations, but always seem proximal to zones of structural complexity, running along the entire Reynolds Range area, producing narrow zones of high grade mineralisation in broad zones of anomalism.

Limited historic data is available for the ‘Reward’ historic copper mine, although a shallow pit and recent rock samples indicate that a small amount of moderate to high grade copper has been mined in the past.
At Barrow Creek, the best mineralisation is found at the Kroda 3 prospect. Mineralisation here is associated with a retrograde shear zone with 14km of known gold anomalism. The higher grade is localized in a quartz-brecia of limited strike length and most likely represents a releasing bend structure along the shear. Most of the mineralisation is associated with increase in sulphides, arsenic and occasionally with increases in copper and zinc.

Historic mining activities exist in the vicinity of ABM’s tenure, and include the Mount Strzelecki copper workings, nearby Home of Bullion copper deposit, and the tantalum workings at Miller’s.

Mineralisation at the Bonita subproject has not yet been identified, but the available geophysical dataset thus far suggests expected similarities to Barrow Creek and Reynolds Range style depositional mechanisms.

5. Previous Exploration

Previous exploration in the North-Arunta part of ABM’s landholding has focussed on the Barrow Creek and Reynolds Range projects, with extremely limited exploration over the Bonita project area.

Exploration at Barrow Creek has historically been largely for base metals, gold and tin, tungsten and tantalum deposits. Within the Crawford, Osborne and Watt Range areas, numerous copper workings can be found, including Home of Bullion and Petricks. The area to the south of the Crawford Range has been the site of the majority of tin, tungsten and tantalum workings, most being small, low tonnage operations. Exploration is predominantly based on surface geochemistry and shallow drilling techniques.

Historically, large parts of the Reynolds Range project area have been intensely explored since 1992 with surface samples collected and vacuum-RAB drill holes completed. A number of prospects were identified from this work and more moderate levels of shallow RC and occasional diamond-drilling, and some magnetic and gravity surveys were completed. This exploration identified some sub-economic gold occurrences; although previous explorers did not do more follow up work in the area.

Exploration over the Bonita target area has been extremely limited, with only a handful of laterite samples collected in the far north-western corner of the tenement by North Flinders in 2000, followed by a line of aircore holes in another part of the tenement in 2002 (CR2002-0143). Normandy NFM also drilled a 42km long line of 2km spaced aircore holes in 1999 (CR1999-0419), of which the easternmost six fall within the current tenement held by ABM. Best result is 260ppb in the aircore line drilled over ABM’s current prospect and geophysical target called Swampy.
6. Exploration Concept

The geology, mineralisation style and structural deformation at Barrow Creek and Reynolds Range are incredibly similar. Comparisons are also made with the Tennant Creek area, which is historically explored differently, and where geophysical surveys have had great success in the past. Magnetic interpretation work suggests that Bonita is characterised by similar stratigraphy as Reynolds Range, and is located along strike of major structures and stratigraphy. However, due to thicker cover of transported material, and difficult access, the area has historically been left out of systematic exploration and mapping campaigns.

Since exploration on ABM’s tenure in North Arunta has historically focussed on gold, no significant amount of EM work has been done as it is usually deemed inappropriate for gold exploration. However, Emmerson has recently employed airborne EM to find weak conductors in areas of very poorly conductive background around Tennant Creek. In addition to mapping geological structures with EM, they found that EM also successfully provided further targets for follow up drilling. The similarities between Tennant Creek and ABM’s tenure suggest that EM would also be highly effective to map geology and generate targets in regions difficult to explore with conventional drilling.

What all project areas have in common, and what is expected for Bonita, is that the majority of the mineralisation is narrow and high grade, set in broad zones of anomalism. Structural complexity seems to be the main driver to localize mineralisation in high grade shoots, with first or second order structural feature being the source of the mineralising fluid. While no single airborne geophysical technique can be used on its own to generate individual targets (other than massive sulphide deposits), ABM hopes that airborne EM data interpretation will help identify favourable first or second order thrust or transfer faults as potential sources for mineralising fluids.

The Bonita project is still one of the most underexplored areas in the Northern Territory. ABM’s intention is to integrate EM data interpretation work with the knowledge from known mineralisation at several prospects and old workings at Barrow Creek and Reynolds Range, to rapidly advance the Bonita project and aid target generation in the area.

7. Details of Collaborative Program

The Bonita airborne EM survey qualified for the NTGS collaborations grant as it covers a large area at 1000m spaced lines. Geophysical data interpretation of this area will greatly benefit from the higher density data collected simultaneously at Barrow Creek and Reynolds Range at ABM’s expense, as well as better geological knowledge from previous explorers and ABMs work in these areas.

All flight lines were designed perpendicular to the general geological trends as identified from magnetic data. The flight height is 120m, to obtain the best data integrity and resolution using Fugro’s acquisition equipment. Fugro’s TEMPEST features include an extremely broad bandwidth which makes it capable of resolving subtle variations in conductivity from the near surface to many hundreds of metres deep, making it ideally suited to high resolution mapping of both deep and
shallow targets (Appendix A). The fixed wing configuration provides fast and cost effective acquisition of detailed conductivity data over large areas, enabling quick identification of high priority targets, and minimizing environmental impact and access problems.

8. Results and Interpretation

For technical background on Fugro’s data acquisition methods and equipment, please refer to Appendix A: Acquisition and Processing report.

Acquired EM data was made available to ABM in located 3D data (.gdb), and grid format (.ers data of slices in both the X and Z component). Data for each flight line was also collated into a cdi image and exported as .pdf images. Raw data and cdi images have been submitted to the NTGS on cd.

In addition to the EM data, coincidental magnetic data was collected. The flight spacing is half of the open file data available from the NTGS website, however, the flight altitude and speed are not ideal for collection of magnetic data. The resulting data is available in grid format (.ers) of the total magnetic intensity (TMI) and the first vertical derivative (TMI_1VD).

ABMs interpretation work on the data received from Fugro concluded the following:

A significant structural break is apparent at the southern end of ABM’s tenement holdings (Figure 2). This structural break is not directly obvious from magnetic data (underlying layer in Figure 2), although regional gravity shows similar structures on a regional scale. The structure highlighted in the EM data most likely represents a regional thrust fault, which has not previously been identified or mapped. A similar regional structure has been identified by the NTGS in the past and mapped approximately 15km south of ABM’s Bonita project, and runs along the southern margin of the Reynolds Range project.

Gravity data suggests that the new identified regional fault could continue and form the northern margin of the Reynolds Range project, with mineralised stratigraphy in between these structures.

On a tenement scale, the most obvious observation is the thick cover of transported material and deep weathering profile. Elsewhere in the Tanami, cover is generally between 1 – 5m in thickness, with the occasional palaeochannel. Palaeochannel cover can be up to 200m but is generally in the vicinity of 10 – 40m.

Transported cover at Bonita, north of the thrust fault, appears to be consistently around 30 – 40m in thickness (Figure 3). Figure 2 shows the deeper sections of the two parallel palaeochannels, running roughly north – south. South of the regional fault, cover is much shallower, with the two parallel palaeochannels represented by much narrower but deep channels. From this, it can be deducted that the regional fault moved the southern block upwards. Assuming that the regional fault is indeed a thrust fault, this suggests a southerly dip on the structure. Alternatively, and slightly better matching Figure 3, the structure could represent a regional normal fault, with a northerly dip. Higher resolution geophysical data is required to better characterise the regional structure.
Figure 2, ‘depth-slice’ of the 8th band of the Z-component of the collected EM data over Bonita. Background image is the open file airborne magnetic data.
Figure 3, part of a CDI section of one of the flight lines over Bonita. View is to the north-west.
Interpretation work by Fathom geophysics on the acquired EM data focussed on the Barrow Creek project, as quantifiable EM anomalies were clearly present in ABMs dataset. Plate modeling resulted in ten EM anomalies possibly representing massive sulphide accumulation, which were subsequently drilled by ABM.

Quantifiable anomalies are also recognized on the Reynolds Range dataset, with the most significant just southeast of the historic Reward Copper mine. Historic drilling appears to have tested directly underneath (down dip) of the historic workings and results were disappointing. However, the identified conductor lies towards the south-east, and at depth, representing a potential down-plunge component. The strength of the conductor is less than those recognized at Barrow Creek.

For Bonita, no quantifiable anomalies are recognized in a first-pass plate modeling exercise done by Fathom geophysics. The main reason for this is again the thickness of the cover. Transported cover is highly conductive, which makes it difficult to identify conductors at depth. Current will flow in a good conductor longer than it will in a poor conductor, so a flat conductor at surface could have a strong and continuous signal potentially completely masking a conductor at depth.

Fathom Geophysics have not done further processing of ABMs EM data since the Barrow Creek drilling program, but may be able to effectively remove the overburden signal from the dataset, which may aid to enhance more subtle conductors at depth.

The Swampy prospect is one of the main reasons for ABMs interest in the Bonita project. Swampy is characterised by a strong circular magnetic high feature of about 2km in diameter (Figure 4) on the edge of a moderate gravity high. The structural setting is also prospective, with structures visible from magnetic data to the north, and along strike from Reynolds Range.

EM data revealed another regional structure just south of Swampy, as discussed earlier (Figure 4). Additionally, the direct vicinity around Swampy seems to have the most conductive material at depth. If nothing else, this means that the area around Swampy has experienced the most extensive weathering, and subsequent palaeochannel formation (Figure 5). Material more prone to weathering may indicate favourable structures and / or fluid flow, possibly associated with mineralisation. Most gold deposits in the Tanami show a deeper zone of weathering around mineralisation, compared to surrounding unmineralised material.

Removing the overburden from the EM dataset may highlight more subtle features of the stronger conductivity and deeper weathering over Swampy, to help put the magnetic anomaly into context.

The thickness of cover over the Bonita project hampers the standard exploration approach using regional geochemical work and mapping. A few holes have been drilled near Swampy, but it is questionable whether these made it through the cover.

ABM has developed and successfully tested a Deep Penetrating Geochemistry (DPG) method using low-detection laboratory assaying on surface soil samples, with the aim to obtain a response from mineralisation through cover. Regional geochemical work has already been completed over Swampy and parts of the tenements, and initial results are promising. Further levelling and interpretation work will be required, but it is anticipated ABM will visit the Bonita project again during 2013 for further regional geochemical sampling campaigns.
Figure 4, Swampy prospect location on TMI magnetic data (top) and ‘depth-slice’ of band 14 EM data (bottom).
9. Conclusion

EM data collection over the Bonita project has resulted in a number of observations:
- A previously unidentified regional structure is recognized
- Thick cover and deep weathering is present over the majority of the Bonita project
- Quantifiable anomalies associated with potential massive sulphide mineralisation have not been identified over the Bonita project, with the Swampy prospect possibly masked due to the thickness of transported cover and deep weathering
- Further work is required;
  - Geophysical processing of EM data to effectively remove the overburden from the dataset
  - Collection of higher resolution geophysical data over the Swampy prospect and the regional structure
  - Integrate EM data with magnetic and gravity datasets
  - Follow up regional geochemical work to put geophysical anomalies into further context
10. References

Black L.P., 1981. Age of the Warramunga Group, Tennant Creek Block, Northern Territory. BMR Journal of Australia Geology and Geophysics, 6, 253-257.


11. Appendices

Appendix A: Fugro, July 2012, Tanami, Northern Territory TEMPEST Geophysical Survey – Acquisition and Processing Report for ABM Resources NL.