Application of electrical geophysics to exploration at the Lake Mackay Project

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Introduction

The Lake Mackay Project is a joint venture between Independence Group NL (IGO), Prodigy Gold NL and Castile Resources Pty Ltd. It is located ~400 km northwest of Alice Springs and consists of 8058 km^2 of granted tenure and 4900 km^2 of tenement applications within the southwestern Aileron Province (**Figure 1**). Initially, IGO identified much of this area to be prospective for lode gold deposits; however, in 2016 significant drill intersections confirmed the area as also being prospective for high-grade polymetallic base and precious metal deposits (Winzar 2016). Consequently, the exploration methodology was reviewed to ensure these attractive target styles are also effectively explored.

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Historical exploration

The project area has had very little historical exploration. In 1999, a previous explorer had targeted the Andrew Young Igneous Complex for magmatic Ni-Cu mineralisation with a large airborne electromagnetic (AEM) survey using the GEOTEM system. This led to follow-up of generated targets using ground-based moving loop electromagnetics (MLEM); subsequently, 10 RC holes were drilled (**Figure 2**) but failed to produce any significant assay results.

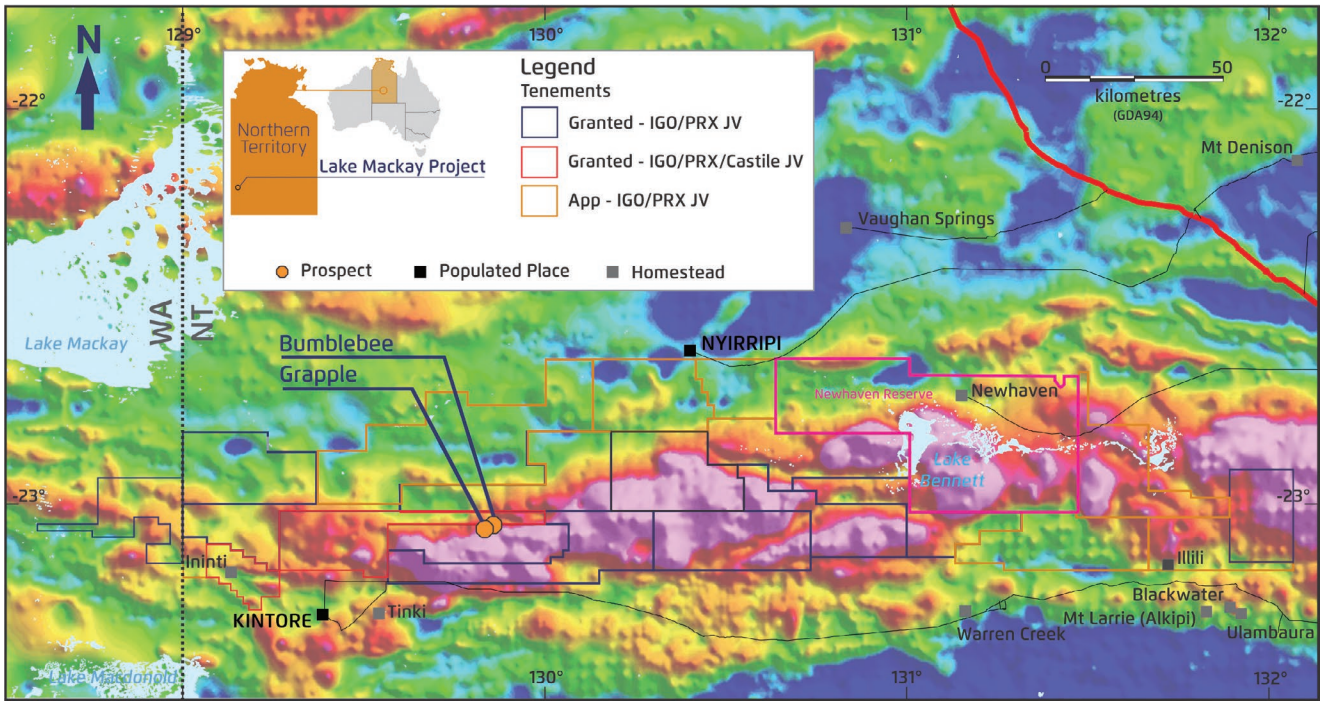

Figure 1. Location of the Lake Mackay Project over Bouguer gravity image.

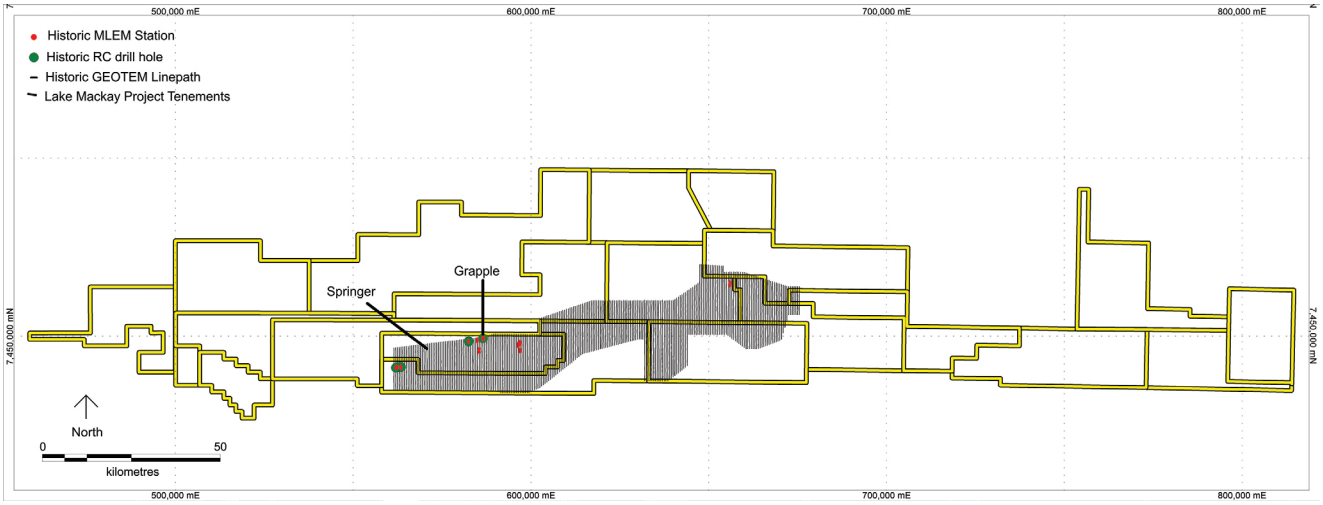

Figure 2. Location of previous exploration activities.

IGO initiated project-wide broad-spaced, reconnaissance soil sampling to locate gold mineralisation. This work culminated in the discovery of the *Bumblebee* prospect. Follow-up air core (AC) drilling returned a best result of 7 m at 3.29 g/t Au, 37.7 g/t Ag, 3.25% Cu, 0.87% Pb, 1.34% Zn, 0.09% Bi and 0.08% Co (15LMAC031).

Application of geophysics

The highest priority targets, including the Bumblebee polymetallic sulfide prospect, were outside of the existing GEOTEM coverage. With this in mind, the JV undertook an initial orientation EM survey in early 2016 over Bumblebee. A small MLEM survey was conducted using a 200 m loop, fluxgate receiver, and battery pack source in a slingram (receiver out of loop) configuration. Lines were spaced at 200 m with 100 m station spacing, providing excellent coverage over the geochemical anomaly. The eleven lines of the survey produced a significant response (**Figure 3**): a late time channel grid of the X component showing a strong single peaked anomaly. This result provided encouragement that EM could be an effective exploration tool.

Using the same configuration, the MLEM surveys were expanded later in the 2016 field season to cover lesser ranked soil anomalies, particularly those which showed anomalous copper. These surveys highlighted anomalies at both the *Springer* and *Grapple* prospects. The Grapple prospect, located only ~2 km southwest of Bumblebee, was previously identified in the historic GEOTEM survey. **Figure 4** shows a late time channel grid of the MLEM X component of the Grapple target. The target consists of two separate conductors. Initially, 11 reverse circulation (RC) drillholes were collared into the Grapple target, with the first (16GRRC001) directed into the eastern conductor.

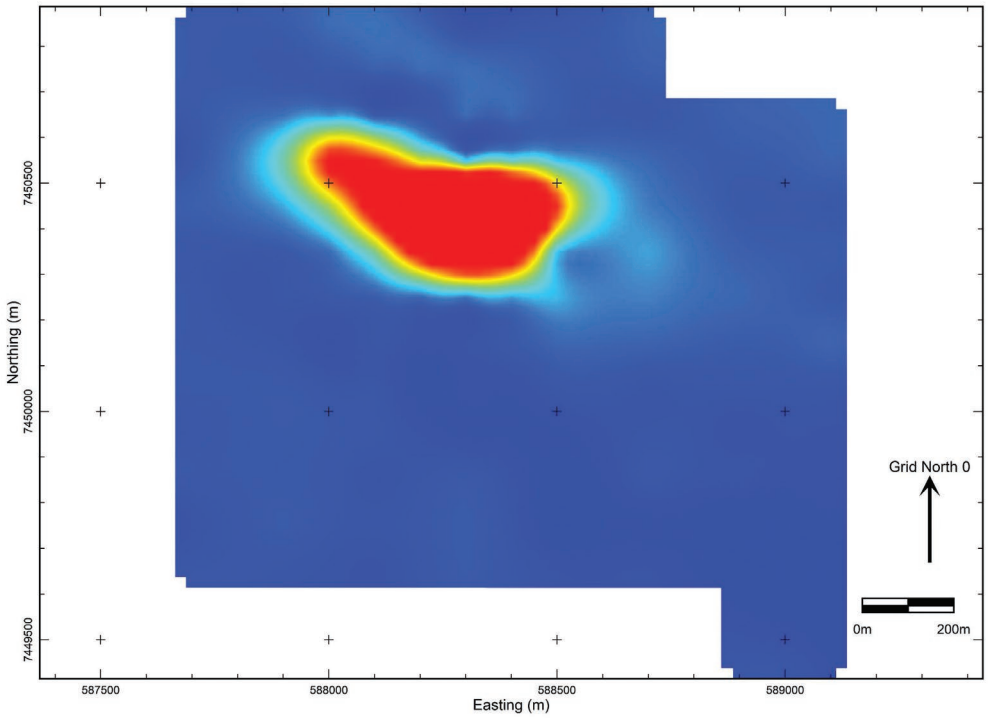

Figure 3. Bumblebee MLEM X component 15.7–20.2 ms channel.

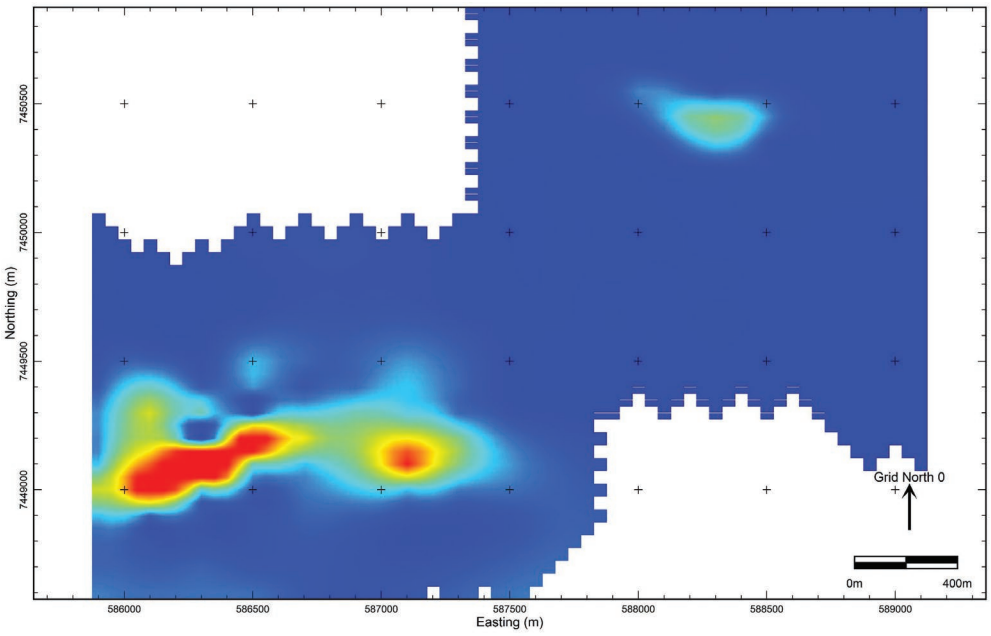

Figure 4. Grapple and Bumblebee MLEM X component 15.7–20.2 ms channel.

This drillhole intersected minor pyrrhotite mineralisation at ~160 m depth. Down-hole electromagnetic (DHEM) was completed on this drillhole using a 400 × 400 m square loop and a Digi Atlantis receiver system. Two distinct off-hole anomalies were identified (**Figure 5**) that clearly indicated the Grapple target had not been effectively tested.

The third RC drillhole (16GRRC003) in the campaign targeting the EM conductor was located further southwest and drilled under outcropping gossanous material. This drillhole intersected a zone of multiple sulfide horizons from ~80 m depth to ~160 m depth, with the most significant assayed interval being 9 m at 1.81 g/t Au, 49.1 g/t Ag, 3.26% Cu and 3.63% Zn from 85 m depth. This result confirmed the Grapple discovery.

DHEM was again completed in this drillhole using the same configuration; results indicated that multiple conductors had been intersected, and again, that off-hole conductors were present. The DHEM log not only confirmed the mineralisation was conductive and amenable to exploration through EM methods, but also confirmed that there was further scope to extend the mineralisation with EM through the identification of off-hole conductors. **Figure 6** shows the profile of the mid-time EM data from 16GRRC003 where the multiple conductors can be clearly seen.

The ground MLEM conducted in 2016 had also identified a significant conductor at the Springer prospect, which the historic GEOTEM survey had failed to identify. Recognising the large area of tenement holdings and the ineffectiveness of soil sampling in areas under cover, it was decided in 2017 to conduct orientation surveying using airborne EM to determine if modern EM systems could detect this conductor. The SPECTREM system was chosen to complete a four line orientation survey over Springer. The system clearly detected the prospect and provided very comparative results to the MLEM.

Figure 7 shows a comparison between similar time channels for the MLEM, the SPECTREM AEM and the historic GEOTEM survey. The MLEM shows a clear, well-defined conductor, while the SPECTREM shows a weaker, but clearly above noise levels conductor. The GEOTEM hints at a conductor; however, the strength is not considered significantly above noise levels. It should be noted here that there is a decrease in lateral resolution for each survey, the MLEM was conducted using 200 m spaced lines, the SPECTREM was completed using 300 m lines, and the GEOTEM was completed using 500 m lines. The completion of this orientation survey and comparison to the MLEM results has provided the confidence that a modern AEM system would be capable of effectively screening for conductive mineralisation under shallow cover.

Through a process of successive orientation surveys, the following strategy for applying EM to the Lake Mackay Project has been developed. A large SPECTREM AEM survey will identify anomalies that could represent conductive mineralisation; follow-up ground-based MLEM will then be conducted to define and rank each target prior to drilling; and finally, every drillhole will be logged with DHEM to confirm the target has been effectively tested. The example from Grapple has indicated that, although EM will be an effective tool for exploration, the method will also detect unmineralised conductors; therefore, it is important that the conductor is fully understood by considering all geological and geochemical as well as geophysical observations when ranking and testing targets.

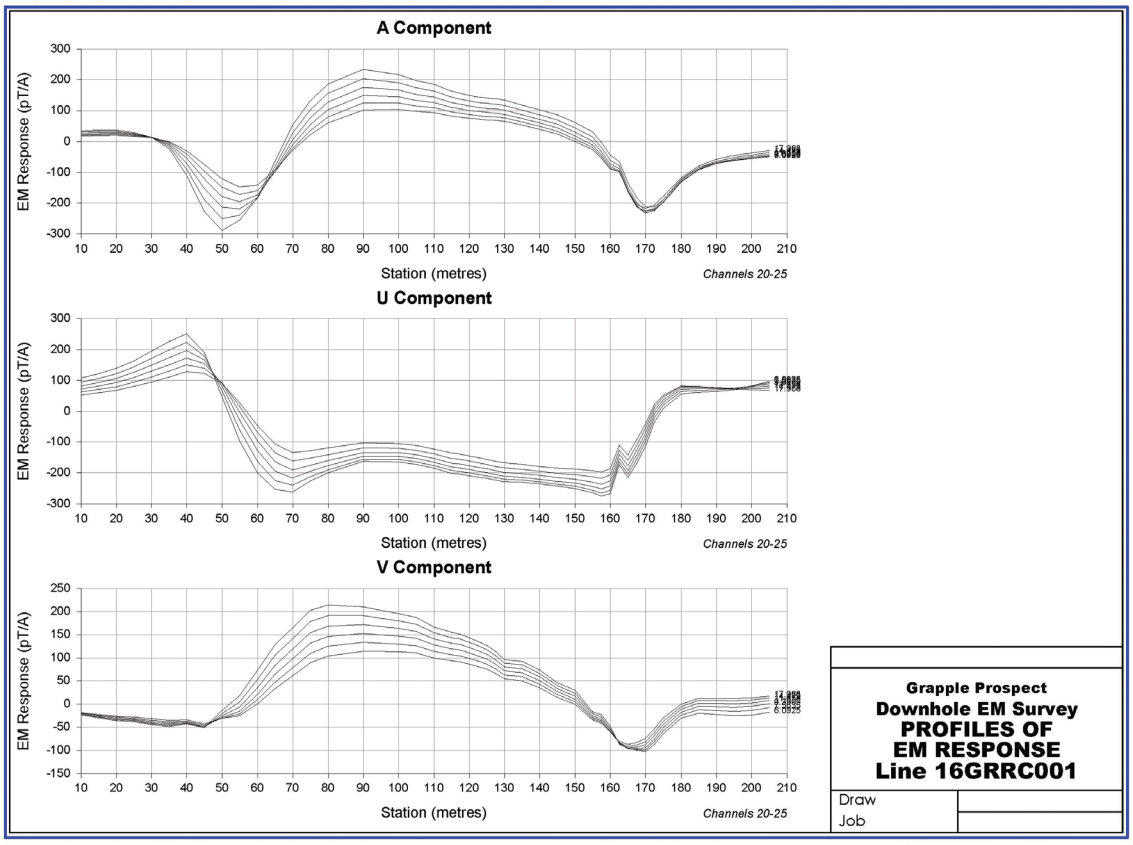

Figure 5. Drillhole 16GRRC001 DHEM profile of late time channels. Two clear off hole responses are present.

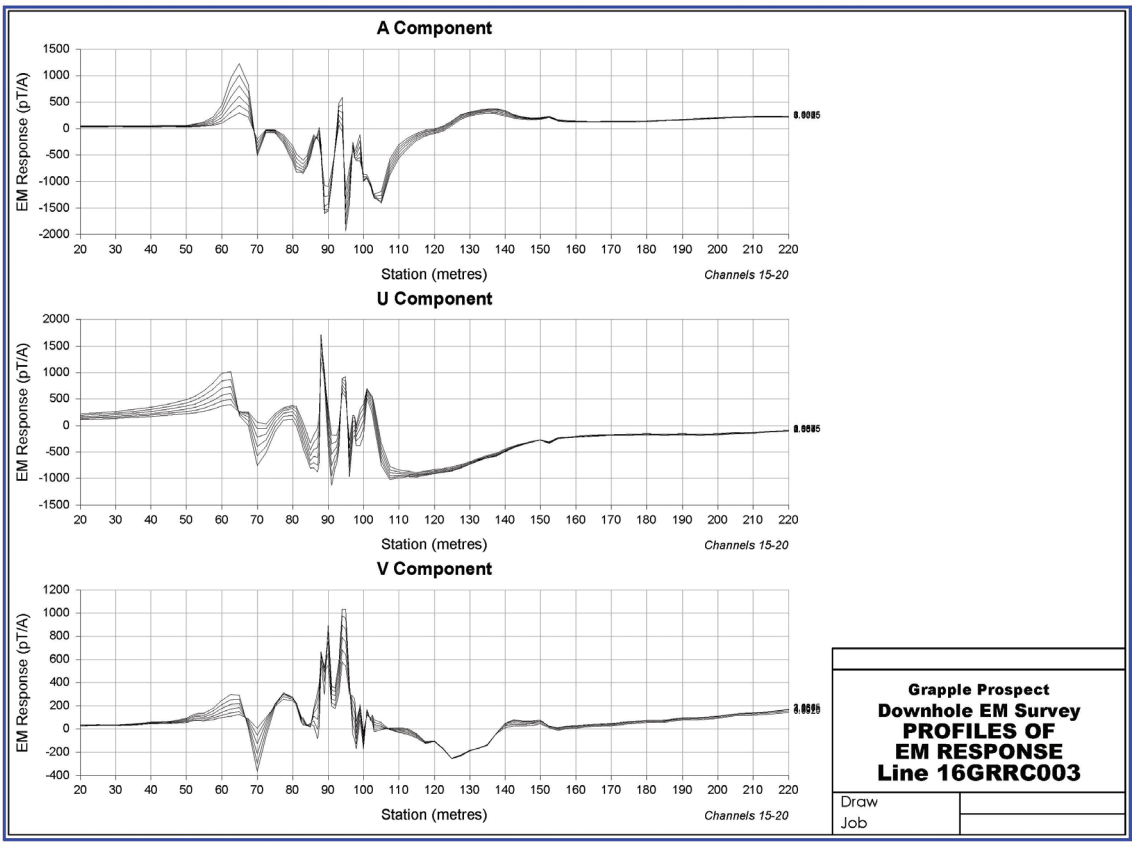

Figure 6. Drillhole 16GRRC003 DHEM profile of late time channels. Numerous significant in-hole and off-hole responses are present.

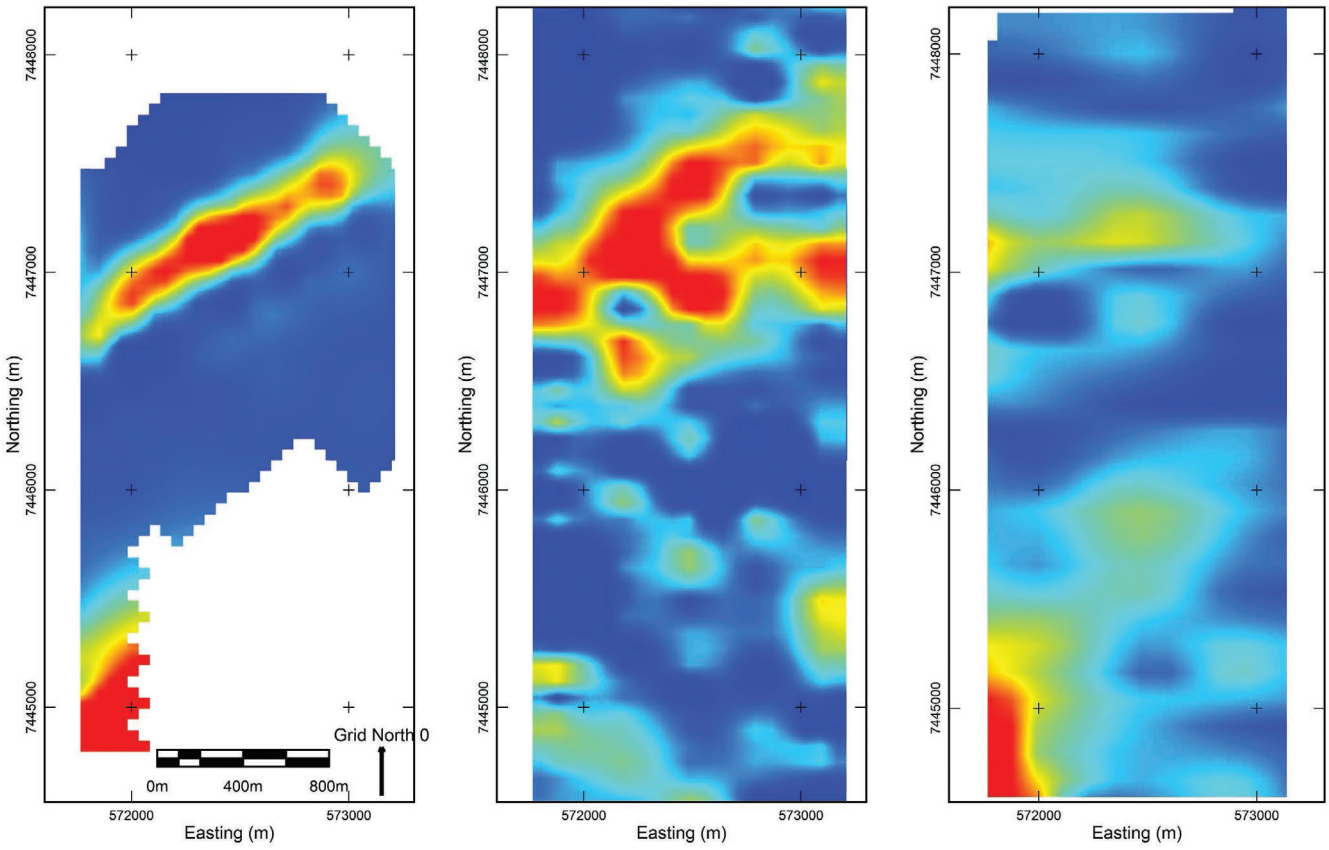

Figure 7. Left-MLEM Z component 1.8–2.3 ms channel. Centre-SPECTREM Z component 1.6–3.3 ms channel. Right-GEOTEM Z component 2.3–2.7 ms channel.

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Reference

Winzar D, 2016. Early indications of a copper-gold belt in the southwestern Aileron Province: in *'Annual Geoscience Exploration Seminar (AGES) Proceedings, Alice Springs, Northern Territory 15–16 March 2016'*. Northern Territory Geological Survey, Darwin.