Integrative geophysical approach for assessing the prospectivity of the Idlewilde intrusion, NSW.

Aurore Joly
St Barbara Ltd
1205 Hay St, West Perth 6005 WA
aurore.joly@gmail.com

David Maidment
St Barbara Ltd
1205 Hay St, West Perth 6005 WA
david.maidment@stbarbara.com.au

Graham Miller
St Barbara Ltd
1205 Hay St, West Perth 6005 WA
graham.miller@stbarbara.com.au

SUMMARY

The Idlewilde Intrusion (IWI) sits below ~150 m-thick sediment overburden and consists of a Palaeozoic basement of presumed Ordovician Macquarie Arc volcanics and the Nyngan Intrusive Complex. The geological setting is similar to the gold-rich Cadia and Northparkes porphyry-style deposits. Geophysical data include ground gravity, airborne magnetic and electromagnetic.

Gravity data define a negative ovoid with an elevated gravity inner zone. Magnetic data show a central high surrounded by a circular low zone as part of a broader regional low. Electromagnetic data outline: (a) ≤150 m-thick dual conductor corresponding to the overburden; (b) a medium conductor associated with the volcanics; (c) a resistor linked to the intrusion and (d) a slightly conductive annulus around the resistor interpreted as alteration, but may instead reflect the lack of sensitivity below the conductive overburden. The central part of the intrusion associated to gravity and magnetic highs could conceivably correspond to: (1) a magnetite-altered potassic core characteristic of gold-rich porphyry, (2) eroded granite with volcanics close to the surface, (3) roof pendant volcanics above a barely-eroded granite, and (4) a late monzonite pulse.

From an exploration point of view, gravity data delineate the extent of the IWI. The regional low magnetisation suggests that the intrusion may be a later intrusive phase. Electromagnetic data identify the footprint of a granitic body which cannot be clearly associated with an alteration system because of conductive overburden. A mineralised system is yet to be identified, and one of the first company priorities is now to resolve the inner part of the IWI.

Key words: gold-rich porphyry, gravity, magnetics, electromagnetics, Nyngan Intrusive Complex.

INTRODUCTION

Whilst no significant mineralisation has been found so far in the Nyngan area of NSW, all of the available geophysical and geological data indicates that this area has potential for a Northparkes style Cu-Au porphyry deposit.

Gravity, airborne magnetic, radiometric and time-domain electromagnetic results are here synthesized with a particular focus on the Idle Wilde Intrusion (IWI) where SkyTEM data were newly acquired. Electromagnetic surveys have the potential to map clay alteration and possibly sulphide rich propylitic alteration zones associated with porphyry-style hydrothermal systems.

The available geophysical data are articulated and interpreted over the IWI. The new results drive SBM targeting strategy by focusing on new areas of interest within IWI.

GEOLOGY

Regional geological setting

The Lachlan Orogen is part of the Tasmanides (Wellman, 1995) and is comparable, especially in regards to orogenic gold deposits, to other Phanerozoic orogens that formed by accretion of continental crust along the complex subduction zone of Gondwana, e.g. New Zealand and South America (Bierlein and Maher, 2001). The lithological units across the Lachlan Orogen include deep marine turbidites, shallow marine to sub-areal sediments, Silurian to Ordovician syntectonic granites and volcano-intrusive complexes attributed to the Ordovician Macquarie Arc (Wyborn, 1992).

Local geological setting

The IWI is part of the Eastern Lachlan Orogen and lies under Mesozoic sediments of the Great Artesian Basin (Figure 1). The interpretive geological map highlights Ordovician granitoids intruding the Ordovician Macquarie Arc that consists of mafic to intermediate volcanoclastics (Stuart-Smith, 2011). Wilson et al. (2007) believed that porphyry copper-gold mineralized zones in the Lachlan Orogen are associated with Late Ordovician monzonitic stocks that have intruded into late Ordovician volcanoclastic sediments rocks.

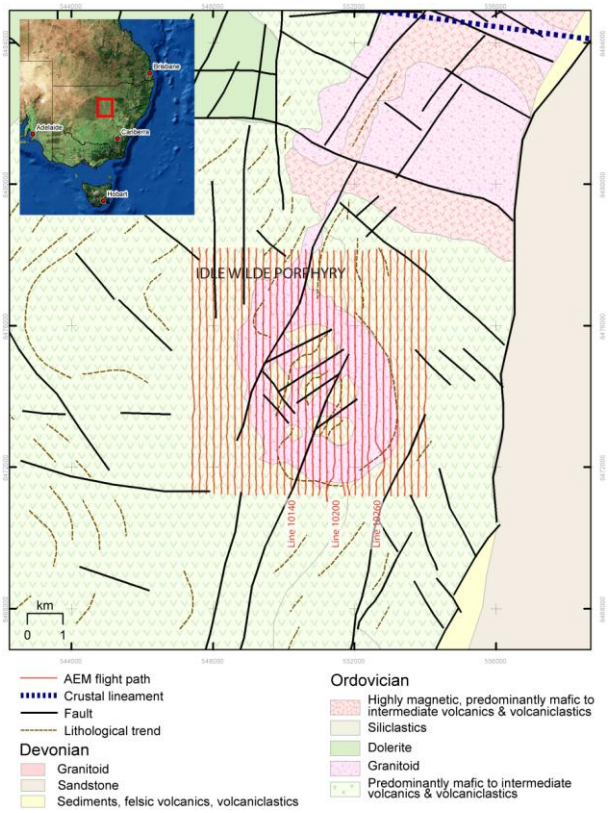

Figure 1. Solid geology interpretative map of the IWI with the AEM flight path location.

GEOPHYSICAL DATA OVER IWI

Gravity

Within the IWI area, gravity data were acquired at a regional station spacing of 4 km. SBM conducted thus a semi-detailed ground gravity survey in December-February 2012 by Daishat Ltd (410 stations with a nominal spacing of 300-800 m).

The limit of the intrusion is well defined on the residual gravity anomaly map: it is outlined by a sharp gravity gradient corresponding to the contact between the lower density granitic pluton and the higher density volcanic host rock. The centre is unexpectedly associated with a moderate positive gravity anomaly (Figure 2a).

Airborne magnetic and radiometric

Airborne magnetic and radiometric data were acquired in 1995 by Kevron Geophysics for the NSWDMR as a part of the Northparkes survey, with a line spacing of 250 m and a flight height of 60 m at a bearing of 090°. A high resolution airborne magnetic and radiometric survey was flown for St Barbara Limited, by Fugro Airborne Surveys Pty. Ltd. in March 2008 over the Nyngan tenements. The overall negative magnetic anomalies are more elongated and narrower that the negative gravity body. Internal to the magnetic low (57046 nT) is a discrete moderate magnetic high (57472nT, Figure 2b). No obvious-K anomaly contours the intrusion due to the presence of younger cover.

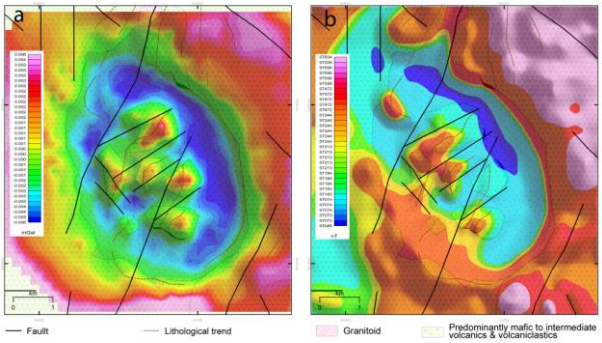

Figure 2. (a) 1VD gravity and (b) RTP magnetic. Major interpreted geological boundaries (Stuart-Smith, 2011) are shown as thin black lines and fault in thick black lines. See Figure 1 for details on geological boundaries.

In 2007, a Naudy Automatic Model routine (Naudy, 1971) developed by Intrepid Geophysics was run over IWI and determine a depth to magnetic basement of less than 120 m.

Airborne electromagnetics (AEM)

A SkyTEM survey, helicopter-borne time domain AEM system was performed by GroundProbe in May 2012 over IWI to identify porphyry copper-gold-type electrical geophysical targets (Auken et al., 2007 and references therein). The survey, flown with 200 m line spacing over a total of about 52 km², represents about 225 km of N-S flight lines (Figure 1). In this survey, the low moment had a magnetic moment of approximately 4760 Am^2 with time gates from about 25.7µs to 268.7 µs and the high moment had a high magnetic moment of approximately 507 840 Am^2 with time gates from 268.7 µs to 13.4 ms. In the context of this study, the maximum depth of investigation is about 400 m. The SkyTEM data were inverted by GroundProbe using a smooth 1D Laterally Constrained Inversion called HyTEM (Auken et al., 2005).

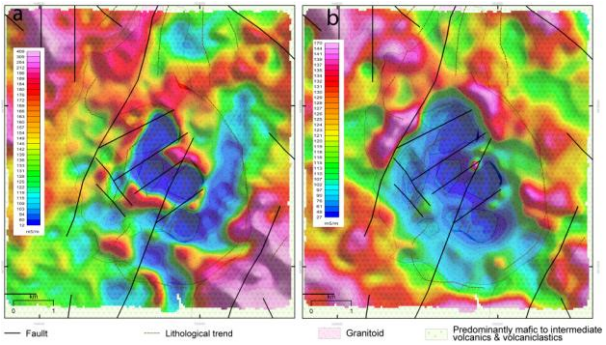

Figure 3. (a) Average conductivity map for the range – 50.7 m to – 61.2 m (HyTEM: 30 layers). (b) Average conductivity map for the range -348.9 to 372.3 m. Major interpreted geological boundaries (Stuart-Smith, 2011) are shown as thin black lines and fault in thick black lines. See Figure 1 for details on geological boundaries.

Four dominant features are evident in the final 400m-thick inverted model (Figures 3 and 4).

(1) A 20 to 120 m thick zone with a dual conductivity of 10 and 400 mS/m; the conductive surficial layer is non-existent on the central part of the AEM data.
(2) A zone with a conductivity of 100–200 mS/m;
(3) An ovoid-shape poor conductor of 30-50 mS/m. This resistor is evident in late time channels (from 231 to 450 m, e.g. Figure 3b) and it is still highlighted in early time channels (Figure 3a).
(4) An area with a conductivity of 50-100 mS/m that juxtaposes the highest resistor (e.g. 6476000N on Lines 10140 and 10200, Figure 4).

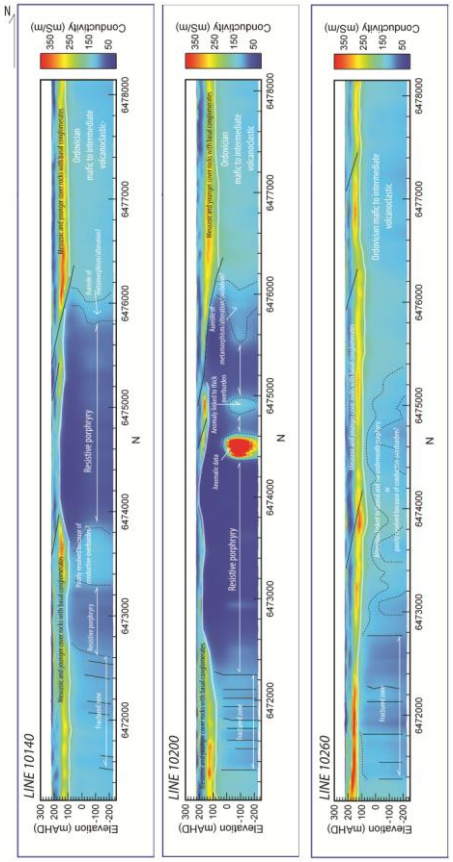

Figure 4. Interpreted conductivity profiles: Lines 10140, 10200 and 10260. See figure 1 for profile location.

IWI INTERPRETED GEOPHYSICAL DATA

All available geophysical datasets confirm the presence of an intrusive hosted within volcanics rock. Geophysical data raise our interest in the inner part of this intrusion associated to magnetic and gravity highs. Four hypotheses are articulated to explain both high gravity and magnetic anomalies (Figure 5). This could be explicated by (1) a dense, resistant and magnetite-altered potassic core, characteristic of a mineralized, altered porphyry system (bullseye signature; Clarke et al., 1992; Sillitoe, 2010), (2) the fact that most of the granitic cupola is eroded, leaving the underlying dense and magnetic volcanics very close to the surface; (3) dense and magnetic volcanic roof pendants sitting on top of the barely-eroded granite or (4) dense, magnetic and resistant monzonite occupying the inner part of the granitic intrusion. No SBM drillholes can corroborate any of these hypotheses as they are 387.2m deep at the most.

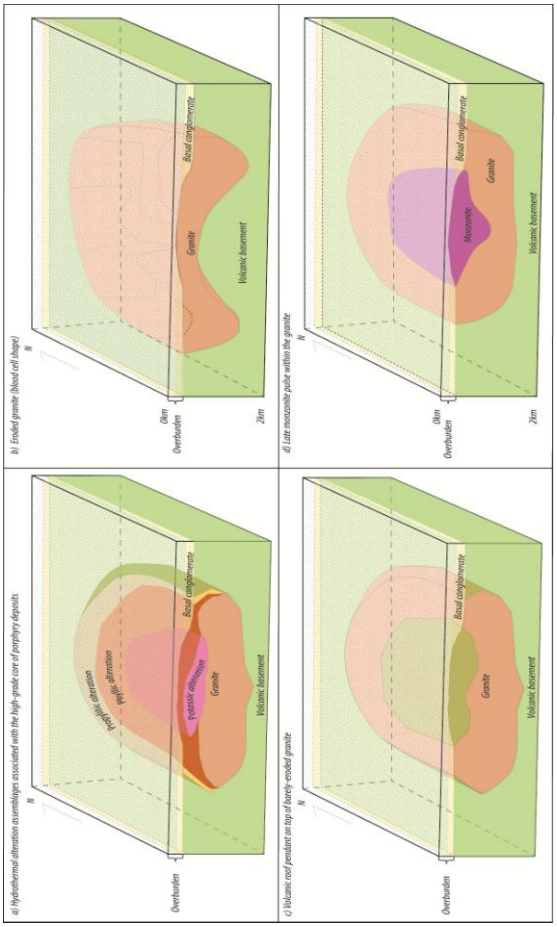

Figure 5. 3D simplified geological models over Idle Wilde illustrating the four possible case scenarios: (a) hydrothermal alteration assemblages associated with the high-grade core of PBM deposits; (b) blood-cell shape eroded granite with volcanic basement close to surface; (c) Volcanic roof pendants above poorly-eroded granite and; (d) late dense monzonite pulse within granitic intrusion.

AEM data highlight a poor conductor of 30 to 50 mS/m that coincides with the intrusion. The resistor is not expressed on profile 10260; but the gravity and magnetic anomaly confirms the presence of the granitic body. This suggests that the LCI EM inversion has difficulties discriminating the porphyry in its eastern part from its 100 to 200 mS/m volcanic host. Therefore, AEM data are here biaised by the 120m-thick conductive overburden, and do not discriminate between the four hypotheses stated above.

A medium conductive halo appears to flank the intrusive body and could be associated with disseminated mineralization, metamorphism aureole, alteration and/or oxidation. However, once again, this halo appears below the conductive overburden where resistivities within the basement cannot be resolved with confidence.

CONCLUSIONS

General

Interpretation of joint gravity, magnetic, radiometric and AEM data is here used to assess the IWI gold prospectivity. All the techniques provide useful information, but struggle to directly detect mineralisation, particularly under the relatively thick cover in this area.

The gravity defines the extent of the intrusion thanks to the presence of sharp density contrasts between intrusive and the volcanic host. The IWI intrudes the Ordovician basement and is thus younger, potentially with a late Ordovician age coeval with the emplacement of gold-rich Cadia-style porphyry (Stuart-Smith, 2011).

Magnetic and gravity data highlight high anomalies in the inner part of IWI that can be explained by (1) magnetite altered potassic core surrounded by magnetite-destructive alteration, (2) eroded granite with volcanic basement close to the surface, (3) roof pendant volcanics above a poorly-eroded granite, and (4) late monzonite pulse. EM interpretation highlights a conductive annulus of alteration around the resistive IWI that needs further investigation as this feature sits below the conductive overburden that affects EM results.

Strategy

The origin of the magnetic and dense areas within the IWI needs to be discriminated and the possible AEM halo of alteration needs to be tested. It is worth noting that the AEM halo is associated with the strongest low gravity that confirms the presence of granite and that may have gold mineralization potential (Cooke et al., 1999).

The cupola is the most prospective area in copper-gold porphyry systems. To determine if the erosion level is at the roof or hangingwall of the IWI is essential for the exploration strategy. If the cupola of the intrusion is preserved, the inner part could still be associated with high grade mineralisation. If the intrusion is deeply eroded, there is considerably less potential for porphyry-copper–gold mineralization.

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