Warramunga Province Deposit Atlas program: An update

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Introduction

Exploration under cover is widely acknowledged as being profoundly more challenging than exploration for near surface deposits. As the depth of cover increases, exploration becomes increasingly reliant on deep-looking geophysics and application of geological models, combined with comprehensive analysis of sparse drill data and samples. In this context, access to all available information on the expression of known deposits in a given region is crucial. Access to such information allows explorers to interpret their new exploration results with reference to the geochemical, mineralogical, textural and petrophysical expressions of known deposits in the region, potentially allowing recognition of subtle indicators of haloes and vectors which may guide further exploration and allow the prioritisation of multiple prospects. Ideally, this information should be made available to explorers in a form in which they can analyse and interpret all available data in their correct three-dimensional context.

The Rover field lies to the southwest of the Tennant Creek mineral field, and the prospective parts of the field are almost entirely under cover (**Figure 1**). Regional solid geology and 3D data (Valenta *et al* 2020b), as well as exploration data and interpretations for the Rover 1 (Gunter *et al* 2020a), Explorer 108 (Gunter *et al* 2020b) and Explorer 142 (Gunter *et al* 2020c) prospects have been compiled in a 3D GIS and PDF atlas format in order to aid explorers in the interpretation of their exploration datasets and formation of exploration targets in this region.

A program of Deposit Atlas compilation has also commenced for the Tennant Creek mineral field with atlases being released to date for White Devil (Esser *et al* 2020a) and Warrego (Esser *et al* 2020b).

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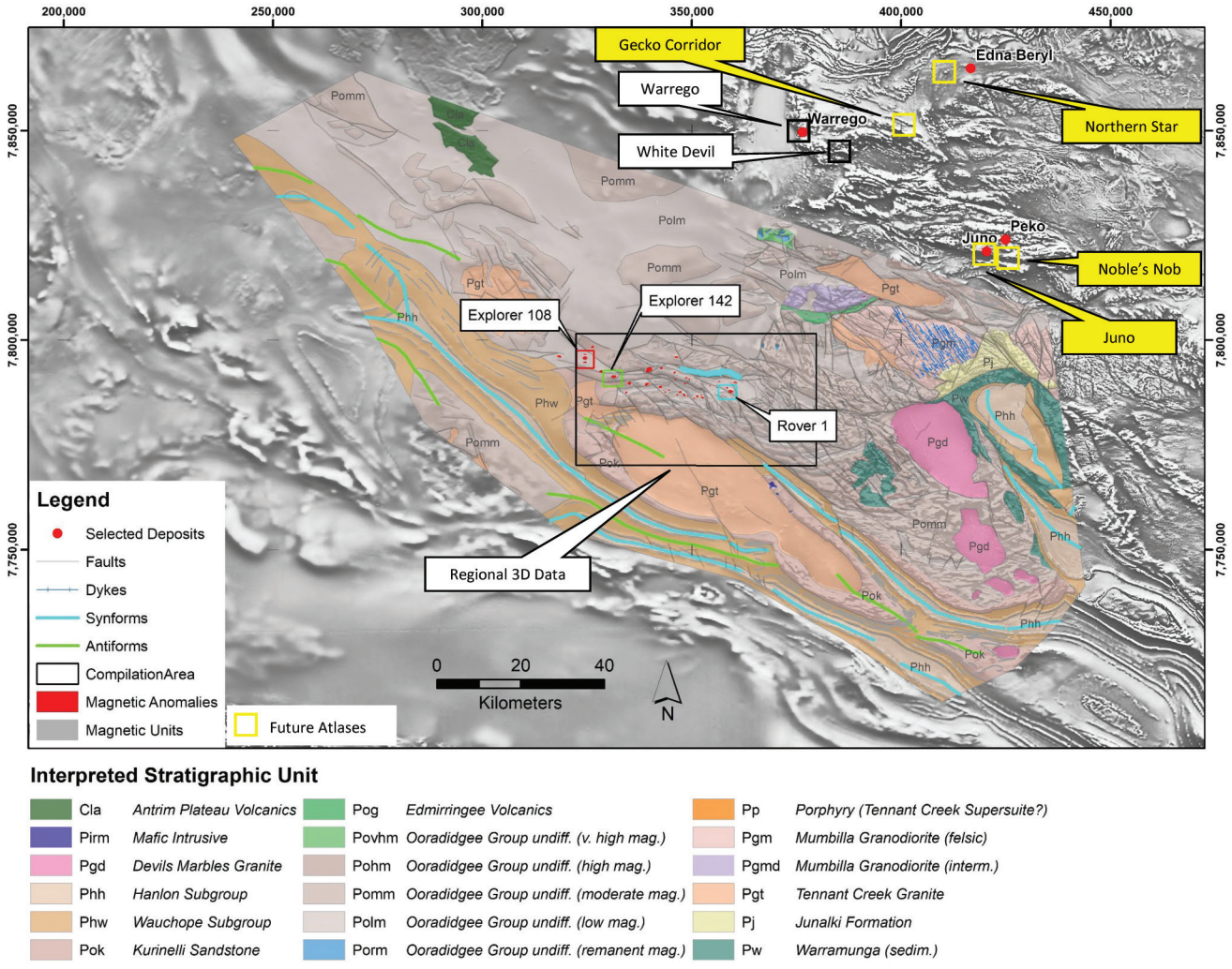

Interpreted Stratigraphic Unit

Cla	*Antrim Plateau Volcanics*	Pog	*Edmirringee Volcanics*	Pp	*Porphyry (Tennant Creek Supersuite?)*
Pirm	*Mafic Intrusive*	Povhm	*Ooradidgee Group undiff. (v. high mag.)*	Pgm	*Mumbilla Granodiorite (felsic)*
Pgd	*Devils Marbles Granite*	Pohm	*Ooradidgee Group undiff. (high mag.)*	Pgmd	*Mumbilla Granodiorite (interm.)*
Phh	*Hanlon Subgroup*	Pomm	*Ooradidgee Group undiff. (moderate mag.)*	Pgt	*Tennant Creek Granite*
Phw	*Wauchope Subgroup*	Polm	*Ooradidgee Group undiff. (low mag.)*	Pj	*Junalki Formation*
Pok	*Kurinelli Sandstone*	Porm	*Ooradidgee Group undiff. (remanent mag.)*	Pw	*Warramunga (sedim.)*

Figure 1. Summary of the Rover field regional solid geology interpretation over a base 1VD aeromagnetic image. Boxes show locations of 3D compilations. Stratigraphic unit codes are as per the 1:500 000 Tennant Creek interpreted geological map (Donnellan and Johnstone 2004). Released and planned atlases are highlighted in white and yellow callouts respectively.

Solid Geology – Rover region

The geology of the Warramunga Province has been well summarised in Donnellan (2013) and Huston *et al* (2020). A newly-released solid geology interpretation (Valenta *et al* 2020b) has made use of all available open file magnetic and gravity datasets to produce a detailed structural and geological framework for the region hosting the Rover mineral field. Even though geochronological studies (Huston *et al* 2020) show that the volcano-sedimentary sequence hosting the Rover field is broadly coeval with the Tennant Creek Supersuite granites at ca 1850 Ma, it appears that the sequence has recorded a very similar deformation history to that of the Tennant Creek mineral field. The (ca 1850 Ma) Tennant Event is interpreted to have affected the rocks in the Rover field. The magnetic alteration associated with this event obscures stratigraphic relationships and, in combination with the extensive cover, prevents resolution of macro-scale folding and most structures associated with the event.

In the Rover 1 and Explorer 142 areas, shearing interpreted to be associated with the Tennant Event strikes east–west (Leggo *et al* 2019). The event may be represented at map-scale in the Rover field by the large, complex shear zone that extends from 8.5 km southeast of Rover 1 eastwards ~60 km, where it separates the Warramunga Formation in the Mount Figg area from the Junalki Formation to the north of the structure, and is terminated by a later, ductile northwest trending structure that appears to be a part of the post-1790 Ma Davenport Event.

Folds of the younger Davenport Event are clearly traceable in magnetic units of the Hatches Creek Group on the southern and eastern margin of the Rover field, with axial planes trending generally west-northwest. In the magnetically-altered units of the Rover field, these folds are not readily recognisable; instead, both ductile and brittle west-northwest- to northwest-trending structures are observed, likely associated with this event.

A large number of non-stratigraphic magnetic units occur in the area of the Rover field, some of which have been tested by drilling and shown to be related to introduction of hydrothermal magnetite and associated base and precious metal mineralisation. Many additional such signatures have not been tested, providing encouragement for the possibility of further exploration success in the region given that not all of the mineralised systems in the Tennant Creek mineral field are associated with the strongest magnetic signatures (Donnellan 2013). Discoveries such as Prominent Hill in the Gawler Craton and Jericho in the Mount Isa region provide additional encouragement for the testing of less magnetic indicators of Fe-oxide alteration.

Rover Field Deposits

The main characteristics relevant to exploration for Rover 1, Explorer 108 and Curiosity, and Explorer 142 are summarised in **Table 1**.

Table 1 is best reviewed in conjunction with the 3D datasets compiled in Gunter *et al* (2020a, b, c). The deposits are mostly hosted in metasediments and show similar structural characteristics to the Tennant Creek deposits in terms of assemblages of alteration and mineralisation, metal associations, and mineralisation style. All the copper- and gold-dominated deposits show coincident highs in magnetic and detailed gravity datasets. Although they do not have bullseye electromagnetic responses, all of the ironstone-hosted deposits lie at the boundary between conductive and non-conductive domains in the Helitem response, which suggests an area-scale redox control on the localisation of mineralisation. Lead-zinc mineralisation at Curiosity is significantly different, showing an association with silica dolomite alteration and a high chargeability signature without strong gravity and magnetic expression.

Tennant Creek Deposits

A program of Deposit Atlas compilations has also commenced for the Tennant Creek Mineral Field (Esser *et al* 2020a, b). This program is expected to continue in

Table 1. Characteristics of major Rover mineral field prospects.

Prospect	Rover 1	Explorer 108 (-Curiosity)	Explorer 142
Cover depth	130 m	180 m	190–210 m
Cover characteristics	recent sediments and flat-lying Cambrian siltstones, dolomitic siltstones, dolomites, sandstones and conglomerates of the Wiso Basin; mineralisation 200 m below basement contact.	recent sediments and flat-lying Cambrian siltstones. Zone of anomalous copper (>500 ppm) immediately above basement contact	recent sediments and flat-lying Cambrian siltstones, mudstones, dolomitic siltstones, dolomites, and sandstones of the Wiso Basin
Metals	Au-Cu-Ag-Bi-Co	Zn-Pb-Ag-(Cu)	Cu-Au-(Bi)
Host rock	fine grained sedimentary sequence: hematitic shales, laminated ironstones, cherty siltstones	sandy siltstones, felsic volcanic units	hematitic metasediments including greywackes, sandstones, siltstones, jaspilite, chert and ironstone
Alteration assemblage	magnetite-quartz-hematite-chlorite (carbonate)	dolomite-chlorite-talc-silica-magnetite-hematite	hematite
Mineralisation assemblage	chalcopyrite-bismuthinite-pyrite-gold	sphalerite-galena-pyrite-(chalcopyrite)	chalcopyrite-bismuthinite-pyrite-gold
Mineralisation style	veins, breccias, stringer zones	domains or veins of semi-massive sulphides, sub-vertical shear hosted	locally, mineralisation occurs within a 20 m wide, sub-vertical east-west striking hematitic shear that continues over a distance greater than 400 m (Leggo *et al* 2019)

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Table 1. Characteristics of major Rover mineral field prospects. *(Continued from previous page)*

Prospect	Rover 1	Explorer 108 (-Curiosity)	Explorer 142
Mineralisation timing	no direct dating, but appears synchronous with Tennant Creek mineralisation; likely to be 1835–1830 Ma	no direct dating, but appears synchronous with Tennant Creek mineralisation; likely to be 1835–1830 Ma	SHRIMP U–Pb zircon dating of an immature mass flow volcaniclastic (part of the mineralised sequence) intersected in drill core at Explorer 142 yielded a weighted mean $^{207}Pb/^{206}Pb$ age of 1798 ± 5 Ma (Smith 2001); suggests younger mineralisation
Structural setting	brittle-ductile shear, steeply dipping	high strain zone in north-northwest-striking anticlinal asymmetric fold	sub-vertical east-west high strain shear zone on southern limb of anticline
Structural control	nearly east-west shear immediately to the north of (and synthetic to?) a 30 km-long regional west-northwest shear, which separates sediment-dominated package to north from metavolcanic package to south	no obvious regional control; local control appears to be a north-northwest-trending antiformal closure, with mineralisation in hinge and steep eastern limb	the near vertical shear is interpreted to have formed along the southern limb of an anticline during a north-south shortening event
Geophysical expression	coincident gravity and magnetic high; no clear Helitem expression, although on boundary between conductive and non-conductive domain	E108 - coincident magnetic and detailed gravity high; no clear Helitem expression, although on boundary between conductive and non-conductive domain; Curiosity - anomalous chargeability	coincident gravity and magnetic high; no clear Helitem expression, though on boundary between conductive and non-conductive domain
Alteration halo	Leggo *et al* (2019) note zones of chlorite, silica, dolomite and talc extending up to 50 m away from ironstone bodies; they also note white mica alteration extending a further 50 m outside of the shear zones hosting mineralisation; halo zone with widespread anomalous copper (>1000 ppm) up to 200 m away from >0.5% Cu shell	widespread outer sericite and inner chlorite-talc alteration, dimensions not well specified but apparently extensive; Pb-Zn extensive and intense silica dolomite breccia; extensive zones of anomalous copper (>1000 ppm) in regional drilling	similar to Rover 1; zones of strongly anomalous copper up to 1000 ppm occur in 100 m envelop around mineralised body

2021 (**Figure 1**), assembling information from published data, open file reports, other company datasets, and regional syntheses (eg Hill *et al* 2015)

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