Geological outcomes of the Mineral Systems Drilling Program along the southern Gawler Ranges

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Introduction

The Mineral Systems Drilling Program (MSDP) was a $3.5 million cash and $4.11 million in-kind collaborative drill program managed by the Geological Survey of South Australia in partnership with the Deep Exploration Technologies Cooperative Research Centre (DET CRC), Minotaur Exploration, Kingston Resources and several service providers. The objective of the MSDP was to further the understanding of mineral systems developed during c. 1590 Ma magmatism, with particular emphasis along the southern Gawler Ranges. From July 2015 to April 2016, 14 diamond drillholes were completed for a total of 7,868 m (Fig. 1). The following is a summary of the geological outcomes of the project and is complementary to outcomes of DET CRC technology trials also summarised in this edition of the *MESA Journal*. The reader is referred to Fabris et al. (2017) for a more comprehensive review of project results and outcomes.

Drillholes by region

Carriewerloo: MSDP01–04

MSDP drillholes in the Carriewerloo region were sited to aid subsurface mapping and assess the mineral potential in what is a mostly covered terrain. Geophysical imagery, in particular the magnetic data, shows considerable variation in texture and intensity that can be related to geology (Fig. 1). Drillholes were located above coincident high magnetic and gravity features on a local scale, but within distinct geophysical domains (Fig. 2):

- MSDP01 and MSDP03 within the Olympic Domain on a NE-trending, narrow linear magnetic feature, that is bound by the Roopena and Wizzo Well faults, but potentially separated by a ENE-trending unnamed fault.
- MSDP02 within the Olympic Domain on the southern margin of a broad gravity high and in a moderate magnitude magnetic anomaly.
- MSDP04 within the Spencer Domain on a broad gravity high, containing numerous high frequency magnetic features.

Prior to the program, it was uncertain whether geophysical anomalies were related to units of the Gawler Range Volcanics (GRV) or to pre-GRV basement. This was predominantly due to having very few constraints on the depth to basement in the region and the overall lack of understanding of the distribution of mafic units within the GRV. In MSDP01, 03 and 04, modelled depths to basement can now be related to the uppermost basaltic unit in each hole (Roopena Basalt). Significant thicknesses of mafic units were intersected in the drillholes and were both magnetic (upper basalt, ~7 x 10^{-3} SI; lower basalt, ~12 x 10^{-3} SI) and relatively dense (upper basalt, 2.75 g/cc; lower basalt, 2.82 g/cc). In MSDP02, the modelled target zone defined through inversion of magnetic and gravity data could be explained by a thick sequence of Tapley Hill Formation (2.72 g/cc) and/or the underlying Beda Basalt (2.84 g/cc). MSDP drillholes demonstrated that high frequency geophysical features are controlled by units within the GRV, and therefore regions of high magnetic susceptibility and density can be used to approximate the distribution of thick mafic units (Fig. 2). High magnitude and high frequency magnetic features most closely correspond with the known distribution of the upper basalt (Roopena Basalt). Gravity highs do not always coincide with regions of high magnetic susceptibility and are therefore interpreted to represent either

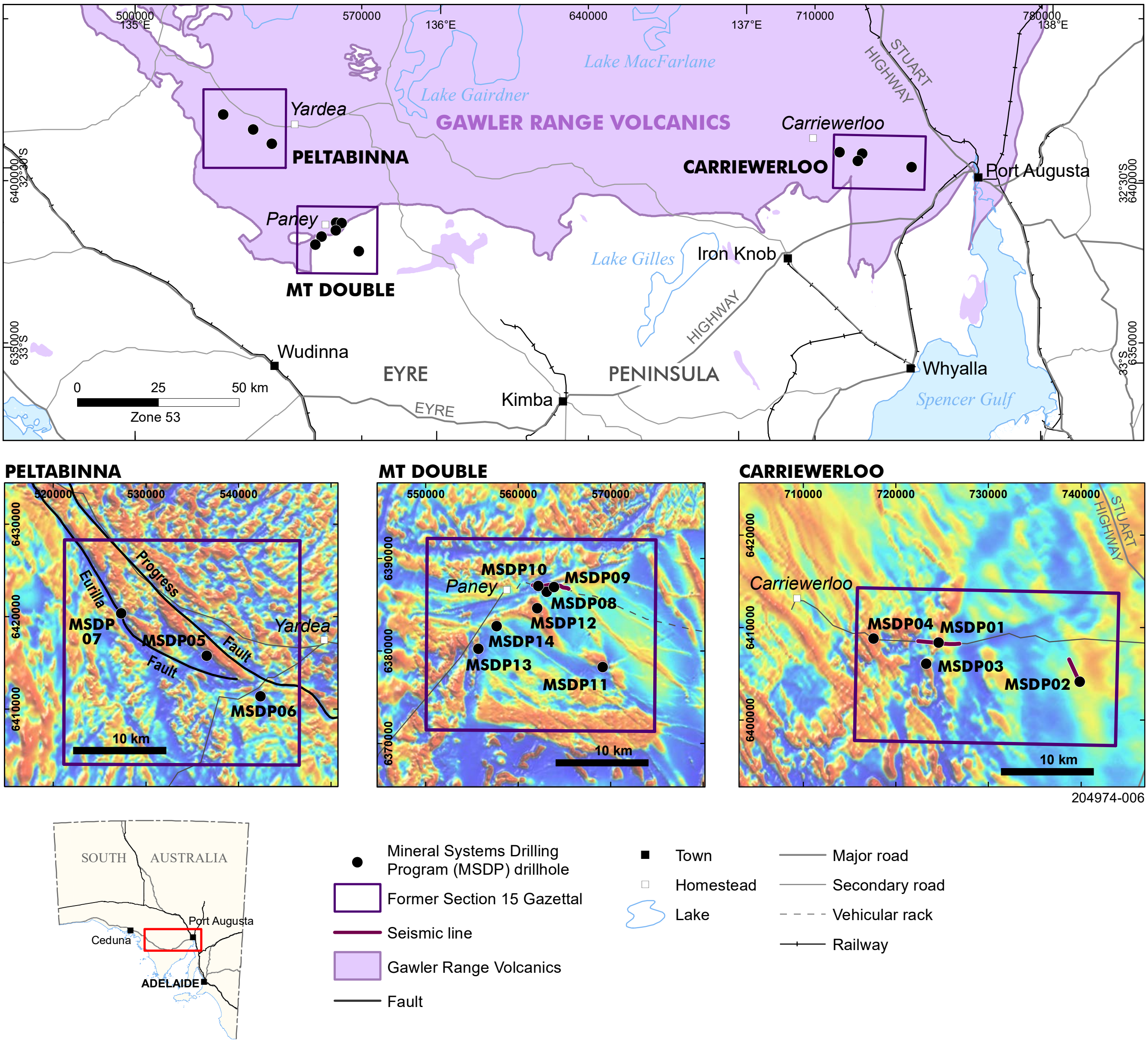


Figure 1 *Location of drillholes MSDP01–14, Mineral Systems Drilling Program, southern Gawler Ranges. Zoom boxes display drillhole locations in relation to residual aeromagnetics.*

thickened mafic units or dense bodies below the upper basalt (i.e. lower basalt or mafic units below). Extensive mafic units, both intersected in drilling and interpreted through geophysics, highlight the difficulty in targeting geophysical features below volcanic flows of the GRV.

Although there is limited deep drilling through the GRV with which to compare, one overarching observation is the large volume of basaltic units encountered in the Carriewerloo region. On a regional scale, Carriewerloo is situated at the southern end of an approximately NNE-trending broad gravity high (Fig. 3). The western margin of this feature coincides with the likely extension of the Uno Fault. The broad gravity high continues north along the eastern margin of the Olympic Domain where it coincides with the approximate position of Lake Torrens. Forward modelling along the 08GA-A1 seismic line by Geoscience Australia (Fig. 3; Carr et al. 2012) reconciled this feature as relating to thick mafic units (>2 km) at the base of the GRV within an extensional setting. Basaltic units intersected in MSDP drillholes and seismic interpretations permit this explanation, although significant ambiguity remains. Of interest, magnetotelluric models indicate a lithospheric-scale linear conductivity anomaly to the immediate west of the gravity feature (Thiel 2016). Crustal features represent first-order fluid pathways and, in this case, may have a direct link to mafic volcanism in this portion of the eastern Gawler Craton.

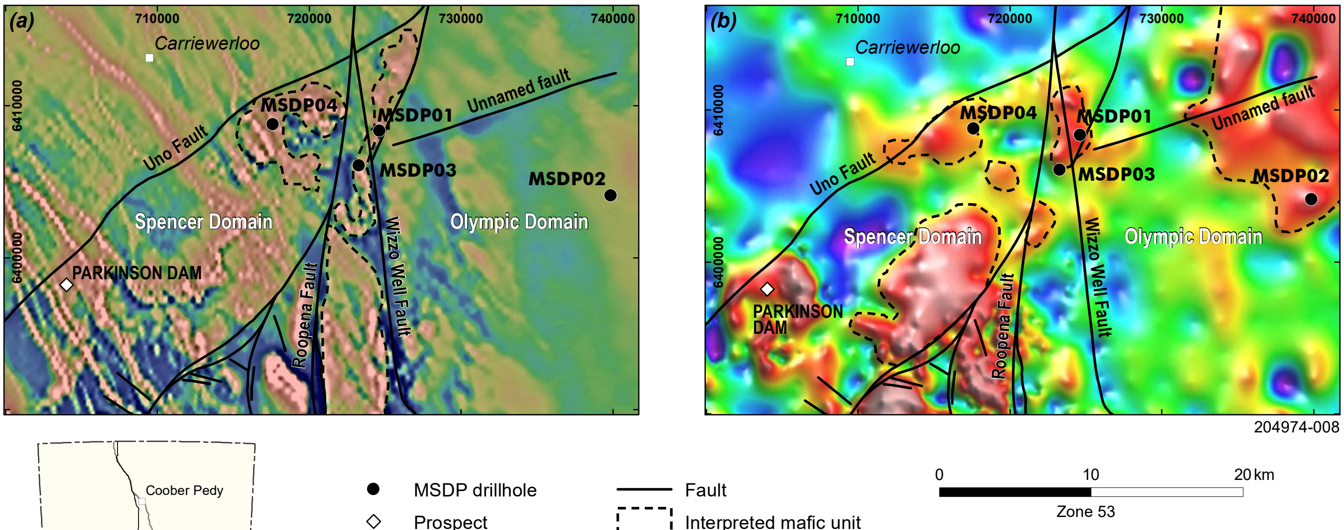
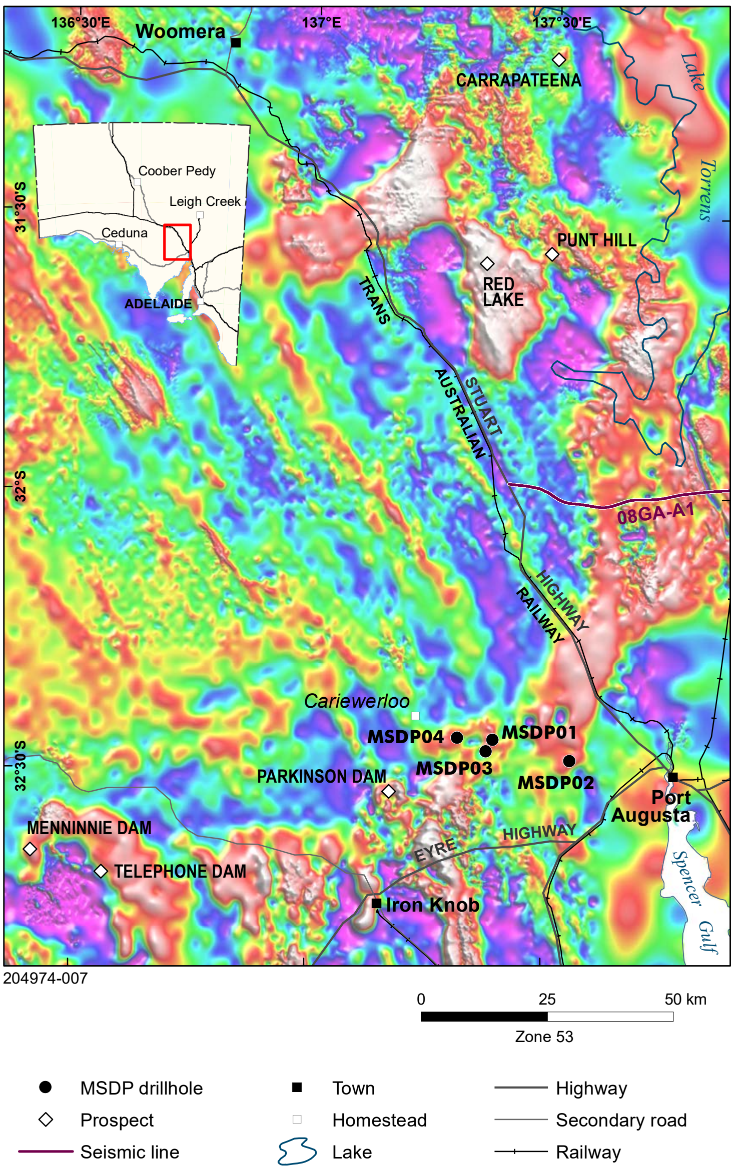


Figure 2 *Interpreted distribution of mafic units within the GRV around MSDP01–04.* ***(a)*** *Interpreted distribution of shallow mafic volcanics based on high frequency magnetic response. Base image is 1VD aeromagnetics overlaid on residual RTP aeromagnetic image.* ***(b)*** *Interpreted distribution of thickened or additional lower basaltic units based on elevated gravity values. Base image is residual gravity.*



The drilling was also aimed to extend knowledge of the Spencer–Olympic domain boundary and determine whether it acts as an important fluid pathway. While the drilling failed to penetrate the GRV, which meant that basement geology and its mineral potential could not be assessed directly, MSDP01 and MSDP03 in combination with seismic surveys by Curtin University (Fig.1) provided useful information on the Roopena and Wizzo Well faults (Figs 2, 4). MSDP01 and MSDP03 were drilled close to the interpreted trace of the Roopena and Wizzo Well faults, but only samples from MSDP03 showed the degree of fracturing indicative of significant brittle displacement. Fracture-fill was common, particularly in MSDP03; however, there was a distinct lack of alteration away from fractures suggesting the absence of a significant hydrothermal system in this region during or post GRV time. Rare crustiform banding was evident, but with no surrounding alteration. This makes it more likely that fracture fills are related to late-stage fluids derived during cooling of the GRV. Overall, the lack of alteration intensity in the region indicates that fracturing intersected in the drillholes is likely to be related to post GRV-cooling tectonic movement (reactivation post 1590 Ma). Based on all MSDP drillholes, alteration zones within the GRV are associated with demagnetisation. On a regional scale, this points towards a different exploration focus than the accepted practice of drilling on or adjacent to

Figure 3 *Residual gravity image displaying NNE-trending, broad gravity high extending along the eastern Olympic Domain.*

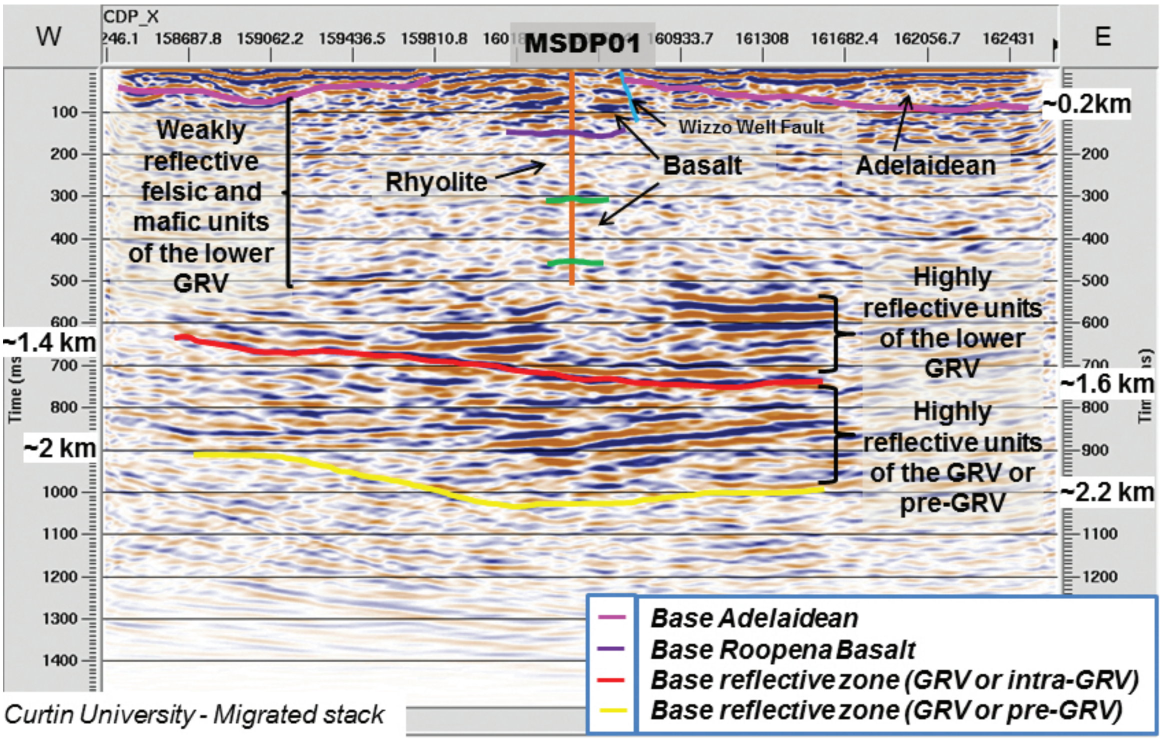


Figure 4 *Interpreted migrated seismic section for Curtin University transect alongside MSDP01.*

magnetic highs. Demagnetised dilational zones associated with the Roopena and Wizzo Well faults offer an alternative exploration model for targeting epithermal/hydrothermal systems within this region.

For exploration models that include basement targets, a fundamental control on the exploration search space is depth to basement. The MSDP has provided new constraints on the thickness and depth to base of the GRV, based on several deep drillholes and two reflection seismic profiles that were part of the broader program (Fabris et al. 2017, p. 25). These indicate that the GRV is >1.4 km thick along the southeastern margin of the Gawler Ranges (Fig. 4). A thickened succession of volcanic units in this region is interpreted to have resulted from local extensional tectonics active during the extrusion of the GRV, particularly between the Roopena and Wizzo Well faults. The depth estimates have economic implications for exploration where the modelled target is at or below the base of the GRV, and underlines the importance of identifying and targeting topographic paleohighs in the pre-GRV landscape.

The MSDP drillholes have provided stratigraphic control and an improved understanding of the depositional environment of the GRV. While the full GRV sequence was not penetrated, the drillholes contained exceptionally well preserved volcanic textures, enabling identification of hyaloclastite, pillow textures and peperite, demonstrating that at least some flows were deposited in a subaqueous setting (Figs 5 and 6; Simpson 2017). In addition to the GRV, MSDP02 is a rare cored hole through the Adelaidean stratigraphy in this region and provides a new reference hole for several units, including a thickened sequence of dolomitic and carbonaceous shales of the Tapley Hill Formation. Of economic interest, elevated copper and silver values were associated with the base of the Tapley Hill Formation over both the Spearfelt Rhyodacite and Beda Basalt, highlighting its widespread potential for sedimentary copper. Notably, grades were higher over the Beda Basalt (Beda Basalt contained average values of 176 ppm Cu; n = 19) and mineralisation continued into the upper Beda Basalt (up to 1% Cu), suggesting this unit provides a source of copper that might be remobilised and concentrated under suitable geological conditions.

Figure 5 *Peperitic mixing between basalt (red-brown to green) and grey sediment, MSDP04, 108.1 m. (Photo 416125)*

Figure 6 *Roopena Basalt within MSDP03 containing clasts with curved to lobate margins suggestive of pillow margins (rows two to four). Monomict autoclastic breccia interpreted as hyaloclastite occurs below 222.45 m. (Photo 416126)*

Peltabinna: MSDP05–07

MSDP drillholes in the Peltabinna region were sited to investigate the mineral potential of two separate regional demagnetised structures, the Eurilla and Progress faults, interpreted to be splays of the Yarlbrinda Shear Zone, which may have been reactivated during the extrusion of the GRV (Fig.1). In what is one of the key findings of the program, MSDP05 intersected a zone of epithermal veining with several veins displaying colloform texture with fine sulfide banding (ginguro veins; Fig. 7). Veining is associated with a ~200 m wide alteration zone which was demagnetised and contains variably intense white mica, chlorite and carbonate (veins and infill). While there were no significantly high gold and silver values recorded over the interval, the veins contain anomalous Ag, As, Bi, Mo, Sb, Cs and S, which is typical of epithermal mineral systems. The stratigraphic position of the alteration zone is important. Mineral exploration in the region has been focused mainly at the base of the GRV, yet this zone of epithermal alteration is developed within the upper GRV, between the Pondanna Dacite Member and Eucarro Rhyolite. This opens up the potential for mineralisation across the GRV, rather than just at its margins.

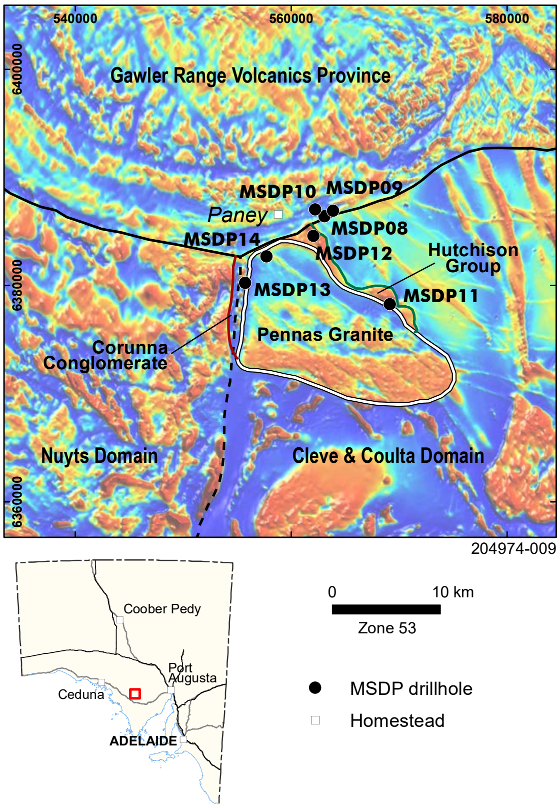
While drilling in the Peltabinna region intersected mostly coherent lavas, both MSDP05 and MSDP07 intersected a newly defined sequence of volcaniclastic sediments within the upper GRV (Mount Friday Formation; Werner et al. 2017). It is postulated that the regional demagnetised features visible in aeromagnetic data are related to extensional faulting and are associated with low lying corridors that accommodated the deposition of thickened epiclastic deposits during periods of GRV extrusion. Evidence for extension comes from the greater thickness of Pondanna Dacite Member (>345 m) and Eucarro Rhyolite (>600 m) intersected in MSDP06 and MSDP07, respectively, than that observed in outcrop in the central Gawler Ranges (200–300 m). In both drillholes, white mica alteration is associated with the volcaniclastic stratigraphic level, and our interpretation is that underlying faults acted as upflow zones and focused fluids into these more permeable units. The presence of permeable volcaniclastics and underlying structures are indicated to be important ingredients in the localisation of the epithermal mineral systems, such as that intersected in MSDP05. High water content of these units may be a factor in controlling zones of boiling during influx of hot fluids. It is uncertain whether alteration in MSDP05 took place during the extrusion of the GRV or was related to a later discrete hydrothermal event. The lack of volcanic facies indicative of a proximal vent suggests that the hydrothermal system developed post-deposition. Granite sills intersected at the base of MSDP07 provide evidence of an intrusive phase that may have been the thermal driver for post-depositional fluid flow.

Black Eagle Rock: MSDP08–10

Several mineral occurrences are known along the southern margin of the Gawler Ranges (Reid 2017; Schwarz et al. 2006). Discoveries such as Parkinson Dam (Smith 2006), Diomedes and Uno are proximal to faults that are broadly subparallel with the margin of the GRV and are outboard of the current GRV margin. While exploration in this region is ongoing and continues to identify evidence of a widespread mineralising event, potential for mineralisation associated with similar but inboard structures within or beneath the upper GRV is largely unknown. These bounding faults are likely to provide major upflow zones. This model is analogous with major silver deposits developed in the Imiter district, Morocco (Fig. 8; Cheilletz et al. 2002; Nicolson and McAvaney 2015). Drillholes MSDP08–10 are the first holes in this area to directly investigate the potential for this style of mineralisation.

Figure 7 *Colloform-textured quartz–sulfide veining within MSDP05, 178.5 m. Some veins display classic ginguro banding. (Photo 416127)*

(a)



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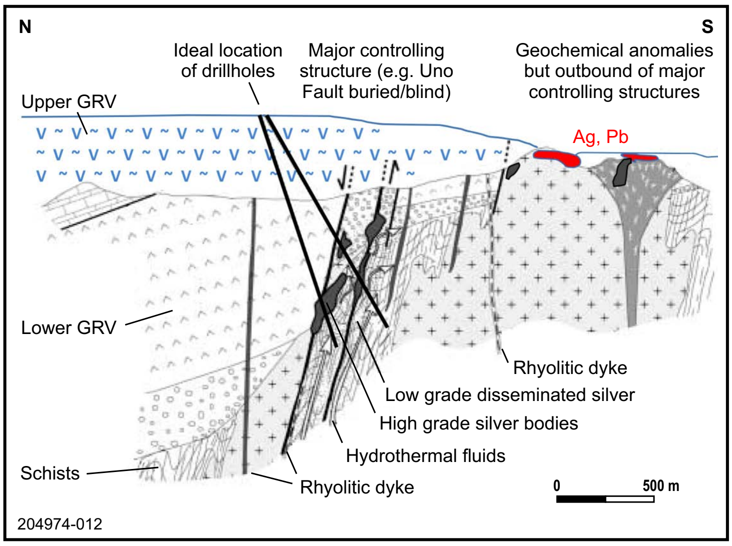


Figure 8 *(a) Location of MSDP08–10 shown over residual magnetics. (b) Conceptual model for the GRV margin proposed by Nicolson and McAvaney (2015) based on the Imiter deposit in Morocco where idealised drillholes target fault-bound massive sulfide mineralisation. (After Cheilletz et al. 2002, fig. 2b, Imiter inlier, Synthesized geological cross section drawn for the A–A′ and B–B′ transects. Reproduced with permission of Springer and modified from Leistel and Qadrouci 1991, fig. 5, © BRGM, Bureau de Recherches Géologiques et Minières.)*

A 4 km long, low-impact seismic survey conducted with Curtin University across the current GRV margin (Fig. 1) infers compartmentalised deposition of volcanics close to the margin but largely failed to define basement contacts or likely structures, possibly due to a less than ideal line orientation (Fabris et al. 2017). Ground electromagnetic data (EM) collected by Minotaur Exploration produced several narrow but very high magnitude EM conductors (up to 100,000 s) in the Black Eagle Rock area. None of the modelled EM conductors were satisfactorily explained by the drilling. The target depths in all holes corresponded to massive and weakly altered dacitic and rhyolitic coherent facies with only minor fracturing. In hindsight, additional ground EM lines were needed to correctly determine the geometry of the conductors.

MSDP08 and 09, drilled within a few hundred metres of the current GRV margin, penetrated ‘basement’ below the GRV, while MSDP10 did not reach pre-GRV units by the end of hole depth of 567 m. MSDP08 and 09 intersected Archean–Paleoproterozoic gneiss and metagranite at a vertical depth of 146 and 234 m, respectively. These units have lower magnetic susceptibility than the overlying GRV but comparable specific gravity values. This indicates that it will not be possible to model depths to the base of the GRV from the magnetic data in this region.

The most significant mineralisation intersected in these holes was in MSDP10 and included elevated zinc values (up to 1,940 ppm from 493 to 494 m) corresponding with intervals containing irregular, late-stage quartz veins with fluorite and sphalerite. Rare to trace galena was evident, associated with quartz veining, but maximum lead values were only 758 ppm. Nevertheless, demagnetisation associated with moderate to intense sericite–chlorite ± pyrite alteration and common chlorite–pyrite veining in the last ~200 m of the hole (within Bittali Rhyolite) does suggest a broad alteration zone and the potential for more significant mineralisation nearby (Fig. 9).

Drillholes MSDP08 and 09 lacked the degree of fracturing and alteration expected close to a significant fluid pathway, although a feeder dyke with a fault breccia at its margin was intersected at the base of MSDP08 and provides evidence of stitching of a pre-existing structure.

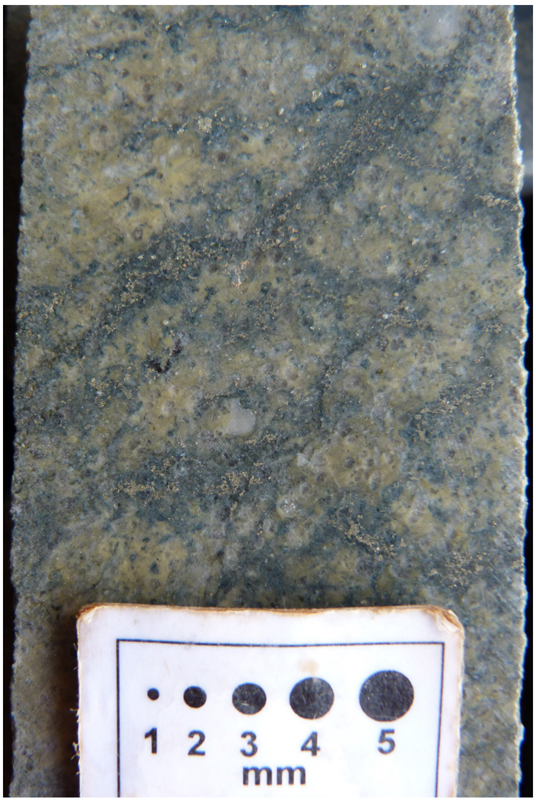
Overall, drilling in the Black Eagle Rock region indicates the most likely position for a mineralised fault zone is between MSDP10 and 08 where both holes, which were angled towards each other, ended with evidence of alteration and faulting.

Paney and Tin Hut Well prospects: MSDP11 and 12

MSDP11 and 12 were sited on potential traps caused by reactive lithologies of the Hutchison Group, located at the margin of Pennas Granite (Fig. 8; informal name of Hiltaba Suite pluton located southeast of Paney Homestead). The porphyritic texture of the Pennas Granite in drill core (MSDP11 and 14) and GRV dykes evident in MSDP11 and 12, indicate the Paney and Tin Hut Well prospects were at an upper crustal level during the 1590 Ma event, but below shallow-level volcanism (part of likely feeder systems).

MSDP11 intersected a fascinating series of rocks that included skarnified Hutchison Group over augen gneiss of presumed Sleaford Complex. These are intruded by foliated intermediate and felsic units. Metadioritic units intersected have not previously been described in this region, although they appear similar to units described within the Peter Pan Supersuite (Moola Suite) on the eastern Eyre Peninsula (Wade and McAvaney 2016). Geochronology on these rocks is pending, but the foliation and dating of similar felsic units in nearby holes supports a Kimban age. In addition to Kimban intrusives, porphyritic dykes of presumed 1590 Ma age are common, particularly above the skarn-altered zone.

The skarn zone is characterised by magnesium-rich minerals (including diopside, serpentine, talc, tremolite) together with iron oxide (magnetite with subordinate hematite; 33% Fe from 320–377 m). This assemblage suggests a protolith of dolomitic sediments poor in iron (Hall, Cohen and Schiffman 1988; forming magnetite in preference to widespread andradite garnet), and supports a stratigraphic correlation with dolomitic units of the Hutchison Group. Both endo- and exo-skarns are evident (Fig. 10). Endo-skarn appears to be



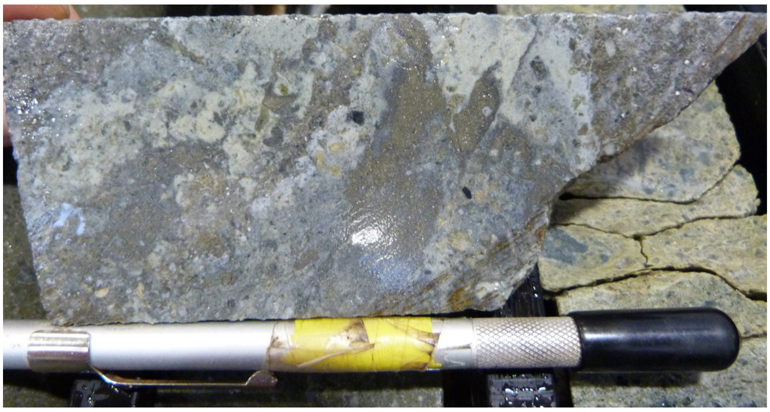


Figure 9 Mineralisation and alteration textures within MSDP10. **Left:** Diffuse network of chlorite–pyrite veins within sericite altered, quartz-phyric rhyolite, 475 m. **Right:** Semi-massive pyrite and silica replacement of sericite-altered volcaniclastic formed on the margin of an ?intrusive volcanic breccia, 555.4 m. (Photos 416128, 416129)

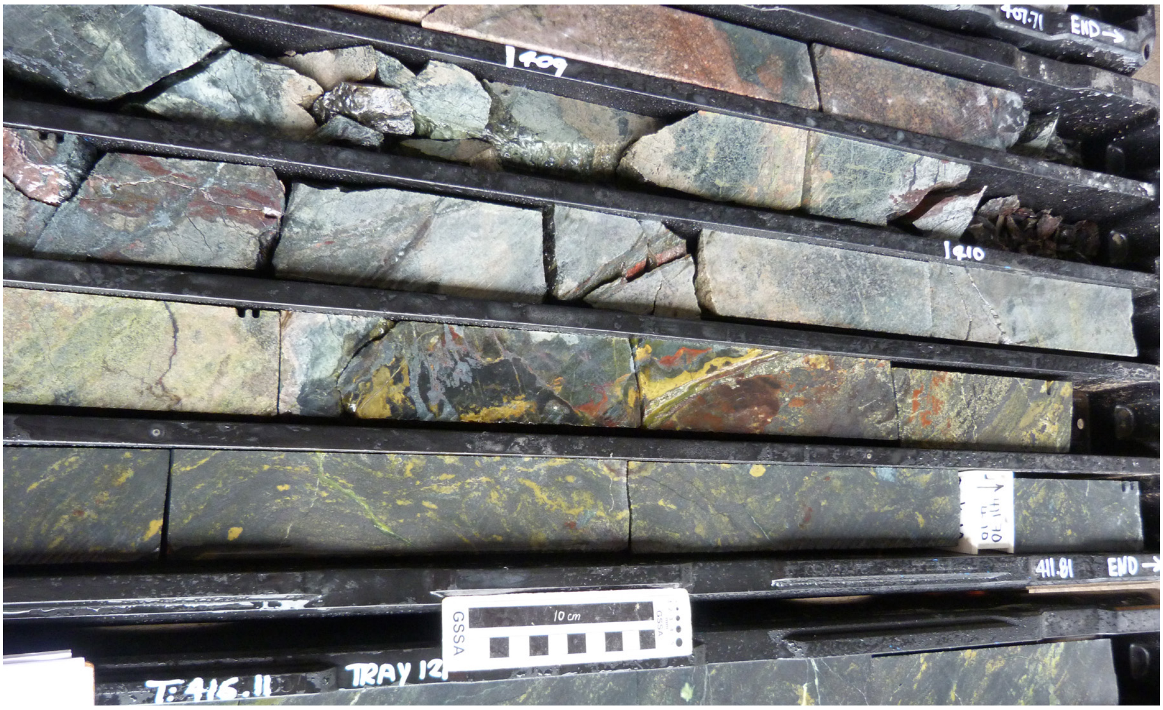


Figure 10 *Felsic intrusive (top row), grading to endo-skarn (muscovite-, chlorite-, epidote-, pyroxene-altered intrusive) to 410.5 m, followed by magnetite-, serpentine- and amphibole-rich exo-skarn, MSDP11. (Photo 416130)*

developed within Kimban granite. Significant quantities of pyrite occur over narrow intervals and are associated with magnetite, commonly proximal to Kimban felsic intrusives. Anomalous but uneconomic intersections of Ag, Pb and Zn in MSDP11 were recorded throughout this zone.

The timing of the alteration and mineralisation is uncertain. Regional evidence indicates widespread skarnification (pyroxene, amphiboles, serpentine, talc) of similar stratigraphic units elsewhere, and it is inferred that this took place during amphibolite facies metamorphism of the Kimban Orogeny (Parker et al. 1993). However, it is likely that there is a 1590 Ma overprint, and the common occurrence of galena in veins and fault zones that crosscut the foliation suggests at least some of the lead mineralisation is related to the 1590 Ma event. This is supported by preliminary analysis of Pb/Pb isotopes in pyrite samples taken from MSDP11 (Jeff Steadman, University of Tasmania, pers. comm. 2017). Remobilisation is likely to be linked with the intrusion of the nearby Pennas Granite.

Although located along strike from MSDP11, the reactive metadolomitic units of the Hutchison Group appear to be absent from MSDP12 (although a highly altered equivalent may now be masked by intense silica alteration). Instead, a narrow graphitic breccia zone, possibly equivalent to graphitic units of the Hutchison Group elsewhere, hosts elevated values of precious and base metals including 1 m at 42 ppm Ag, 29 ppb Au, 0.54% Cu, 0.35% Pb and 0.96% Zn (410–411 m).

In addition to mineralisation associated with skarn and graphitic breccia, a distinct mineralisation style is evident within MSDP12 and at the base of MSDP11 which is not controlled by reactive lithologies. Alteration zones characterised by intense silica and lesser sericite–chlorite overprint pre-1590 Ma units. In places, alteration is so intense that the original rock texture has been almost entirely overprinted (Fig. 11). These zones contain up to 20% pyrite as veins, stringers and disseminations. These mainly overprint felsic igneous units, but also appear to be associated with mafic units where the highest copper and silver values were reported. The timing and style of this mineralisation is unknown and requires further investigation.

Mount Allalone and Pennas Granite: MSDP13 and MSDP14

MSDP13 was drilled into a fault zone between outcrop of the Corunna Conglomerate and the Pennas Granite (intersected by MSDP14), also inferred as the margin of the Nuyts and Coulta–Cleve domains (Fig. 8). A sequence of metasandstone and calc-silicate units were intersected, with the uppermost metasandstone unit returning a maximum depositional age of 1717 ± 4 Ma (n = 39; age range of detrital spectra between c. 1780 and 1680 Ma; SHRIMP; Liz Jagodzinski, Geological Survey of South Australia, pers. comm. 2016), which indicates a temporal relationship with conglomeratic units at Mount Allalone (Corunna Conglomerate). Based

Figure 11 Common disseminated and veined pyrite within quartz–sericite-altered felsic rock, MSDP12, 94.25 m. The assayed interval 93.7–94.5 m contained elevated Au, Ag, Pb and Zn. (Photo 416131)

on the lack of any obvious depositional break above 492.8 m, it is inferred that sediments in the remainder of the hole are of similar age. Calc-silicate units are composed predominantly of diopside (clinopyroxene), wollastonite, prehnite and quartz, which are common products of skarnified or thermally metamorphosed dolomitic and/or silty limestones. The units are variably mylonitised, which is a record of the high strain accommodated along this domain boundary and indicates significant post-Kimban tectonic movement (likely to have occurred during the Kararan Orogeny, 1620–1575 Ma). This is supported by field observations of a tectonic fabric in outcrop on the eastern margin of Mount Allalone. The close proximity to Pennas Granite implicates the emplacement of this large Hiltaba Suite granite as a driver for the thermal metamorphism and/or metasomatism.

The sequence of alternating calc-silicate and metasandstone below medium- to coarse-grained sandstone and conglomerate observed at Mount Allalone suggests that the Corunna Conglomerate was deposited in a localised shallow-water evaporitic basin, which was subsequently infilled by coarse conglomeratic fluvial units.

Geochemical associations and vectors

Several distinct styles of mineralisation were identified in samples from the MSDP. Trace element associations with each of these are summarised below and provide a regional benchmark for comparison. Although mineralised intersections were subeconomic, trace element associations may still be useful as pathfinders and for identifying geochemical vectors.

Epithermal, colloform quartz–sulfide veining, MSDP05

Epithermal veining identified in MSDP05 is associated with a ~200 m wide alteration zone that is characterised by magnetite destruction and variably intense sericite, chlorite and carbonate (veins and infill) alteration (Fig. 12). Chemical associations include broad Ca, Cs and Sb anomalism over the entire alteration zone, and individual veins containing elevated Ag, Au, As, Bi, Mo and S values.

Phyllic alteration zone, MSDP10

MSDP10 hosts strong pervasive sericite ± chlorite–silica–sulfide alteration from 378.95 m to end of hole (Fig. 9). Alteration is most intensely developed along vein networks and within breccia matrices. Sulfide zones are generally minor (<5% sulfide) but are associated with elevated Au, Ag, As, Cd, Cu, F, Li, Mo, Pb, Sb, Te and Zn values. Chlorite alteration in this hole is iron-rich which contrasts with a background Fe–Mg composition seen in similar units in other drillholes.

Magnesian skarn, MSDP11

Intervals of magnesian skarn intersected in MSDP11 (Fig. 10) are associated with selective to massive magnetite (with subordinate hematite; up to 52% Fe) and several pyritic zones. Trace element association includes elevated but insignificant levels of Au, As, Bi, Cu, Pb, Sb, S, Sn, W and Zn.

Silver mineralisation, MSDP12

Silver and minor base metal mineralisation over the interval 392–415 m in MSDP12 is associated with moderate to strong silica, sericite and chlorite alteration of presumed Hutchison Group (Fig. 13). Silver values average 7.8 ppm but are up to 42 ppm. The interval is also associated with elevated Au, Co, Cr, Li, Mo, Ni, Pb, S, Sb, Te, W and Zn values. Copper is also highly anomalous within a graphitic breccia at 410–411 m.

Intense silica–sericite–pyrite alteration zones, MSDP11 and MSDP12

Intense silica–sericite alteration zones evident in MSDP11 and 12 are generally associated with depletion in trace elements. Within pyritic zones (up to 40%), several trace elements are enriched (Fig. 11). In addition to silver, which ranged from 0.09 to 5.29 ppm in the intervals assayed, the following trace elements were elevated: As, Bi, Cd, Co, Mo, Pb, Sb, Te, W and Zn.

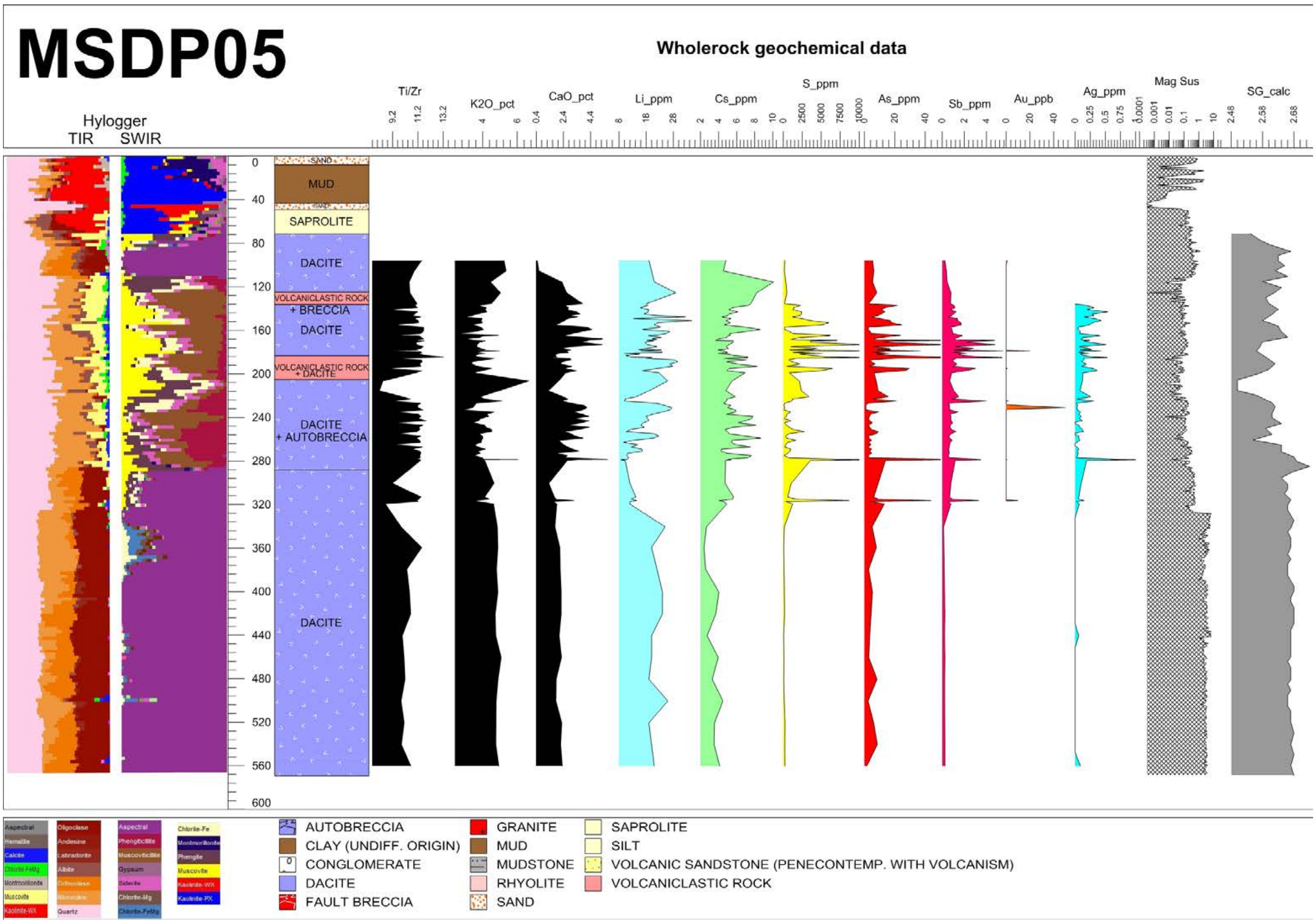


Figure 12 Summary plot for MSDP05 of spectral mineralogy from HyLogger^{TM}, lithology logging, selected whole rock geochemical results, magnetic susceptibility and specific gravity. Alteration zone associated with epithermal veining is associated with intense white mica alteration, demagnetisation and elevated Cs, Ca and Sb values across the entire alteration zone, with individual veins containing elevated Ag, Au, As, Bi, Mo and S values.

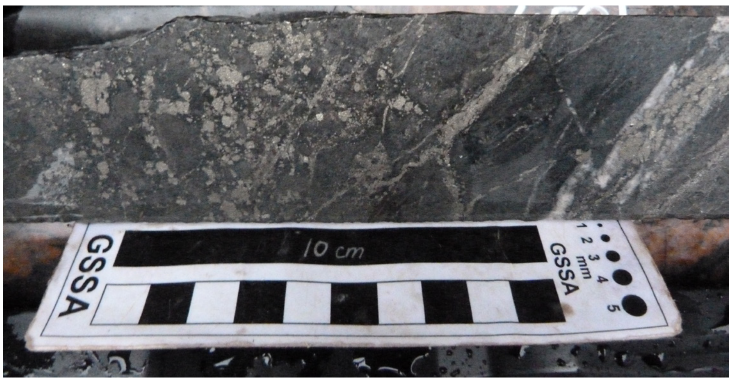


Figure 13 Pyrite-rich alteration zone within variably brecciated, chloritised and silica-altered, fine-grained rock, MSDP12, 392.8 m. (Photo 416132)

Regional implications

The Pennas Granite is interpreted to have been a source of heat and fluids that remobilised Pb–Ag–Zn at the Tin Hut prospect and facilitated thermal metamorphism and/or metasomatism of the Corunna Conglomerate. Similar Hiltaba Suite intrusions can be interpreted from regional gravity and magnetic images across the southern margin of the GRV. Known and interpreted granites are proximal to identified mineralisation that includes various mineralisation styles (Fig. 14). Hiltaba Suite intrusives are inferred to be crucial in either upgrading existing mineralisation or in forming new mineral deposits in the region. Reactive units (e.g. carbonates, graphitic units) of the Hutchison Group provide significant chemical contrast and are a likely source of metals. The Hutchison Group is therefore regarded as an important ingredient for localising mineralisation. Interpretive mapping of the subsurface distribution of reactive rocks of the Hutchison Group would refine regional prospectivity mapping.

Alteration trends

The MSDP intersected numerous lithologies and stratigraphic units across the southern Gawler Ranges, all of which have been characterised through whole rock geochemistry and spectral mineralogy (HyLogger^{TM}). The degree of alteration in drillholes varied greatly, providing examples of both unaltered to highly altered variants of many units. Of most significance were trends observed

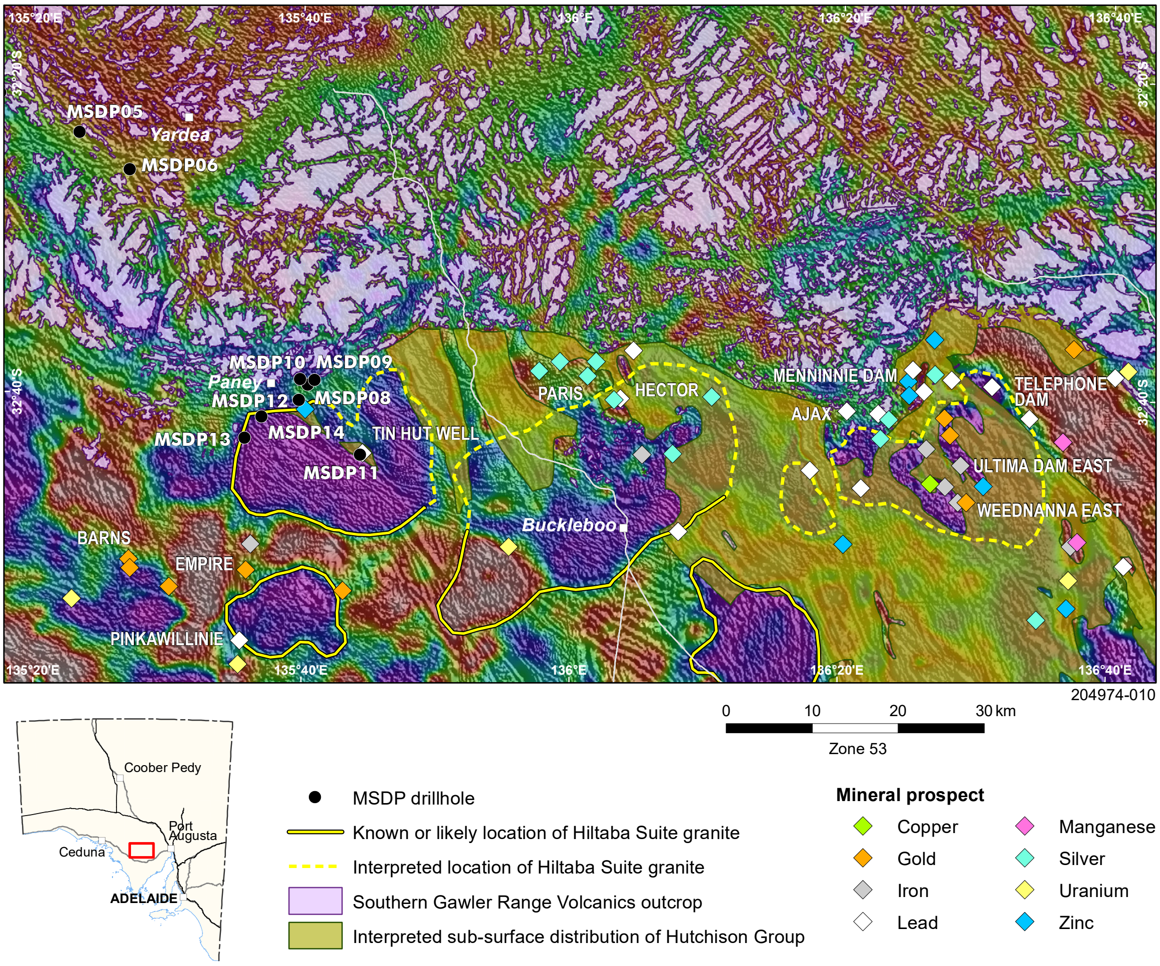


Figure 14 Known and interpreted location of Hiltaba Suite granite along the southern GRV margin. Known mineral occurrences are predominantly close to the current margin of the GRV and show an association with the location of Hiltaba Suite granite and Hutchison Group (from solid geology interpretation). Prospects containing Ag, Pb and Zn are mostly located around the margins of interpreted plutons. Solid yellow lines surround known or likely location of Hiltaba Suite granite at or close to the surface. Dashed lines indicate interpreted outline at depth and are based on geophysical interpretation. Base image is a combination of gravity (colour) and 1VD magnetics (texture).

within felsic volcanic units in the region. While white mica alteration was common within intersections of felsic volcanic rocks, spectral analyses have shown that white mica composition changed from a mixture of phengite and muscovite in background rocks, to dominantly muscovite close to mineralisation. Where chlorite is present in alteration assemblages, the chlorite composition is more iron-rich close to sulfide mineralisation. Along with demagnetisation, which is observed within alteration zones, these compositional variations of alteration minerals provide a potential vector to mineralisation.

Conclusion

The MSDP sought to address technical and scientific challenges present along the southern Gawler Ranges. Contributions to scientific objectives have been made through improvements to geological knowledge of the regional stratigraphy and lithological variation, deposit models, alteration styles, regional controls on fluid flow and mineralisation, and in providing new constraints on the depth to base of GRV. These data contribute to a growing understanding of the geology and mineral potential of the region, and provide stimulus to future exploration.

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FURTHER INFORMATION

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