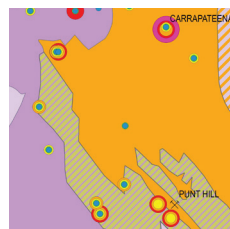
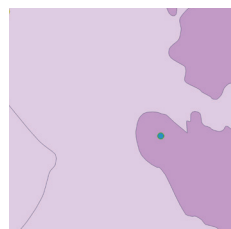
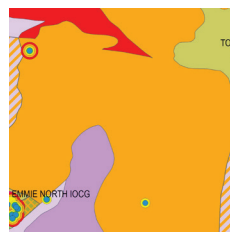




IOCG-style mineralisation in the central eastern Gawler Craton, SA; characterisation of alteration, geochemical associations and exploration vectors



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October 2013

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1 INTRODUCTION

While South Australia is well known as a geological province that hosts major iron-oxide-copper-gold (IOCG) deposits such as Olympic Dam, Prominent Hill, Carrapateena and Hillside, there is a lack of understanding in the public forum on what the broader hydrothermal systems look like away from the mineralised centres. For instance, there is very little information available on the characteristics, size and spatial distribution of the alteration patterns and associated geochemical signatures of IOCG's in South Australia. This significant knowledge gap means that distinguishing between regional alteration and near-miss intersections are difficult. In addition, the overall paucity of comprehensive geochemical and mineralogical data in the public domain limits the opportunity to identify and evaluate the full range of possible alteration and geochemical vectors to aid drillhole targeting.

This project was commenced with the objective of contributing data to begin to fill the knowledge gap in characterising alteration related to IOCG mineral systems. The approach was to collect additional data on drill samples, principally from publically available drill samples held in State government drill sample storage facilities. The focus was the eastern Gawler Craton, broadly within the Olympic Cu-Au Province (Fig. 1). This type of systematic regional investigation of alteration had not previously been attempted within the province. Key datasets acquired as part of the project were multi-element geochemistry and visible to infrared spectral data, with interpreted mineralogy, on drill core using the HyLoggerTM system. These data were combined with regional inversion models of potential field geophysical data to form integrated 3D models, to be described in subsequent reports.

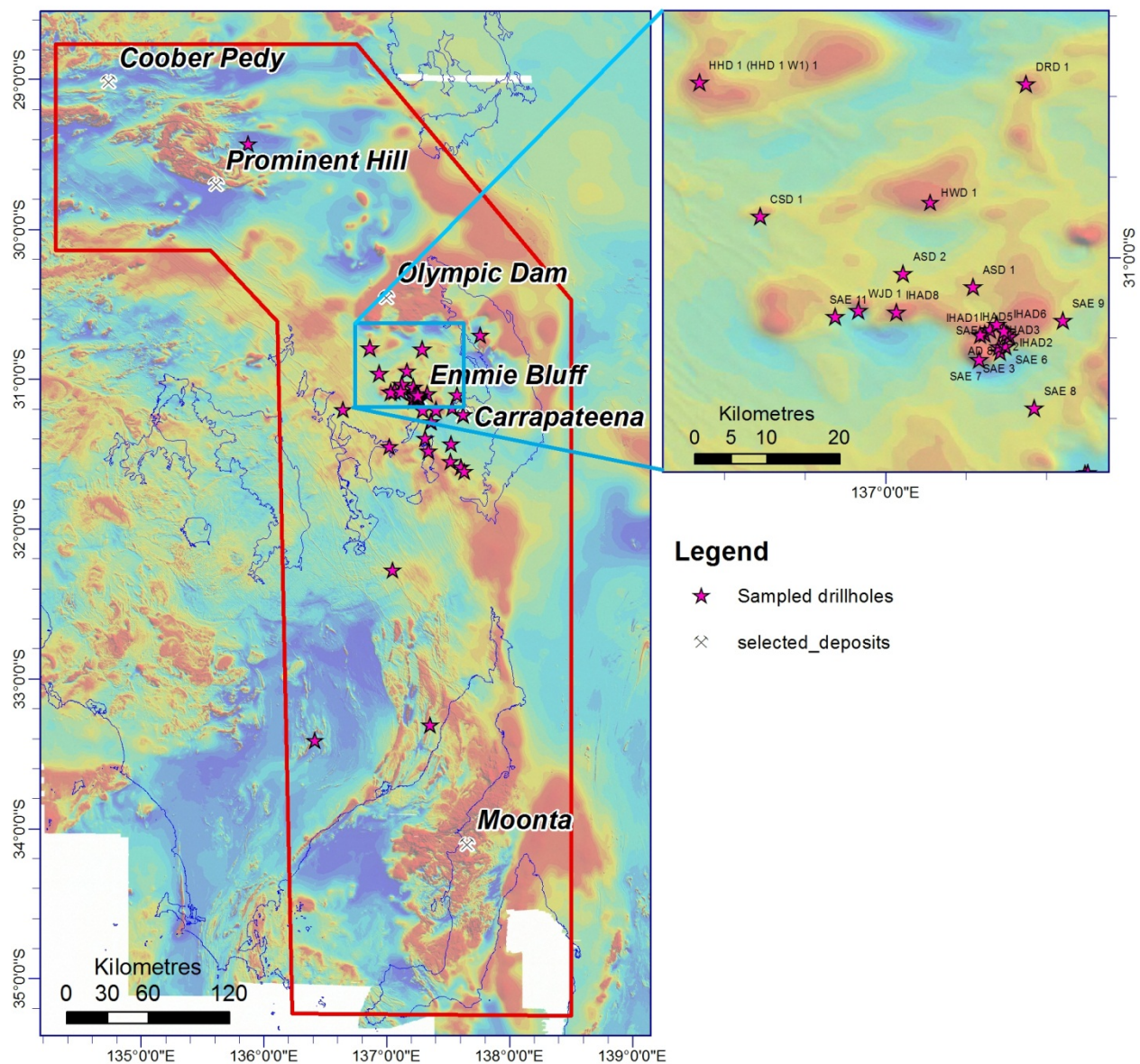


Figure 1. Location of drillholes sampled in this project on a state aeromagnetic image. The area defined as the eastern Gawler is shown by a red outline. Inset shows the Emmie Bluff region with sampled drillholes in more detail.

2 BACKGROUND

The project commenced in May 2011 following a meeting of the Geological Survey with consultant Scott Halley, to consider the feasibility of integrating geochemical and spectral data. It was determined that systematic sampling of drill core held in government core storage facilities coupled with the existing spectral scanning campaign using the HyLogger™, would form a powerful and cost-effective method for characterising alteration around IOCG systems.

2.1 PREVIOUS RESEARCH

Several significant studies have previously been undertaken and have implications for this project, as summarised below.

2.1.1 Regional spectral investigation

As a prelude to the project, all existing spectral Hylogger™ data from drillholes within the Olympic Cu-Au Province were examined and summarised. Spectral data for various stratigraphic rock units were subset and collated. These were further subset into altered and relatively unaltered intersections. For most drillholes included in the summary, moderately to highly altered intersections related specifically to IOCG-style mineralisation. Mineralogy was based primarily on automated interpretation using software 'The Spectral Analyst™' (TSA) and based on characteristic absorption features in the short wave infrared (SWIR) and very near infrared (VNIR) spectrum. The results of this investigation are summarised in the following observations:

Hiltaba Suite (18 drillholes) — when altered; phengitic white mica dominates over muscovitic compositions, chlorite is significantly more common and there is a notable increase in the wavelength of the FeOH (2250 nm) absorption feature (Fe chlorite); hematite dominates over goethite.

Donington Suite (13 drillholes) — when altered; phengitic white mica dominates over muscovitic compositions, chlorite is more common and its composition varies; a greater abundance of Fe oxides are present.

Wallaroo Group (26 drillholes) — when altered; white mica is more common and its composition is slightly more phengitic (longer wavelength); there is significantly more chlorite and the position of its characteristic FeOH (2250 nm) absorption feature correspond to longer wavelengths (towards Fe-rich compositions); Fe oxides and Ca-rich minerals (epidote, ankerite, siderite, calcite, hornblende and dolomite) are more common in altered Wallaroo Group.

Gawler Range Volcanics (18 drillholes) — when altered; chlorite is common and more often with a longer FeOH (2250 nm) absorption feature; the abundance of white mica is variable and it is slightly more phengitic in composition.

Observations were also made on specific open file holes that were drilled into mineralisation at the Olympic Dam, Carrapateena and Emmie Bluff deposits.

Olympic Dam

Based on drillhole, RU 39 5371, drilled from within the Olympic Dam IOCG deposit, chlorite and white mica are common on the margins of the orebody (within altered Hiltaba Suite) and their compositions are overwhelmingly of the long wavelength variety (Fe-rich and phengitic respectively). White mica associated with the ore is muscovitic in composition.

Carrapateena

White mica alteration is strongly associated with the upper part of the Carrapateena ore body and chlorite is common deeper in the system and corresponding with the highest Cu grade. The white mica in the mineralised zone is muscovitic. Chlorite is overwhelmingly of the longer wavelength variety (Fe-rich).

Emmie Bluff

Phengitic white mica is dominant at the margins of the mineralised zone at the Emmie Bluff prospect (drillholes SAE6 and IHAD series). The mineralised zone is associated with abundant chlorite of dominantly Fe-rich composition (long wavelength).

2.1.2 Stuart Shelf geochemical project (Tonkin 2009)

Following on from historical investigations into interface sampling within Adelaidean rock units of the Stuart Shelf (Tonkin 1979; Tonkin 1999), Tonkin (2009) conducted a pilot study looking at sampling conglomerate at the sedimentary cover-basement boundary in the Stuart Shelf region, and using the geochemistry of this sample as an exploration tool for IOCG deposits. A geochemical dispersion halo defined by the presence of hematite pebbles and high Sr-U-Th-Cu-Fe-Cr-V values (pXRF) was found as far as 10 km from the Carrapateena deposit. Dispersion around several other Cu occurrences in the Arcoona region was identified. Encouraging results from Tonkin (2009) were behind the strategy adopted in this project to include routine sampling above the sedimentary cover-basement unconformity.

2.1.3 Geoscience Australia research mid 2000s

Geoscience Australia undertook a study that identified key ingredients for IOCG deposits in the eastern Gawler Province. Along with developing models to explain the different styles of IOCG deposits in the Gawler, common alteration assemblages and paragenesis were detailed (Bastrakov et al 2007). The two main mineral assemblages recognised in the central Olympic Cu-Au Province include;

1. magnetite - alkali feldspar (albite or K-feldspar after albite) - calc-silicate (actinolite &/or diopside) $\pm$ Fe-Cu sulphides, quartz, apatite, titanate, allanite, scapolite;
2. hematite-sericite-chlorite-carbonate $\pm$ Fe-Cu sulphides $\pm$ U and REE.
In addition, a third common mineral assemblage is known from the Moonta-Wallaroo district and Mt Woods Inlier;
3. magnetite-biotite-albite $\pm$ Fe-Cu sulphides.

In IOCG mineral deposits containing hematite, mineral assemblages 1) and 3) are commonly overprinted by mineral assemblage 2).

Bastrakov et al (2007) and Skirrow et al (2007) noted that alteration and paragenesis were similar in both economic and sub-economic IOCG deposits. However, Olympic Dam could be discriminated from other sub-economic counterparts by evidence of greater input of mantle-derived REE and other ore components (e.g. Cu, Au). One of the aims of the project described in this report was to determine if there are spectral and/or geochemical discriminators between economic and sub-economic IOCG systems.

2.2 GAPS IN CURRENT KNOWLEDGE

Although alteration relating to IOCG deposits has been described for several deposits in the eastern Gawler, there is limited publically available information that also describes the regional alteration relating to the broader mineral system. In addition, very little spectral characterisation of alteration has been done and there is no publically reported study that has attempted to combine geochemical and spectral alteration trends. This project addresses these gaps in current knowledge and seeks to identify measurable criteria that can be used to distinguish areas of greater potential for IOCG mineralisation and to use these criteria to improve drillhole targeting of ore-grade mineralisation.

3 METHODOLOGY

Alteration relating to IOCG mineralisation was characterised using geochemistry, mineralogy by spectral analysis, and petrophysics. Data were obtained mainly on samples from drillholes held in storage by DMITRE. Some data from confidential company drillholes were included where agreement was reached for public release of results. Drillhole selection was based on location, length of core into basement, and logistics related to spectral scanning. Basement intersections were sampled over 1 m intervals within every 10 m with flexibility to vary the sample spacing to achieve the most representative samples. Where feasible, a sample was also taken above and below the sediment cover-basement unconformity, specifically targeting any basal conglomerate containing basement rock fragments. Portable XRF measurements using the Olympus Delta Premium 6000 were acquired on drill core. Measurements were spaced at 5 m intervals. Spot analyses were selected to be most representative of the mineralogy for each metre of core. Magnetic susceptibility and specific gravity measurements were made at similar intervals to the geochemical sampling. All drillholes were scanned using the Hylogger™ core scanning system (Huntington et al 2010).

3.1 GEOCHEMISTRY

Chemical analyses on drill core samples were done by Genalysis Laboratory Services in Adelaide. Each sample was crushed, pulverised and analysed using the following routine;

Lead collection fire assay on 25g samples, ICP-MS finish – Au, Pt, Pd

Four acid ICP-OES – Cu, Li, Ni, Pb, S, Zn

Four acid ICP-MS – Ag, As, Bi, Cd, Co, Cs, Ge, In, Mo, Nb, Re, Sb, Se, Te, Ti

Carbonate fusion, selective ion electrode – F

Lithium borate fusion with ICP-OES finish – Al₂O₃, CaO, Cr, Fe₂O₃, K₂O, MgO, MnO, Na₂O, P₂O₅, SiO₂, TiO₂, V

Lithium borate fusion with ICP-MS finish – Ba, Be, Ce, Dy, Er, Eu, Ga, Gd, Hf, Ho, La, Lu, Nd, Pr, Rb, Sc, Sm, Sn, Sr, Ta, Tb, Th, Tm, U, W, Y, Yb, Zr.

Note: the IHAD series of holes were analysed before the geochemical routine was fully established. For these samples, fusions were done using sodium peroxide and there were no analyses determined for Au, Pt, Pd and F.

3.2 SPECTRAL MINERALOGY

Spectral scans of drill core were made using the semi-automated hyperspectral logging tool, HyLogger™, located and operated at DMITRE's Glenside Core Storage Facility. Reflectance spectra were measured for all drillholes in VNIR (400-1100 nm) and SWIR (1100–2500 nm) wavelengths prior to sampling. After October 2012, drillholes were scanned with an updated version of the HyLogger™ system which included reflectance spectra in thermal infrared (TIR; 5000–14000 nm) wavelengths. Spectral data were used to interpret mineralogy, with strong reliance on automated mineral identification using software package The Spectral Geologist™ (TSG).

3.3 PETROPHYSICS

Drill hole sampling was accompanied by measurements of magnetic susceptibility and specific gravity. Magnetic susceptibility measurements (Terraplus KT9) were obtained every two metres and specific gravity measurements approximately every three metres.

4 RESULTS

Geochemical data (Appendix 1) was assessed using standard methodologies employed by Scott Halley (Mineral Mapping Pty Ltd). This involved first determining the protolith, defining the predominant alteration style for each sample and then examining the element associations for each of the major alteration types.

4.1 DETERMINE PROTOLITH

Samples were collected from various stratigraphic units. These included: Wallaroo Group, Donington Suite, Gawler Range Volcanics, Hutchinson Group, Mt Woods Metamorphics, Mt Shannon Iron Formation, ?Willamulka Volcanics and where unassigned, were relegated to 'undifferentiated rock'. Samples were classified based on visual logging of lithology that attempted to identify the unaltered protolith (Fig. 2). The degree of alteration in most drillholes meant this classification was somewhat unreliable and consequently of limited value. However, refinements to these classifications were made based on geochemistry. Mafic rocks which are difficult to distinguish visually amongst highly altered rock units were geochemically differentiated using Sc v Nb and Sc v Zr plots (Fig. 3). Separate data clusters corresponded to geochemically distinct dolerite dykes. Plots of Ca, SiO₂ and Al were used to reclassify the samples logged as having a sedimentary protolith (Figs. 4 and 5). Those with high SiO₂ and low to moderate Al were classified as quartz-rich; those with high Ca were classified as Ca-rich; the remainder were reclassified as general metasediment to reflect their varied composition. In all cases, the rock composition reflected a combination of original sediment mineralogy and an alteration overprint.

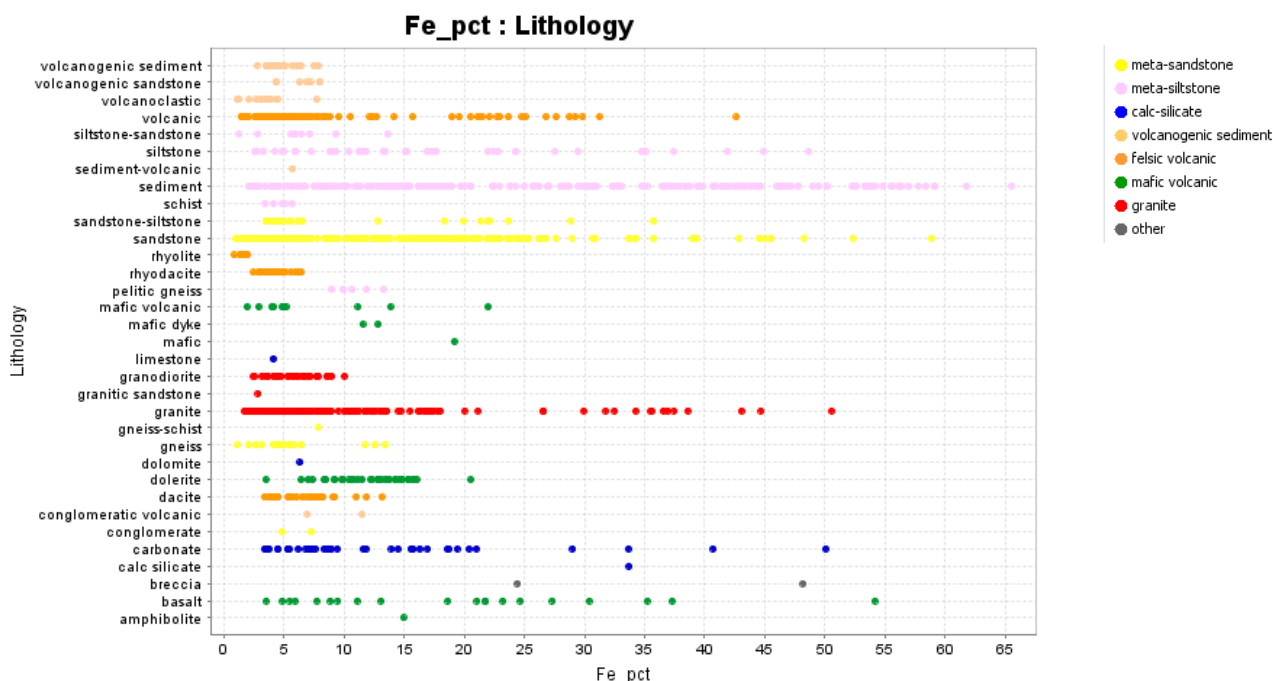


Figure 2. Drillhole samples differentiated by lithology logging plotted against Fe values. Samples have been coloured by simplified lithology. Significant Fe-alteration (Fe>10%) has affected most lithologies.

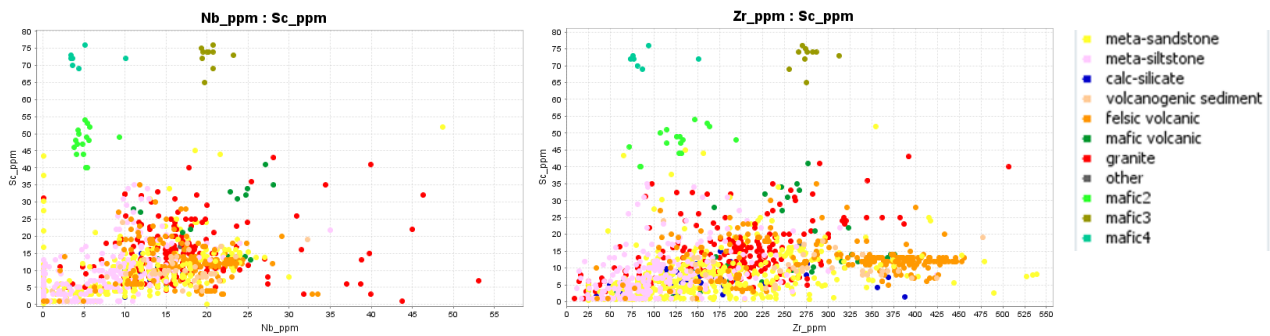


Figure 3. Plots of Sc versus Nb and Zr. Classification is based on lithology logging and refined by geochemistry. Those points labelled as mafic volcanics are GRV basalt and dolerite samples; mafic2 are dolerite samples, mainly from CAR01; mafic3 are dolerites from drillhole ASD1; mafic4 are dolerite samples, mainly from ASD2.

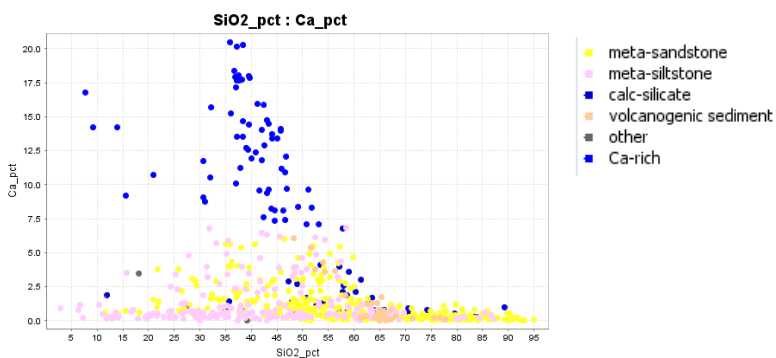


Figure 4. Plot of Ca versus SiO₂. Used to discriminate Ca-rich metasediments.

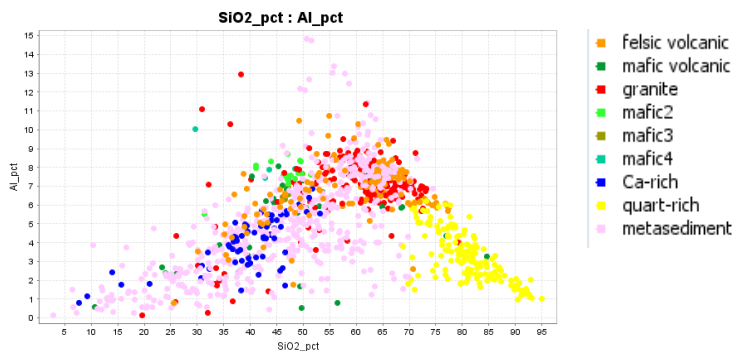


Figure 5. Plot of Al versus SiO₂. Used to discriminate quartz-rich samples. The remaining sedimentary rocks have been classified as metasediments in this diagram.

4.2 CHARACTERISE ALTERATION

4.2.1 Geochemical characterisation

A plot using Fe values illustrates the degree of Fe enrichment in the dataset (Fig. 6) Values of >10% Fe were used to classify samples that were Fe-altered. The Fe-alteration was most common within metasediment samples of the Wallaroo Group, although this style of alteration affected most lithologies and stratigraphic units, to some degree (Fig. 7).

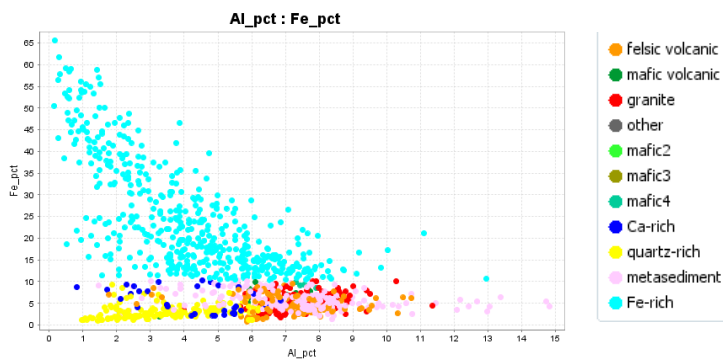


Figure 6. Plot of Fe versus Al in percent. An Fe-enrichment trend is defined by rocks that are progressively Fe-altered. Those with >10% Fe have been classified as Fe-rich.

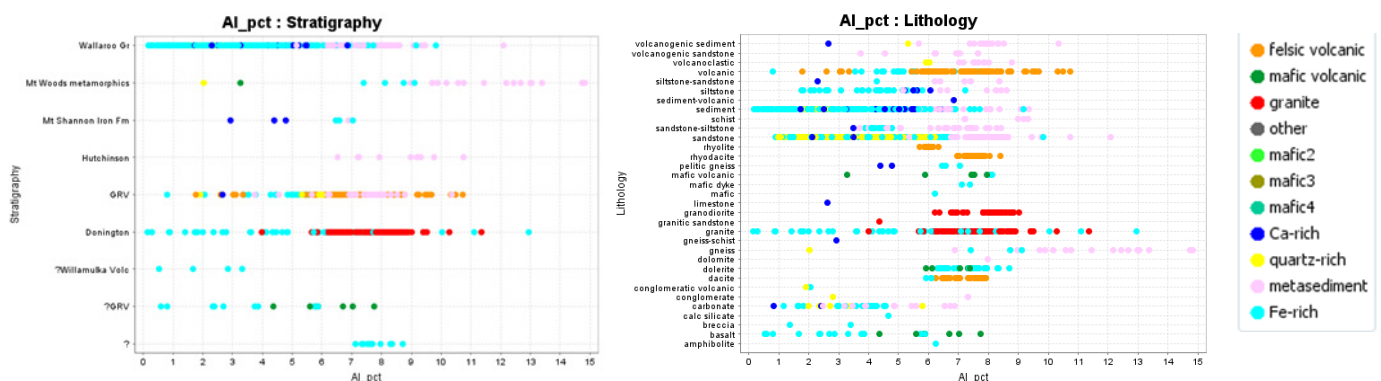


Figure 7. Plots of Al versus lithology (a) and stratigraphy (b), as defined by visual logging of the core. These plots demonstrate that Fe alteration affects most lithologies and stratigraphic units.

Broad alteration styles were characterised geochemically by plotting molar ratios for K and Na (Fig. 8; Feldspar Na-K element ratio diagram from IoGasTM). Using molar ratios, mineral fields were plotted where a rock that is totally K feldspar (KAlSi_3O_8) altered would have a K:Al ratio of 1:1, muscovite ($\text{KAl}_3\text{Si}_3\text{O}_{10}(\text{OH})_2$) altered rock a K:Al ratio of 1:3 and an albitised ($\text{NaAlSi}_3\text{O}_8$) rock a Na:Al ratio of 1:1. Samples depleted in both K and Na contain limited feldspar and white mica. Where this is true, the Al content most likely relates to the presence of chlorite ($\text{Fe, Mg}5\text{Al}(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH},\text{O})_8$). Relatively unaltered GRV samples plotted as a cluster near the centre of the diagram (contain both albite and K-feldspar; Fig. 8). Similarly, relatively unaltered Donington Suite samples clustered in the centre of the plot, but with slightly less Na than for GRV samples. The majority of samples are intensely Na-depleted. The Fe-rich samples plotted towards the chlorite field and many of the rock-types showed evidence of potassic alteration. Based on the Feldspar Na-K General Element Ratio (GER) diagram, samples were reclassified into dominant alteration types (K-feldspar, sericite, sericite-chlorite-Fe oxide, chlorite-Fe oxide; Fig. 9). In addition, those samples that plotted near the centre of the diagram were considered less altered and were classified as representative of background (relatively unaltered) samples.

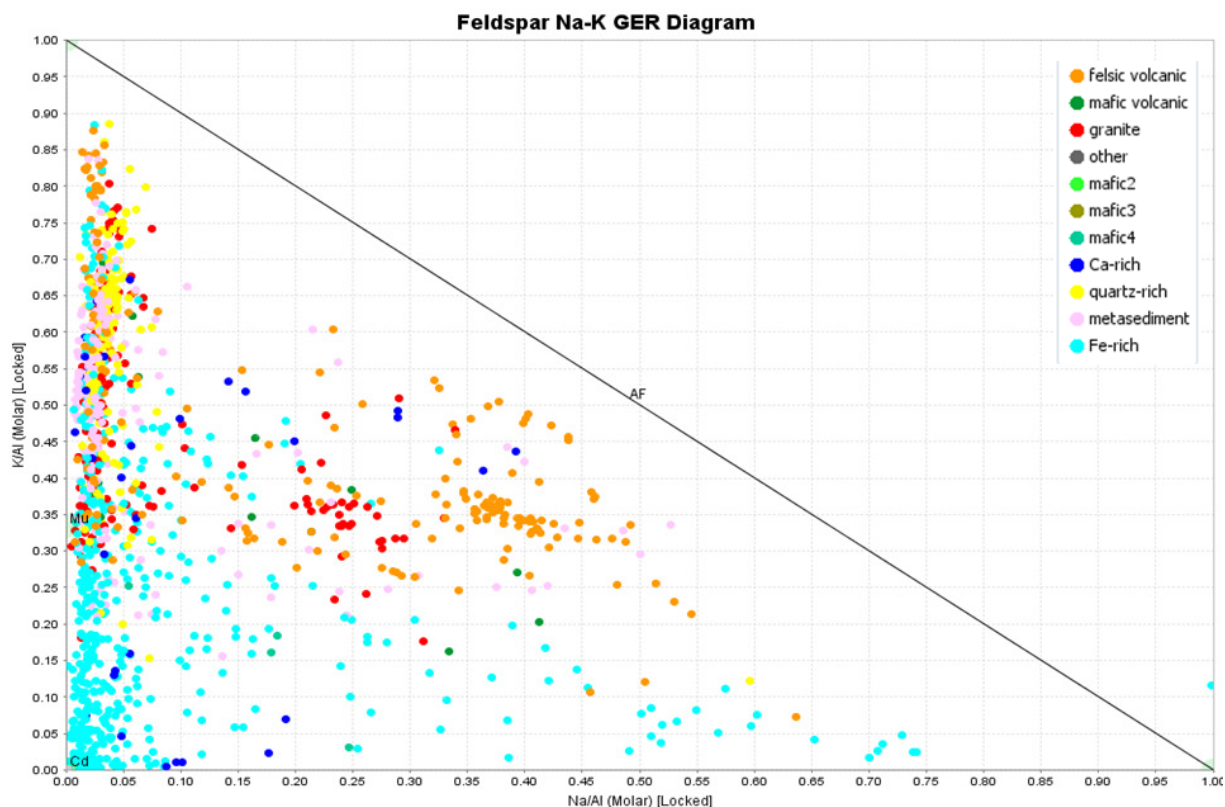


Figure 8. Plot of K/Al versus Na/Al using molar ratios. The mineral fields K-feldspar, muscovite, chlorite and albite are plotted. Regions indicating relatively unaltered rock types are shown.

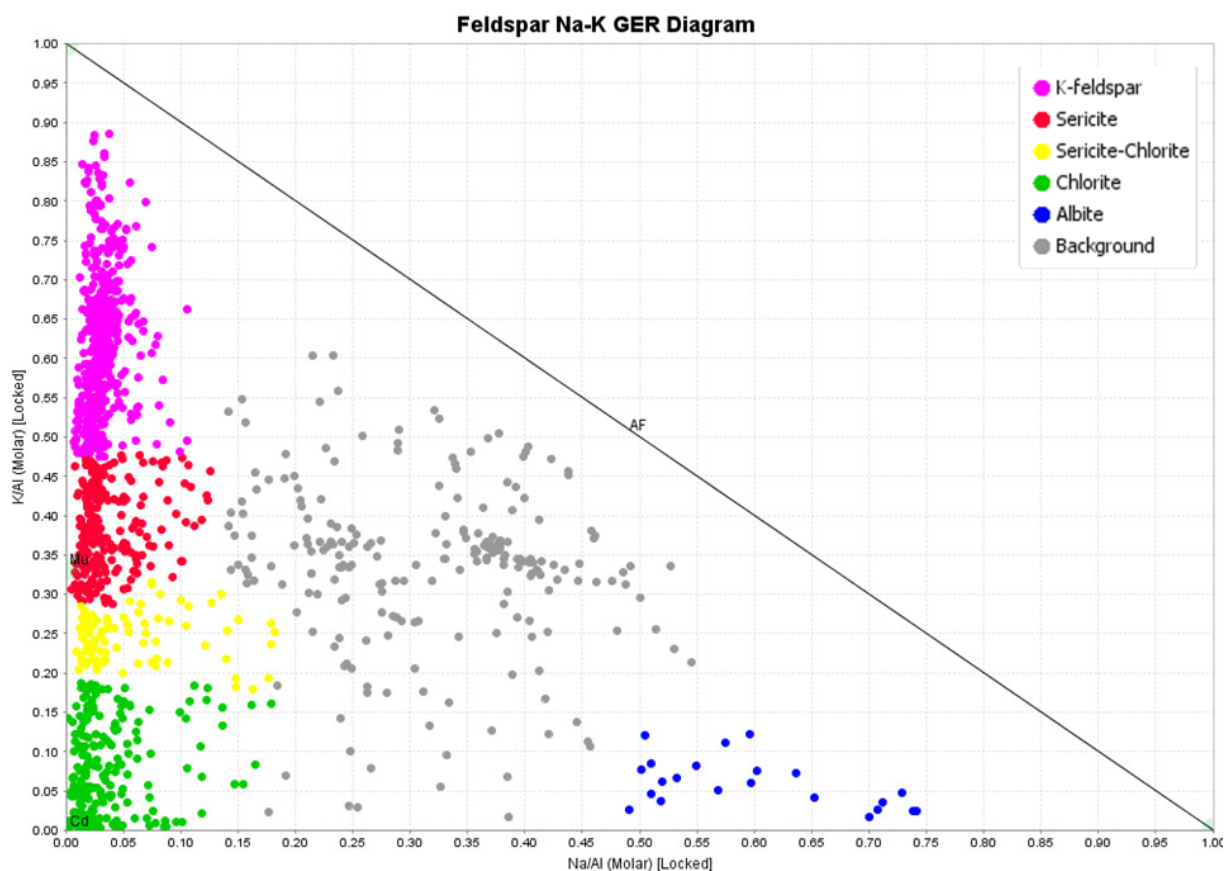


Figure 9. Plot of K/Al versus Na/Al using molar ratios. Samples have been classified based on dominant alteration mineralogy. This diagram can be used to define samples that are relatively unaltered.

4.2.2 Spectral characterisation

For selected minerals, HyLogger™ was the preferred method of identification over the geochemical approach. Samples were classified based on SWIR spectral data using mineral identification by TSG™ software (group 1 and group 2 minerals; Fig. 10). The majority of samples were either sericite- or chlorite-altered. Most of the chlorite-altered samples had high Fe and were therefore also mostly associated with Fe-oxide alteration.

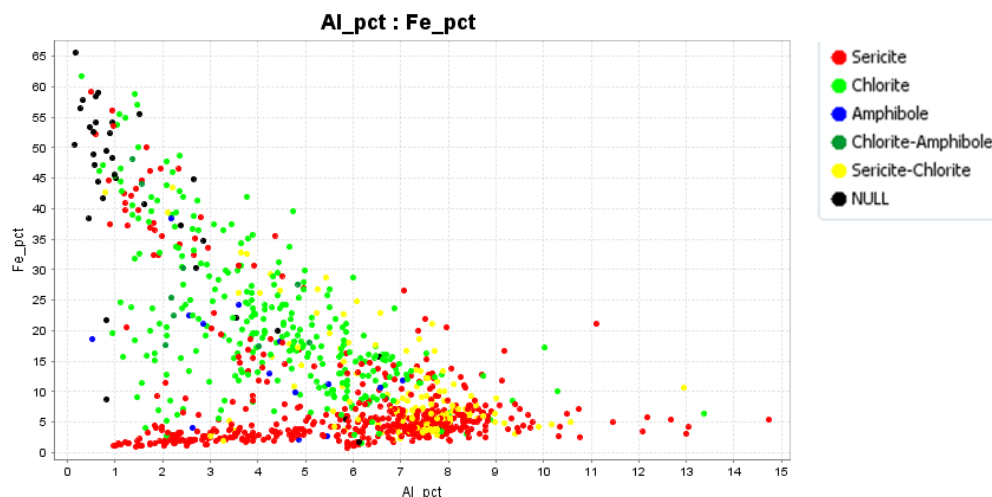


Figure 10. Plot of Fe versus Al in percent. Sample points are coloured by simplified mineral identification from The Spectral Analyst (HyLogger™ results). Null results represent samples where no mineral was identified.

4.2.3 Combined spectral and geochemical characterisation

A more robust alteration model was developed by combining mineral identification from the HyLogger™ (VNIR, SWIR) with the geochemical data. Firstly, Fe oxide was added to the spectral mineral classification based on Fe values (Fig. 11). In doing so, the new mineral classifications of chlorite+Fe oxide, sericite+Fe oxide and Fe oxide were created. While the HyLogger™ can be used to identify Fe oxides in the VNIR, it was not found to be a sufficiently robust method for identifying all the Fe oxides/oxy-hydroxides present.

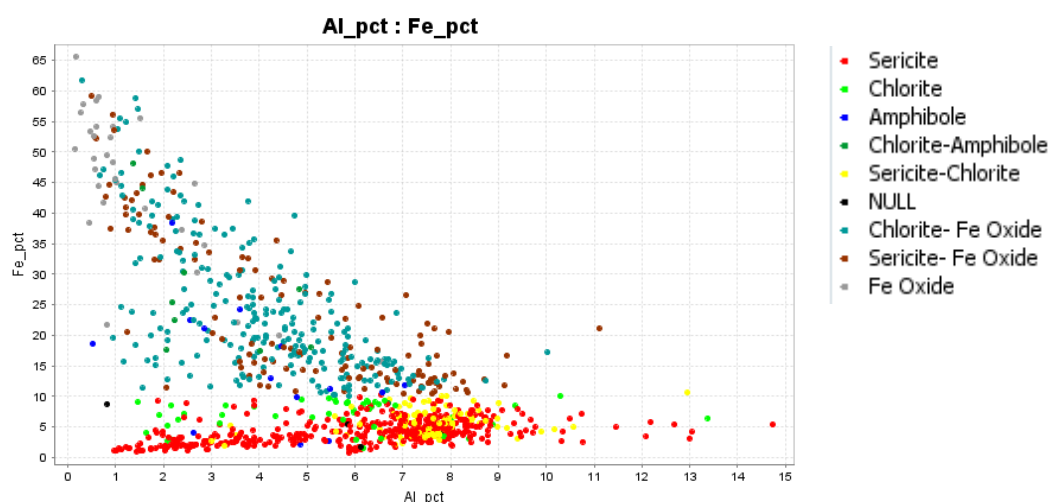


Figure 11. Plot of Fe versus Al in percent. Sample points have been classified based on a combination of simplified mineralogy from The Spectral Geologist (HyLogger™ results) and geochemistry.

K-feldspar was added to the alteration assemblages using a Feldspar Na-K GER diagram. Samples identified spectrally as having abundant white mica and with high K/Al and low Na/Al

values were classified as K-feldspar+sericite (Fig. 12). Samples within the K-feldspar field of the Feldspar Na-K GER diagram with high Fe were classified into a K-feldspar+Fe oxide assemblage.

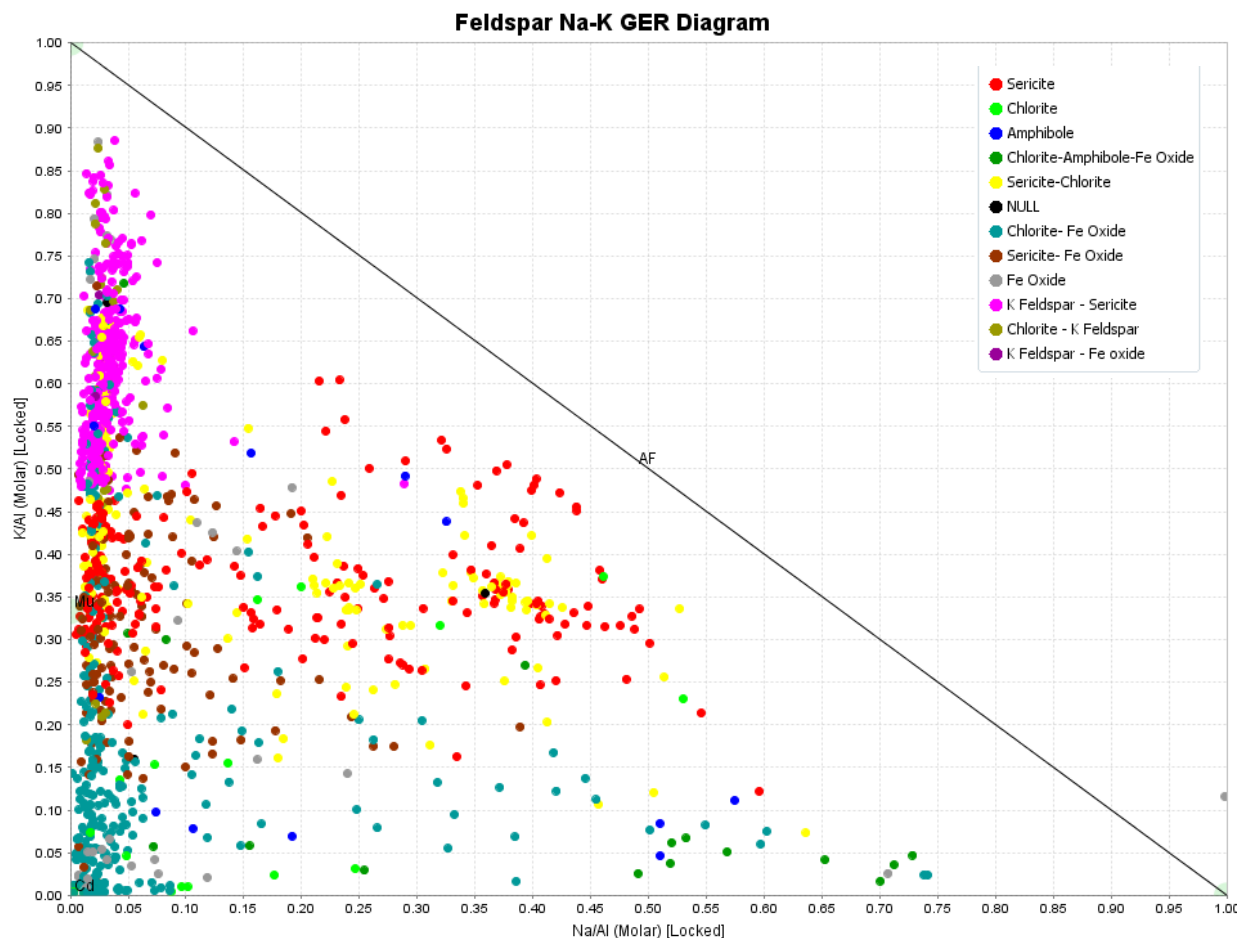


Figure 12. Plot of K/Al versus Na/Al using molar ratios. Sample points have been classified by a combination of spectral (HyLogger™) and geochemical data.

4.2.4 Combined spectral, geochemical and petrophysical characterisation

Measurements of magnetic susceptibility taken from all drillholes sampled as part of this project were used to define those mineral assemblages associated with magnetite (Fig. 13; Appendix 1.4). Magnetic susceptibility values of more than 0.05 were used to indicate the presence of magnetic minerals (equivalent to $>1\%$ magnetite). Using this value, the magnetite classification was mainly associated with chlorite-Fe oxide and Fe oxide alteration assemblages and excluded relatively unaltered GRV with trace magnetite content. Figure 13 shows that relatively few samples were associated with magnetite alteration and that most of the Fe oxide alteration was related to hematite.

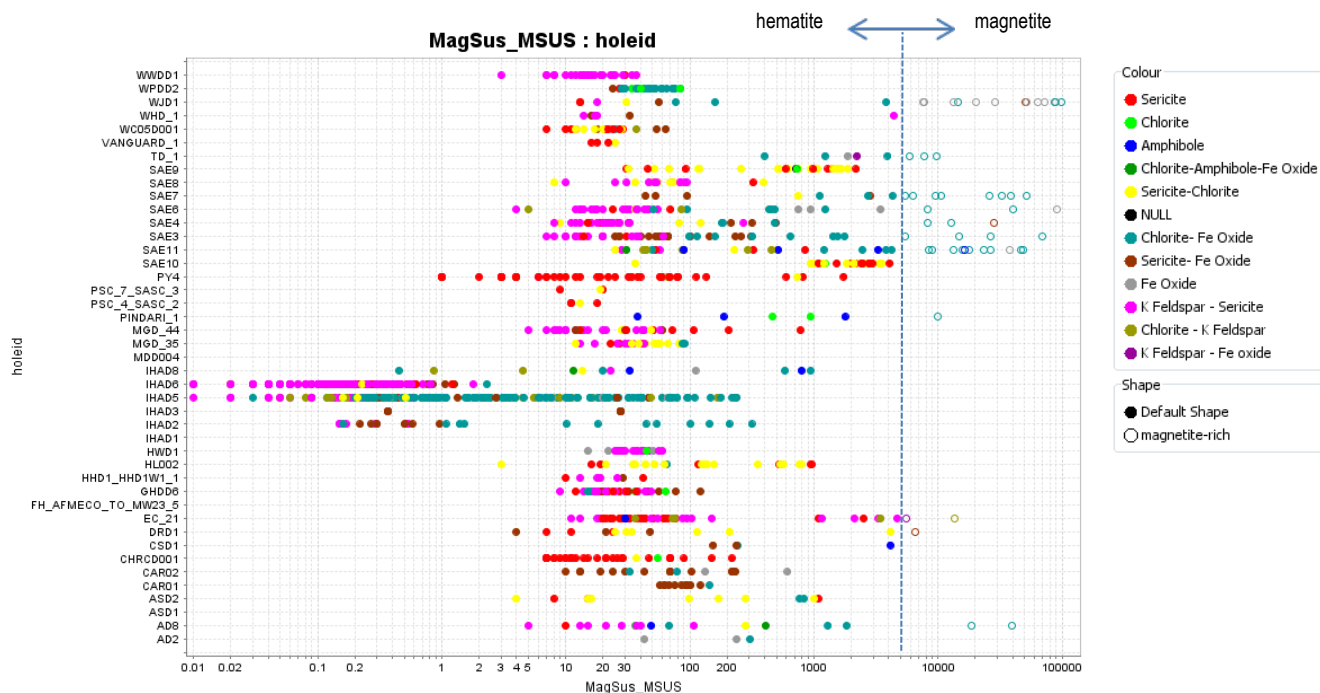


Figure 13. Magnetic susceptibility for all drillholes. Values of $>5000 \times 10^{-5}$ have been classified as containing significant magnetite (open circles).

These data were then re-plotted on a Feldspar Na-K GER diagram (Fig. 14). Although all samples showed signs of alteration, those that plotted towards the centre of the diagram represented samples that were affected by background or regional alteration, as opposed to those close to areas of mineralisation. The Feldspar Na-K GER diagram can be used to represent the degree of alteration towards mineral assemblages known to relate to IOCG mineralisation (Fig. 14).

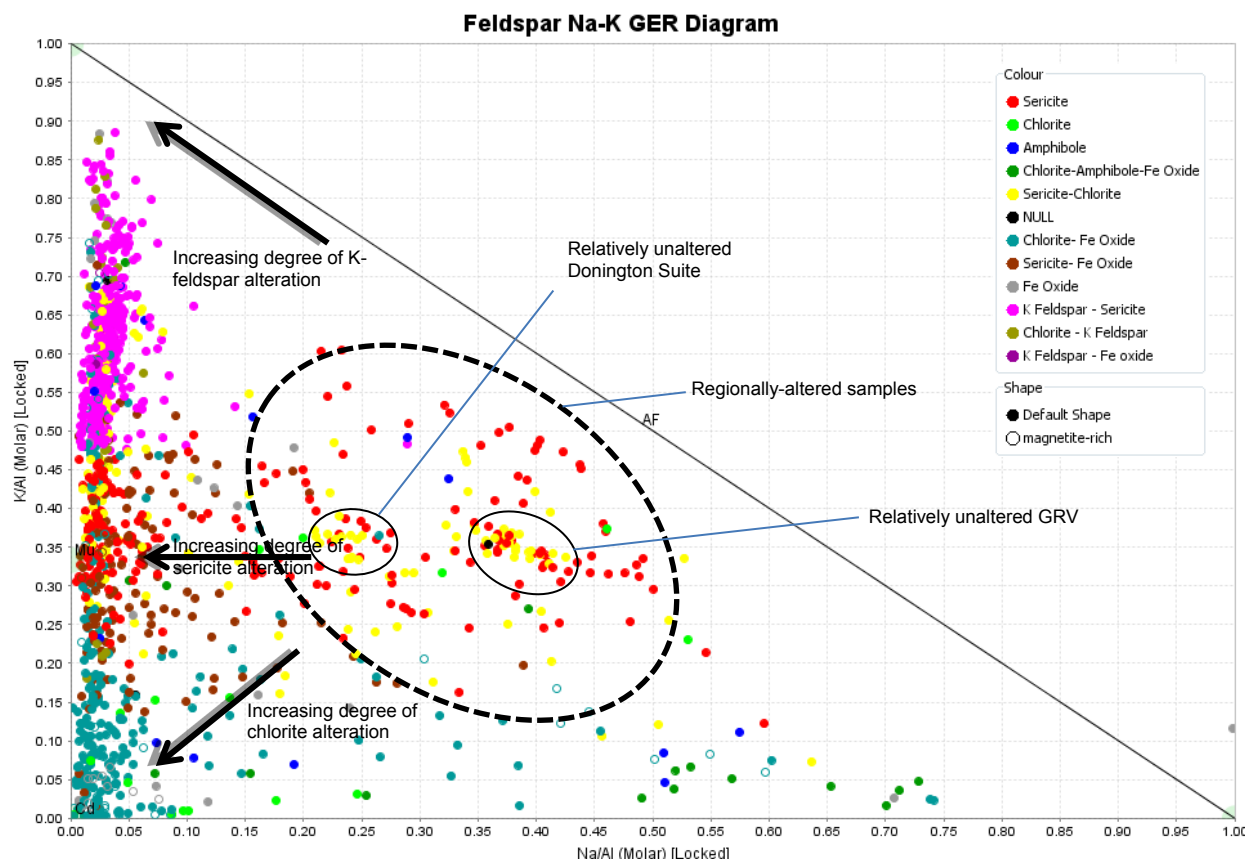


Figure 14. Plot of K/Al versus Na/Al using molar ratios. Sample points have been classified by a combination of spectral (HyLogger™), geochemical and magnetic susceptibility data.

4.3 ELEMENT ASSOCIATIONS WITH ALTERATION ASSEMBLAGES

Element associations with each of the alteration assemblages were examined using probability plots (Appendix 1.5). In probability plots, values are plotted against the N score for each sample where $N = (X - \text{mean}) / \text{standard deviation}$. Elements typically associated with IOCG mineralisation (viz. Cu, Au, U, Ag, Ce, La) were enriched in the sericite-Fe oxide and chlorite-Fe oxide alteration assemblages (Fig. 15). Relative to average crustal abundance (Rudnick and Gao 2003), many of the samples from the central Olympic IOCG Province are strongly anomalous in these elements.

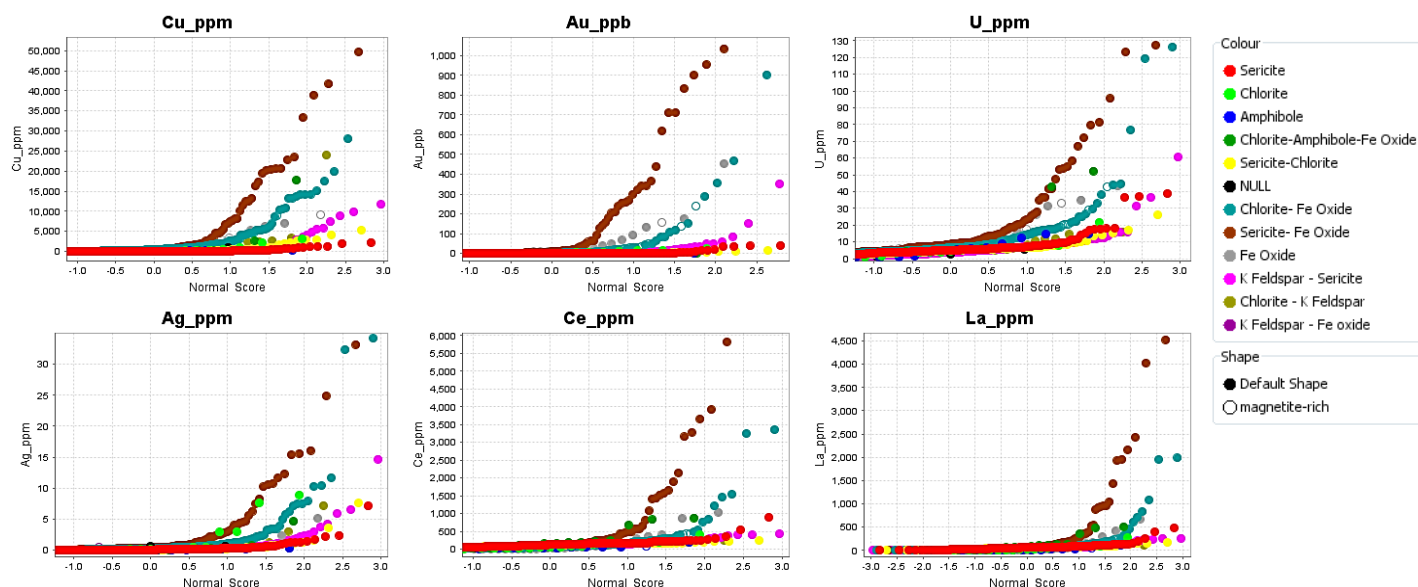


Figure 15. Probability plots for Cu, Au, U, Ag, Ce and La with respect to alteration mineral assemblages. Significant trends are those that diverge from the x-axis and other mineral assemblages. The dashed line on each graph signifies 10 times the crustal abundance for that element.

Samples in this dataset showed strongly anomalous values for pathfinder elements (Fig. 16). High W and Mo values were most commonly associated with the Fe-oxide dominated mineral assemblages (Fe-oxide, sericite-Fe oxide and chlorite-Fe oxide) and often with samples containing magnetite. Highly anomalous As, Co and Te values were most commonly associated with the chlorite-Fe oxide alteration assemblage. Values above 10 times crustal abundance for Sb, Se and Bi were typical in all alteration assemblages and were therefore not as biased towards mineral assemblages containing Fe oxide as with many other pathfinder elements in the dataset. Other elements with high values across all alteration assemblages include Ba, Cu, Ag ± W, S (Fig. 16; Appendix 1.5).

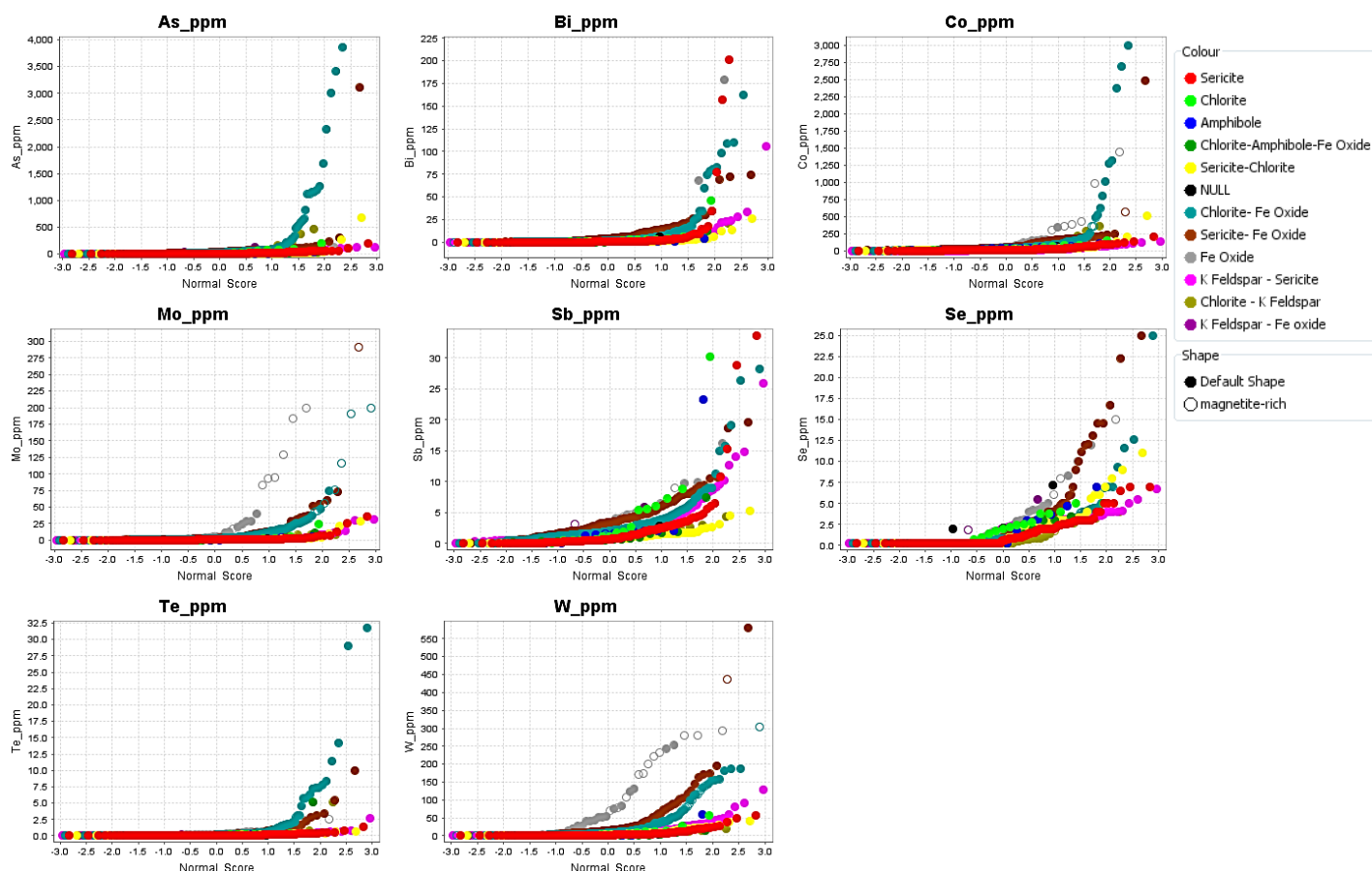


Figure 16. Probability plots for the pathfinder elements As, Bi, Co, Mo, Sb, Se, Te and W.
The dashed line on each graph signifies 10 times the crustal abundance for that element. Note: some extreme values plot off the graphs.

4.4 INTER-ELEMENT ASSOCIATIONS - CORRELATION COEFFICIENTS

Although limited to describing simple relationships, a correlation matrix was used to identify associations between elements where a coefficient of >0.5 was defined as significant (Appendix 1.6). Several key groupings were identified. Copper was correlated to Au (0.52) and S (0.59). Au was correlated to Ce (0.69), La (0.74), Nd (0.56), Pr (0.61), Te (0.57), U (0.55) as well as Cu. Ag was correlated to Te (0.67). REE all show an association with each other and U. Other significant correlations included As with Co (**0.96**), Zn with Cd (**0.98**), Cr with Ni (**0.82**), Rb with K (**0.88**) and Al (0.71), Pb with Cd (0.74) and Zn (0.67), Tl with Al (0.62), Cs (0.52), K (0.63) and Rb (0.79), V with Sc (0.72) and Ti (0.63), W with Fe (0.5), Zr with Hf (**0.99**), Al (0.56), Nb (0.54) and Ta (0.54).

4.5 KEY SPECTRAL PARAMETERS AND RELATIONSHIPS

While HyLogger™ was used to aid interpretation of the mineralogy of drill core, mineral identification is subject to error during the allocation of mineral species from spectra by the available software (TSG™). An alternative method of using the spectral data is to map the wavelength position of characteristic absorption features (AusSpec International Limited 2008). For example, white mica has a characteristic absorption feature around 2200 nm (AlOH absorption feature). Chlorite has a characteristic absorption feature around 2250 nm (FeOH absorption feature). Variation in the position of these absorption features can relate to compositional variation in these minerals. For white mica, the variation in the absorption feature can provide information about the fluid chemistry and potentially the chemical conditions at the time the mineral formed (Fig. 17; Schofield and Van der Wielen 2007). Although conditions that effect the chlorite system

are not well understood, where the FeOH absorption feature has a longer wavelength (>2256 nm), the composition is generally associated with a more Fe-rich species of chlorite (AusSpec International Limited 2008). Conversely, an absorption feature at a shorter wavelength is associated with a more Mg-rich composition (<2246 nm). The Hylogger™ spectral data can be used to map these shifts in the absorption features and derive relationships between mineral chemistry and alteration.

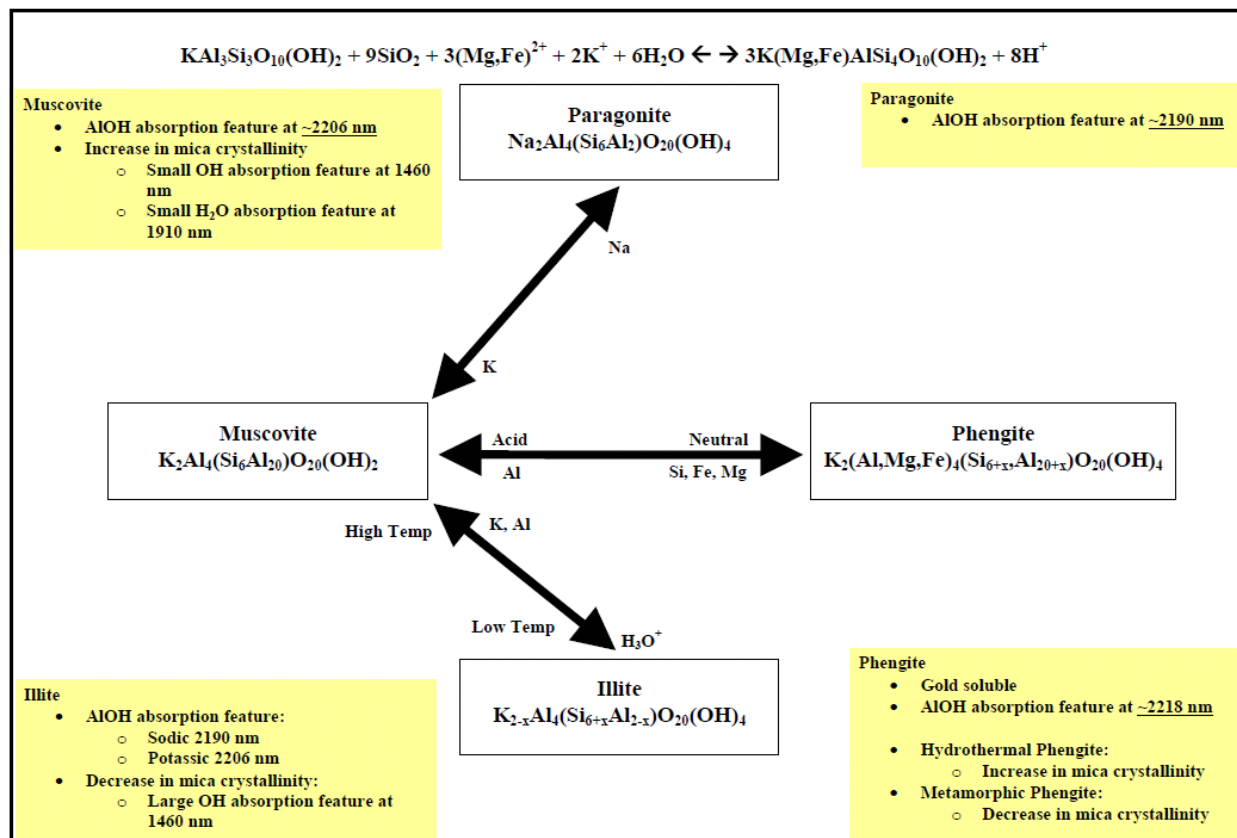


Figure 17. Compositional variation of white mica and associated absorption features.
From Schofield and van der Wielen, 2007.

4.5.1 White mica

The position of 2200 nm wavelength (w2200) absorption feature was determined for all samples and the wavelength of the feature plotted as a histogram (Fig. 18). This showed a normal distribution with the dominant wavelength around 2210 nm, indicative of samples with intermediate white mica compositions. However, when the dataset was subdivided based on each alteration assemblage, the distribution of the w2200 varied (Fig. 18). Mineral assemblages that do not have white mica as a dominant alteration mineral were included (e.g. chlorite-Fe oxide) since many of these samples also showed a w2200 absorption feature. There was a wide range in AIOH wavelength position for the sericite-chlorite, sericite-Fe oxide and sericite alteration assemblages, whereas there was a narrow distribution for the K-feldspar-sericite and chlorite-Fe oxide assemblages. Bimodal distributions were evident for the sericite-Fe oxide, chlorite-Fe oxide and sericite assemblages. The sericite assemblage had a population dominance around 2204 nm and 2213 nm, indicative of muscovitic and intermediate compositions. The w2200 feature for the sericite-Fe oxide alteration assemblage indicated a wide range in white mica composition from muscovitic to phengitic, although with a bimodal distribution that indicates a dominance towards an intermediate composition around 2210 nm and phengitic composition around 2219 nm. For samples from the chlorite-Fe oxide assemblage, the w2200 feature tended toward longer wavelengths and there was a distinct distribution around more phengitic compositions.

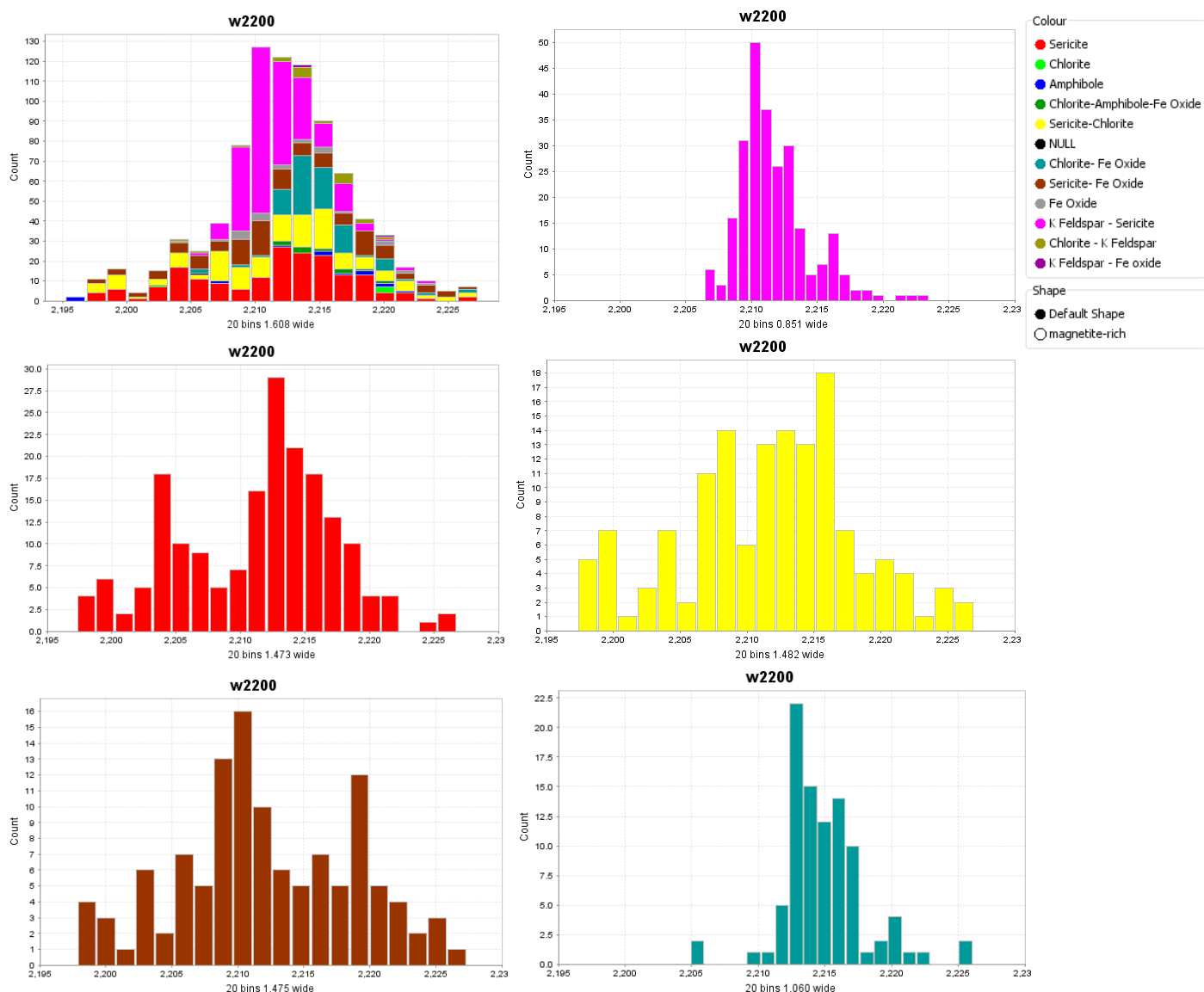


Figure 18. Histogram showing the variation of the 2200 nm wavelength features for the combined alteration assemblages and for each individual assemblage. Bars coloured by alteration assemblages. Mineral assemblages without white mica as a dominant component of the assemblage have trace occurrences only.

Probability plots of the relationship between trace elements and the w2200 absorption feature indicated that apart from U, very few high values were associated with white micas with an AIOH feature of <2207 nm (Fig. 19). High Bi and F had an association with long wavelength white micas (>2218 nm; Fig. 19). High Au, Ag, Ce, La, Mo and Te values are most commonly associated with intermediate wavelength w2200 features whereas high As, Ba, Co, Cu and U showed an association with intermediate and long wavelength w2200 features (>2207 nm).

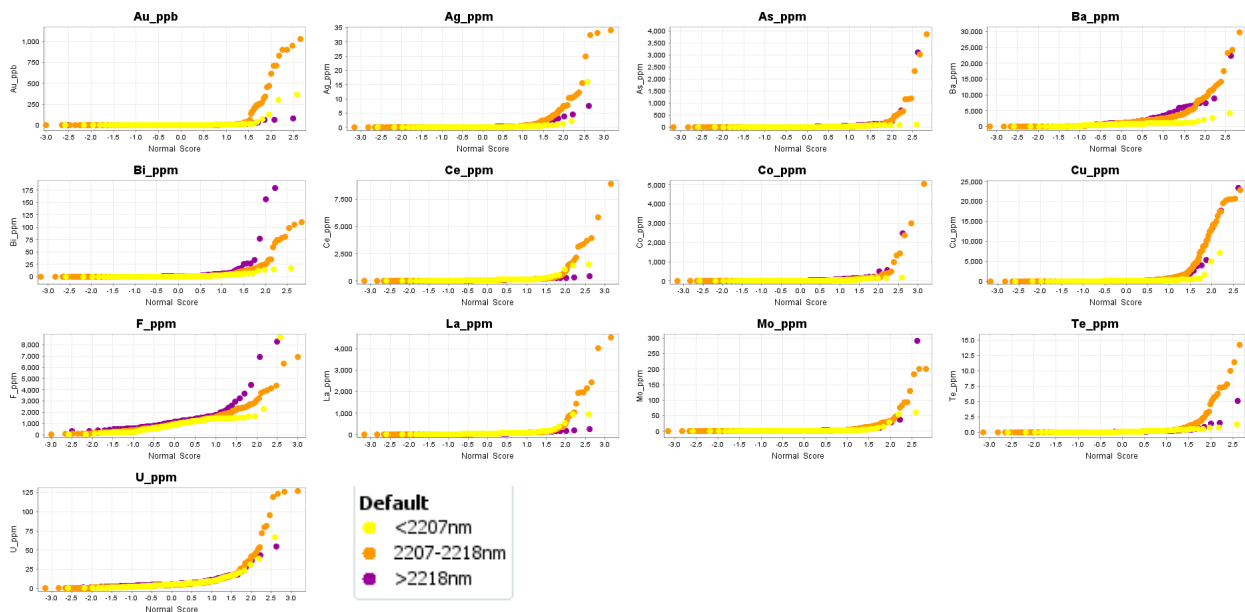


Figure 19. Probability plots of trace elements in relation to the w2220 absorption feature.

A comparison of wavelengths versus Cu values indicated that across all alteration types, most high Cu values were associated with w2200 features of between 2206 and 2221 nm (Fig. 20).

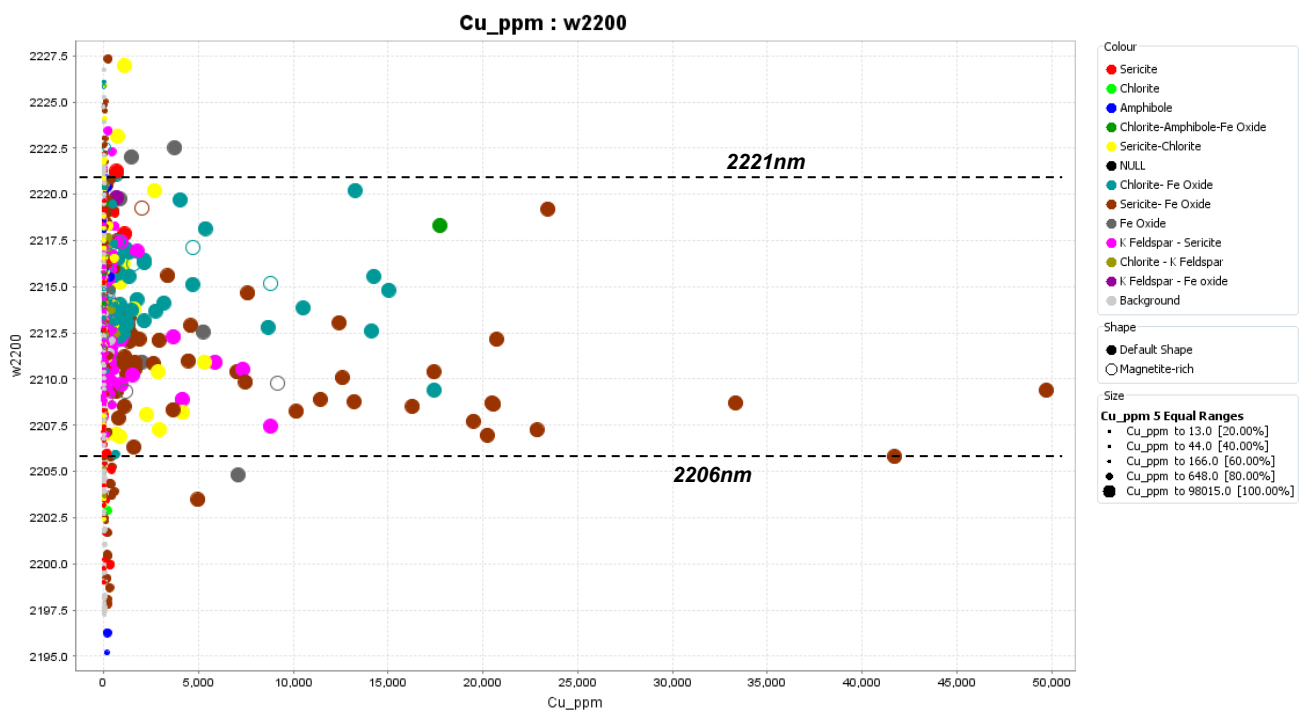


Figure 20. Plot of Cu versus w2200. The majority of samples with high Cu have w2200 between 2206 and 2221 nm.

4.5.2 Chlorite

The wavelength of the 2250nm absorption feature in all samples ranged from 2240 to 2267nm with a skew towards longer wavelengths (Fig. 21). There was a clear association between the chlorite-Fe oxide alteration assemblage and w2250 absorption features of >2253 nm, or, Fe-rich chlorite compositions. A similar relationship was shown by the chlorite-K feldspar, chlorite-amphibole-Fe oxide and Fe-oxide assemblages. The chlorite-sericite, chlorite, sericite-Fe oxide and sericite alteration assemblages had significantly shorter wavelength features that corresponded to intermediate chlorite compositions. There were very few samples with absorption features in a position that was indicative of Mg-rich chlorite (<2246 nm).

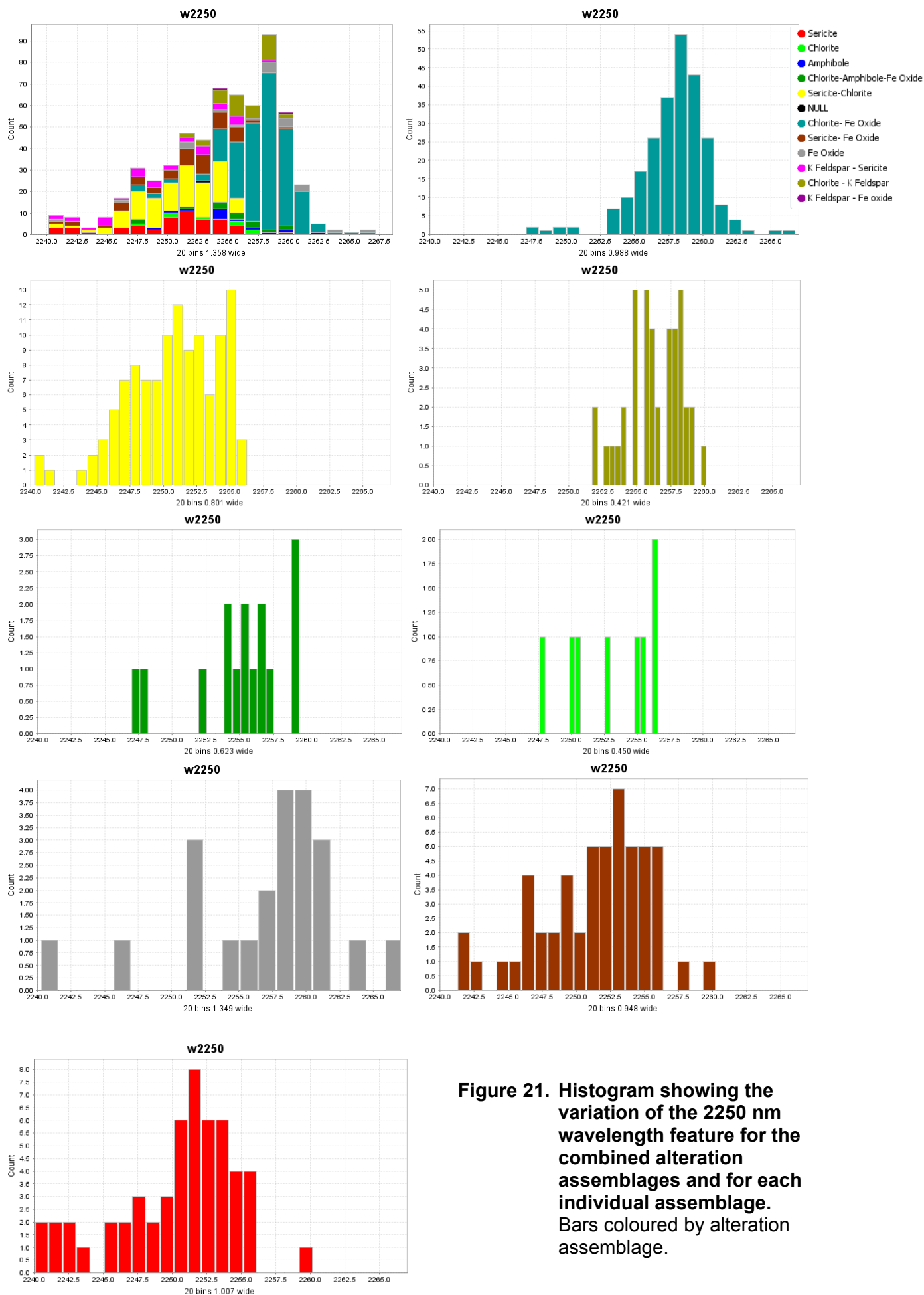


Figure 21. Histogram showing the variation of the 2250 nm wavelength feature for the combined alteration assemblages and for each individual assemblage. Bars coloured by alteration assemblage.

Several trace elements show a relationship to the w2250 absorption feature (Fig. 22). High values for As, Te, Co, Ag, W and Mo were commonly associated with long wavelength chlorites (w2250>2256 nm). ‘Short wavelength’ chlorites (<2246 nm) had a weak association with high Ba and U values. Most high Cu, Au, Ce and La values were associated with a w2250 absorption feature of >2246 nm (intermediate and Fe-rich chlorite; Fig. 22 and Fig. 23).

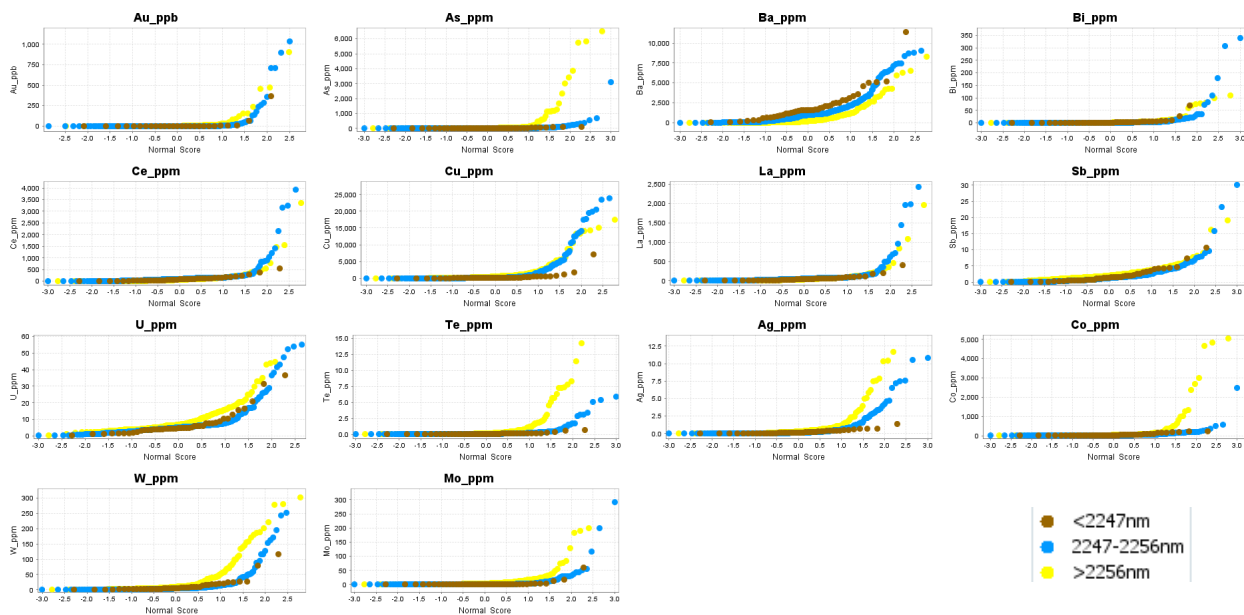


Figure 22. Probability plots of trace elements in relation to the w2250 absorption feature.

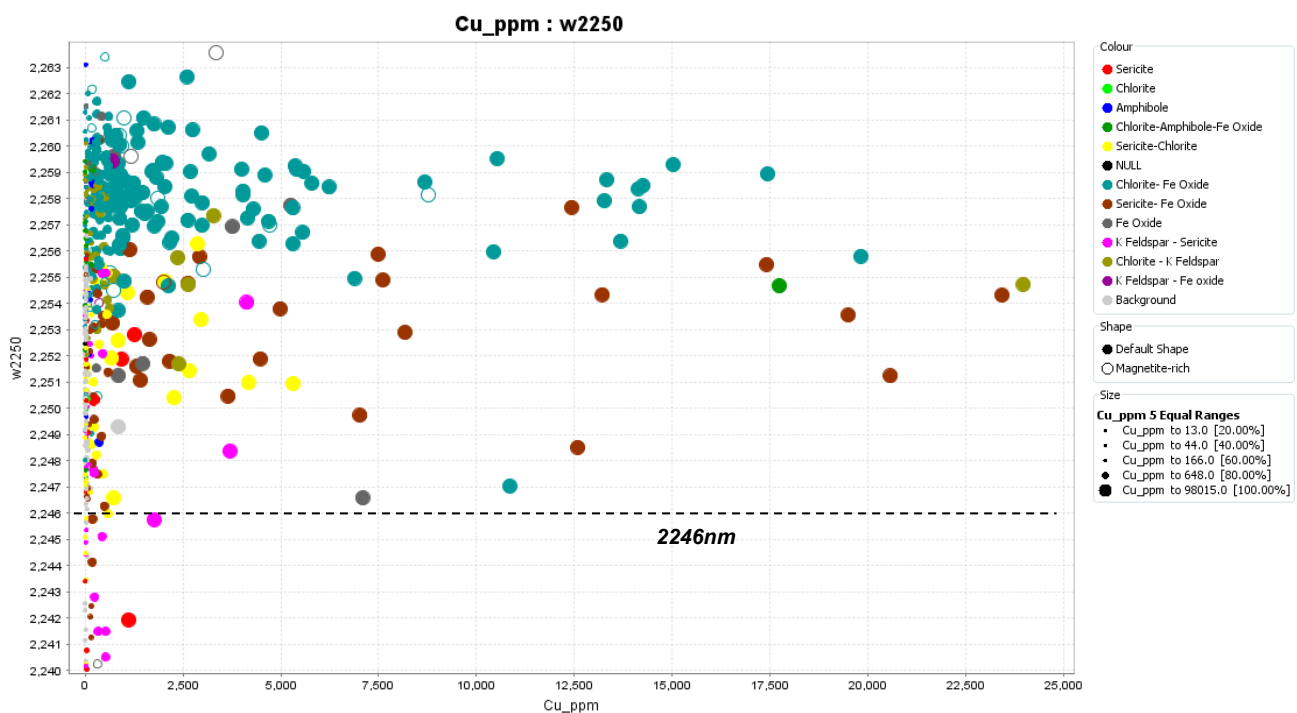


Figure 23. Plot of Cu versus w2250. The majority of samples with high Cu have have w2250 >2246 nm.

4.6 INTERFACE SAMPLING

Samples were taken from most drillholes just above the basement-cover unconformity. Grain size and host rock varied from siltstone to conglomerate and included Pandurra Formation and Adelaidean sediments. Details of each sample are given in Appendix 1. The primary target was conglomerate and gravel beds that commonly occur within cover sediments in the region where these directly overlie basement. Most commonly, this was as thin conglomeratic units within Pandurra Formation. Where coarse-grained units were not present, a sample was taken just above the cover-basement contact.

Ferruginous fragments were commonly observed within the interface sample. Many of the fragments clearly originated from previously exposed hematite breccia. Over the Emmie Bluff and Carrapateena deposits, ferruginous fragments were common within coarse-grained beds for up to 40 m above the basement-cover unconformity (e.g. SAE6, CAR02) and commonly showed km-scale lateral footprints (e.g. Emmie Bluff region; Fig. 24; Appendix 2).

All known IOCG occurrences other than the Groundhog Prospect (Punt Hill), showed high trace element values for multiple elements (above 5 times average crustal abundance) in the overlying cover sediment (Figs. 24–37). In particular, elements Bi and W were indicative of underlying mineralisation. Elements Sb, As, Cu, Se, Fe, Au, Ce, La, Ag, U, Te and Sn, were more variable but were also indicative of the underlying mineralisation.

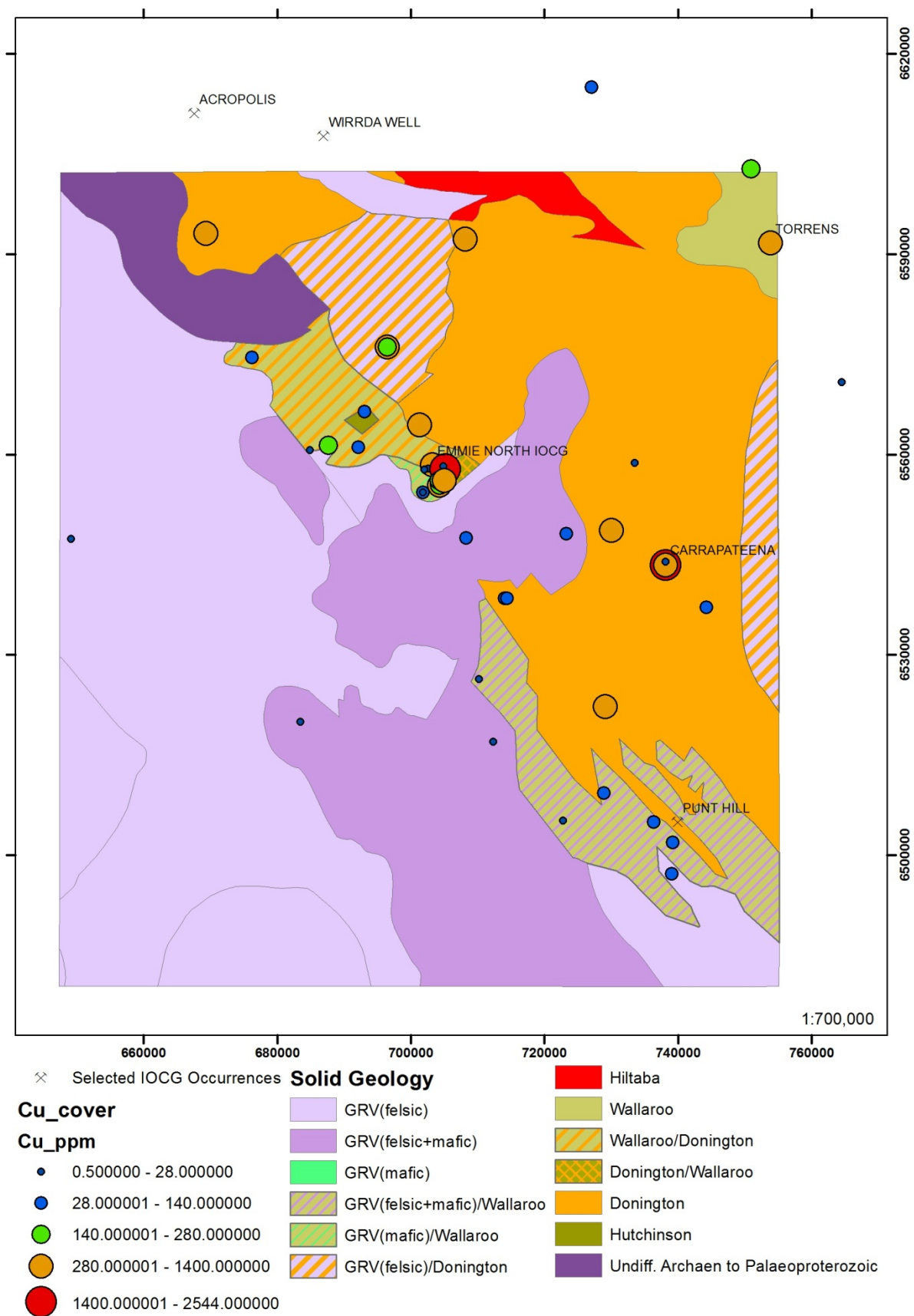


Figure 24. Plot of Cu in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

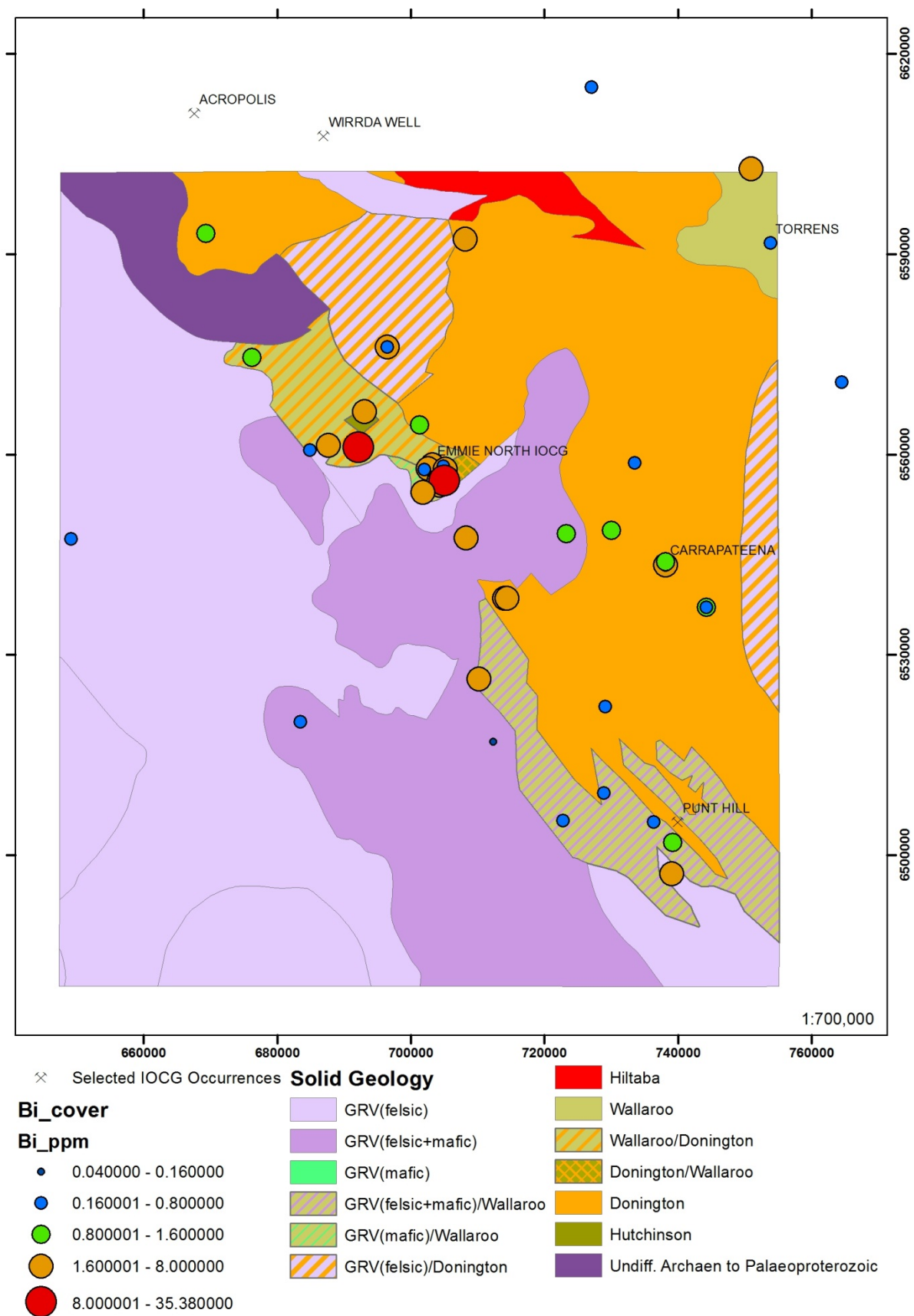


Figure 25. Plot of Bi in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

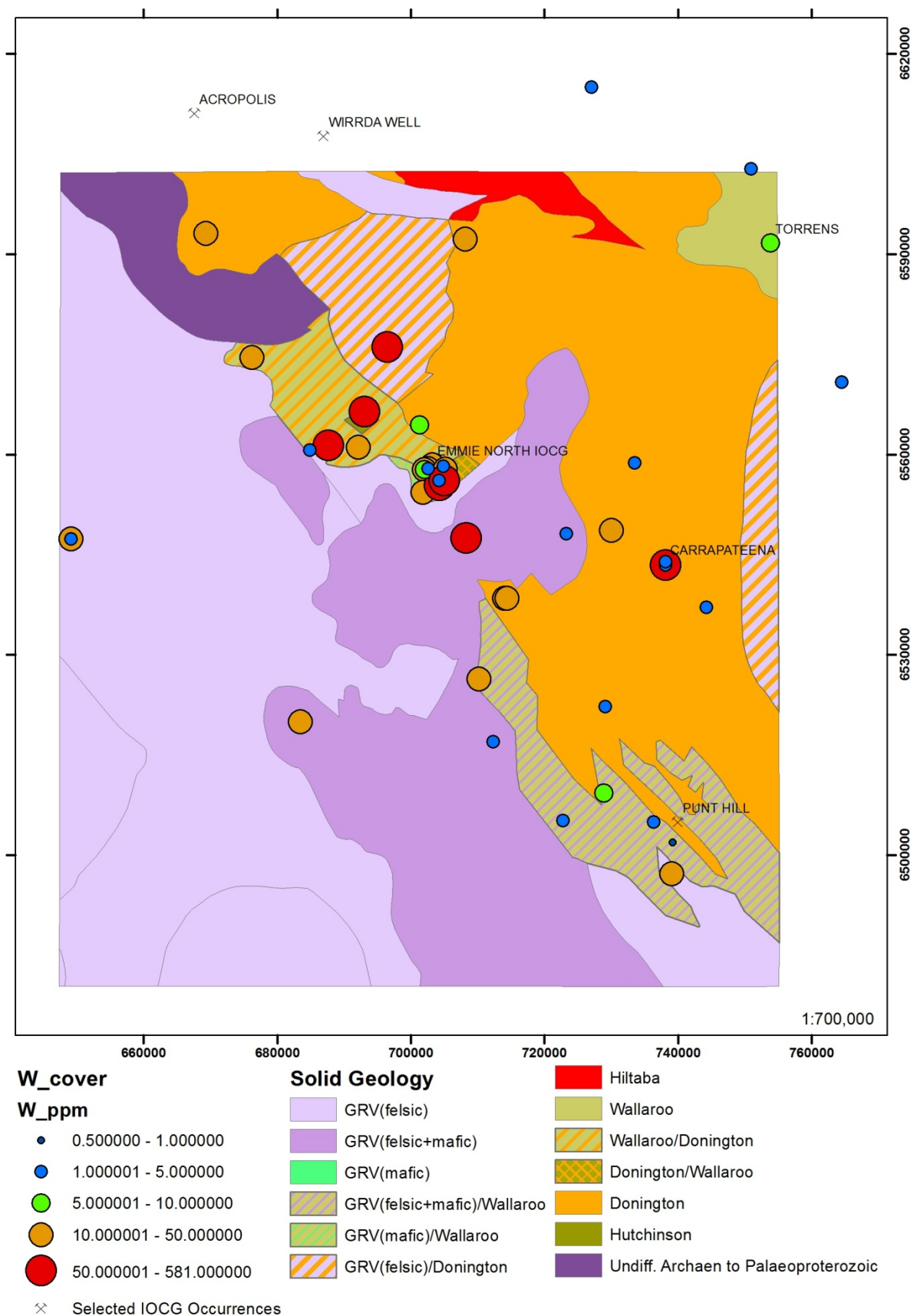


Figure 26. Plot of W in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

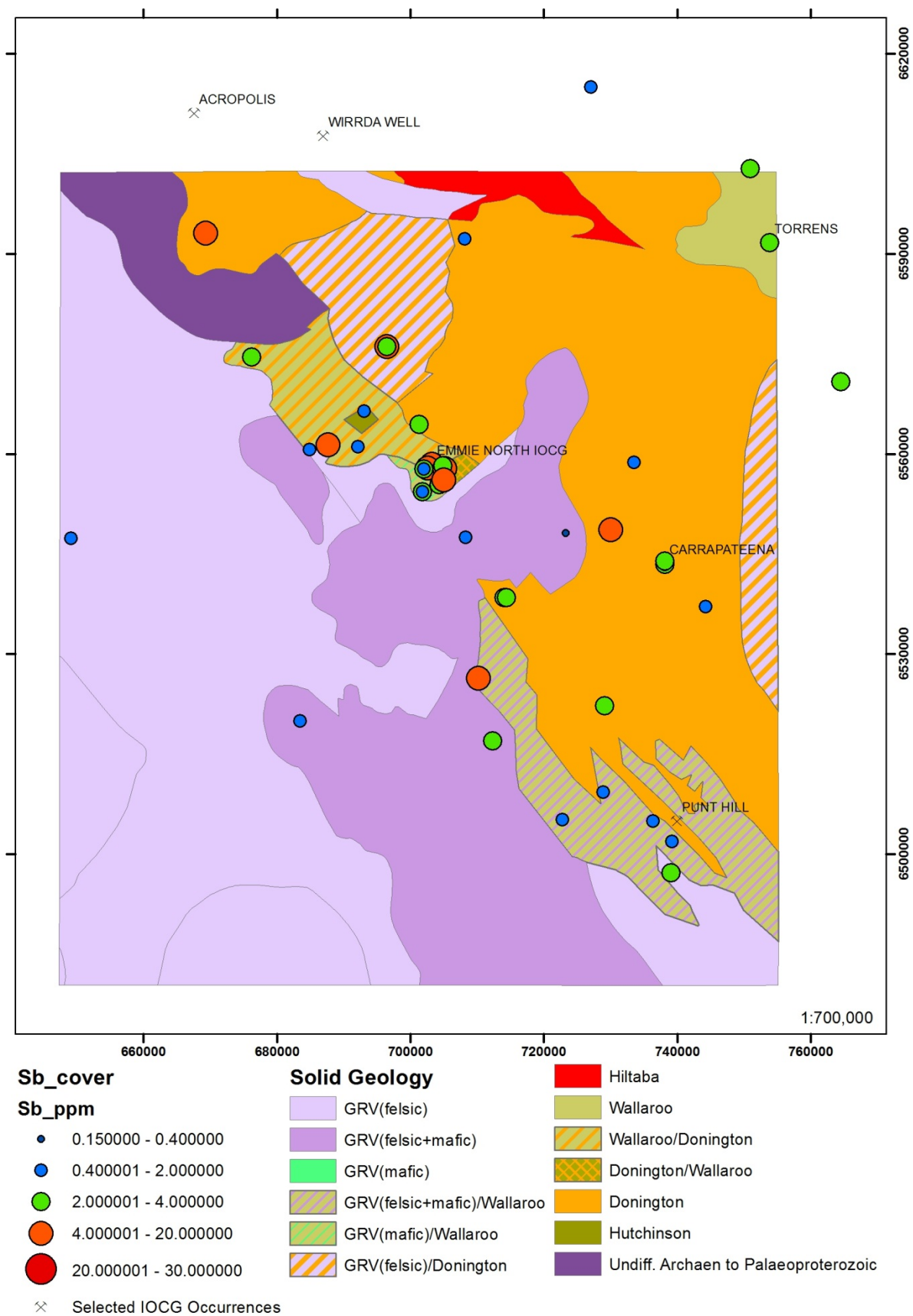


Figure 27. Plot of Sb in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

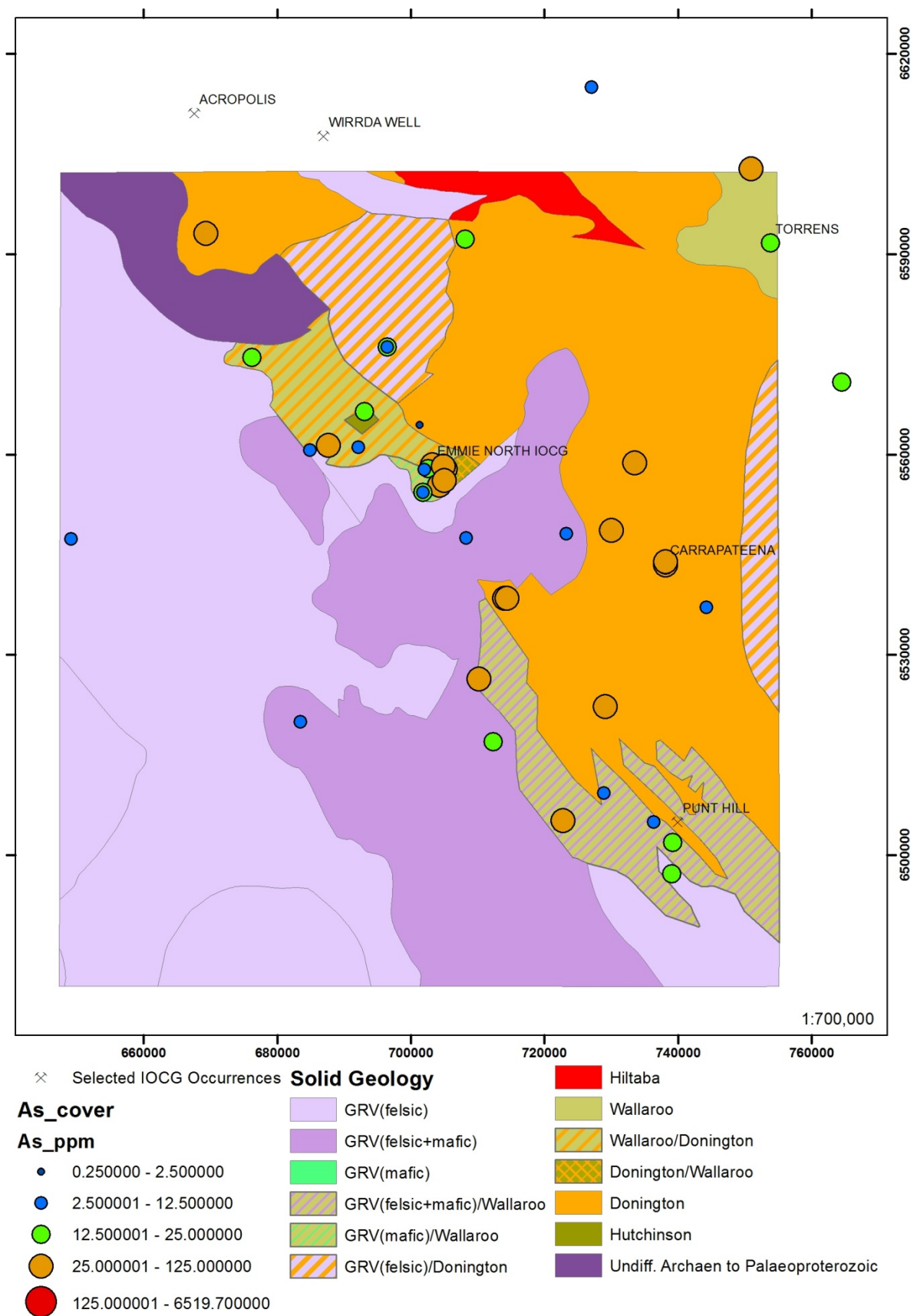


Figure 28. Plot of As in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

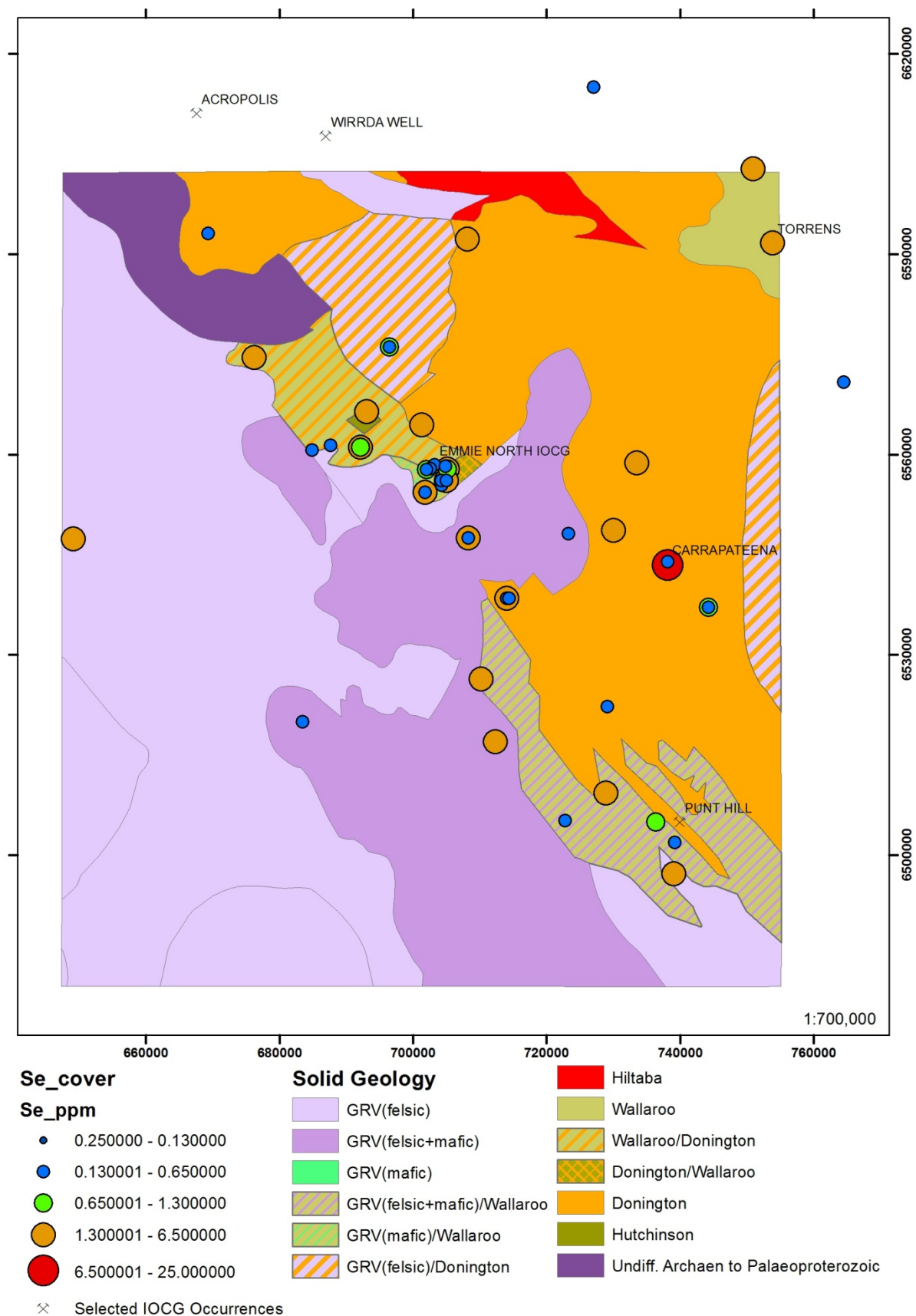


Figure 29. Plot of Se in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

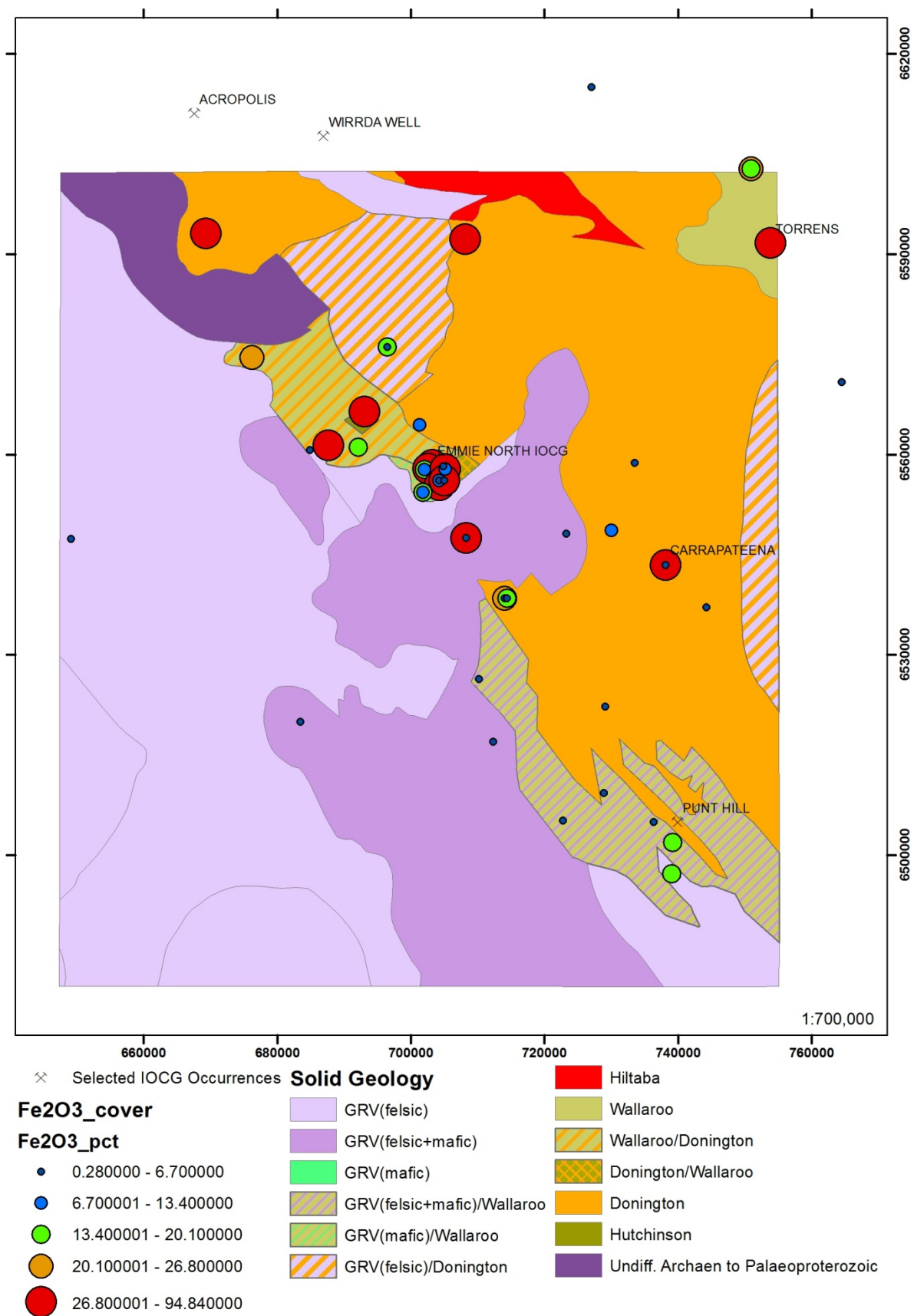


Figure 30. Plot of Fe₂O₃ in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

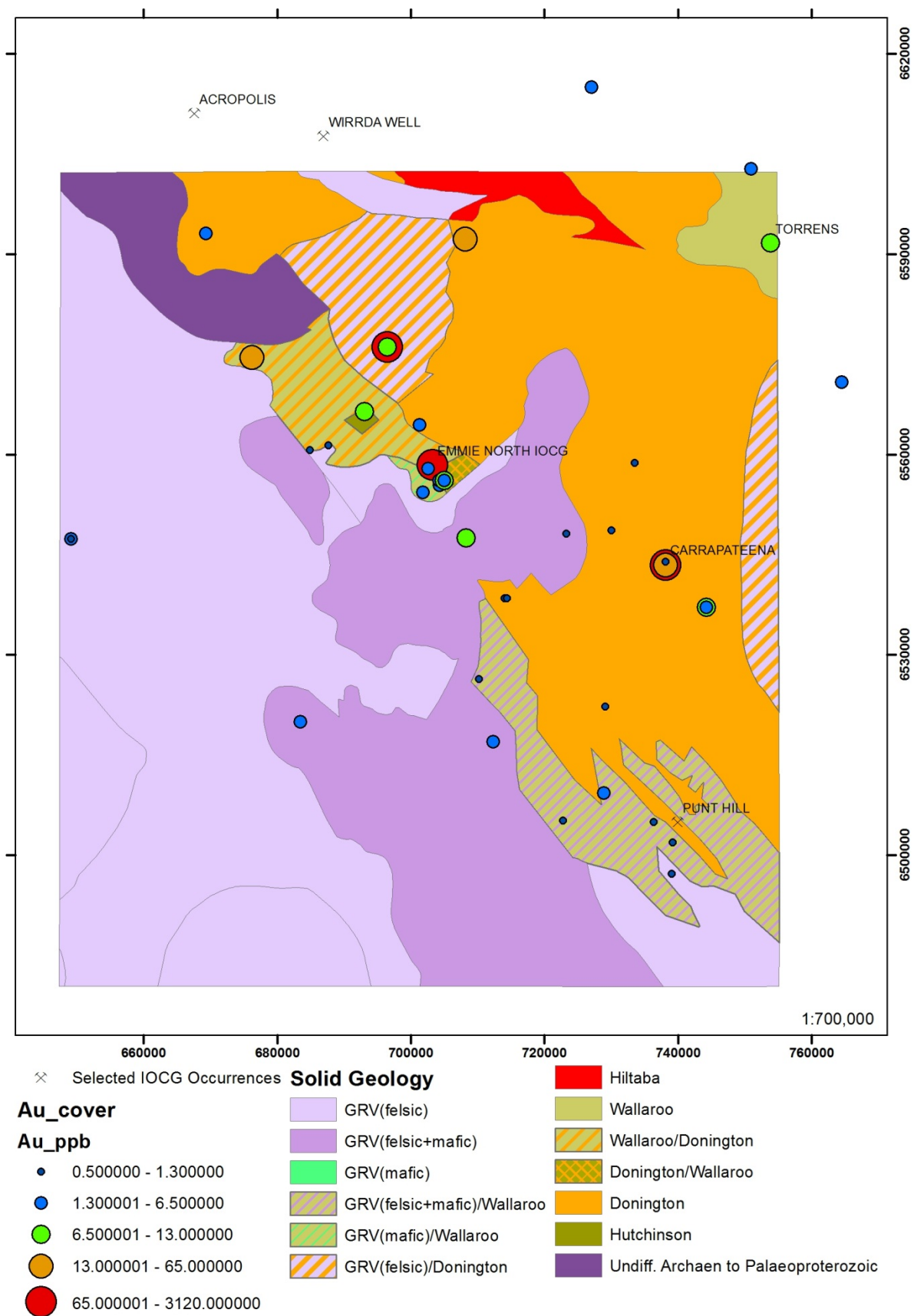


Figure 31. Plot of Au in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

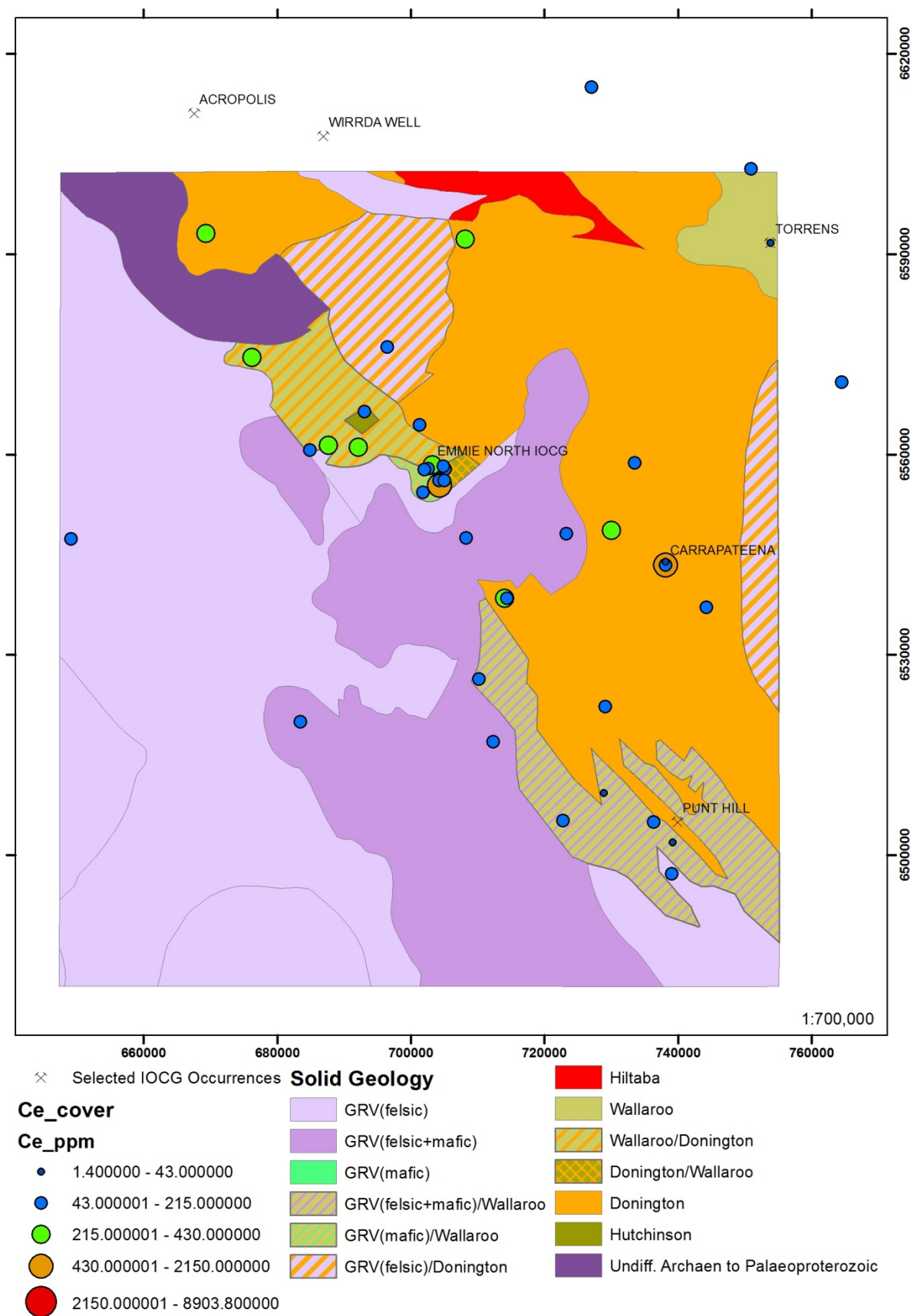


Figure 32. Plot of Ce in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

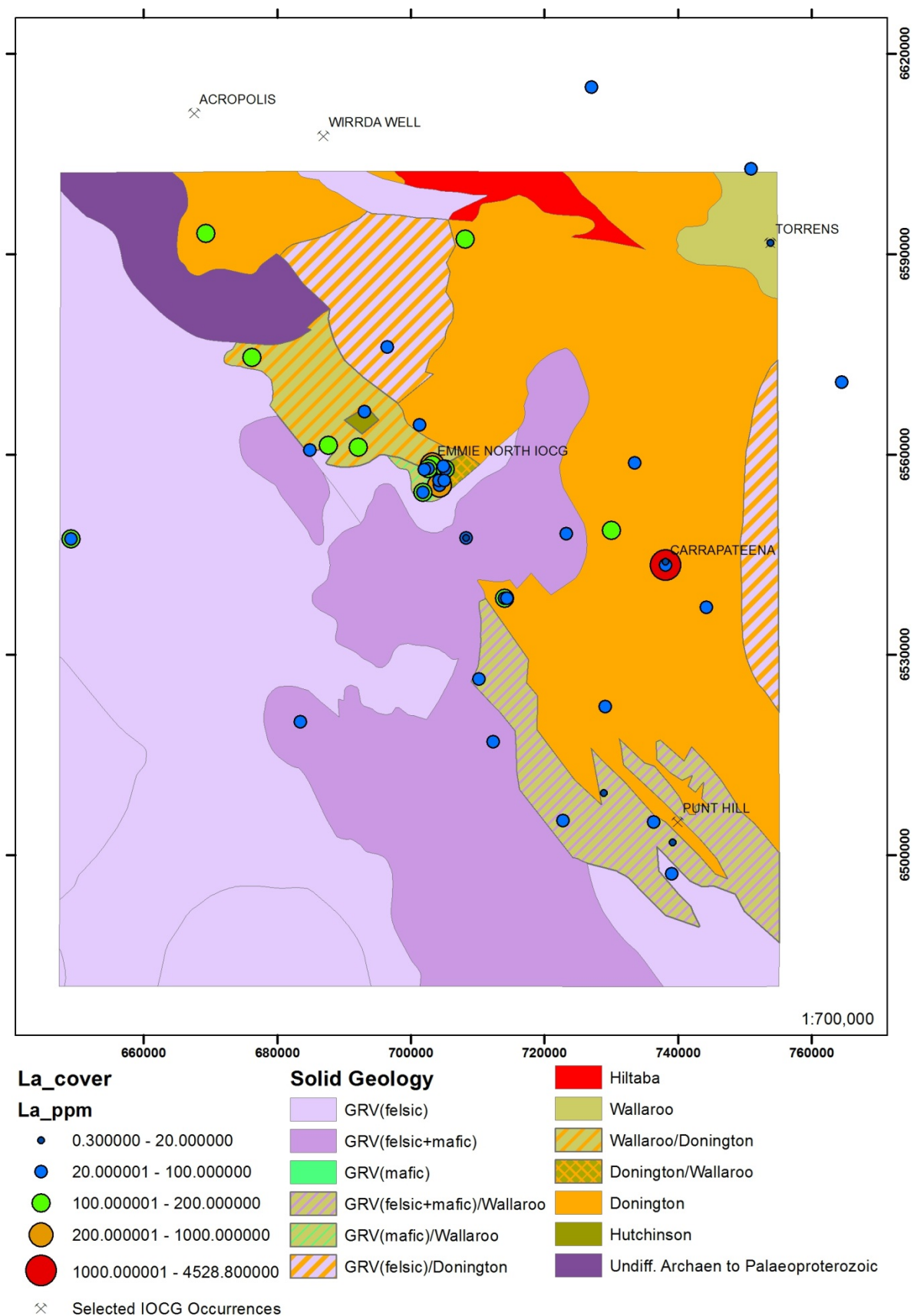


Figure 33. Plot of La in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

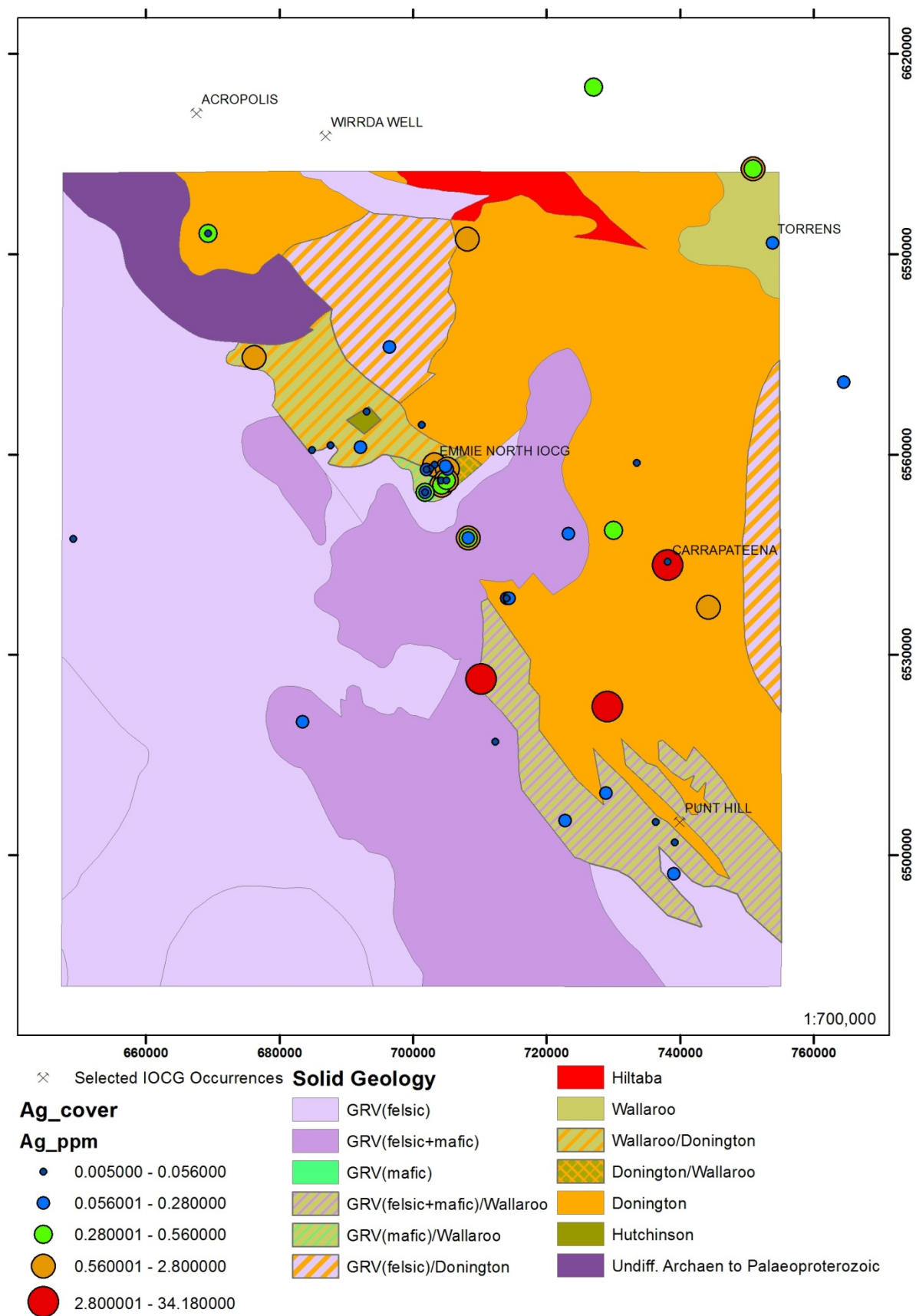


Figure 34. Plot of Ag in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

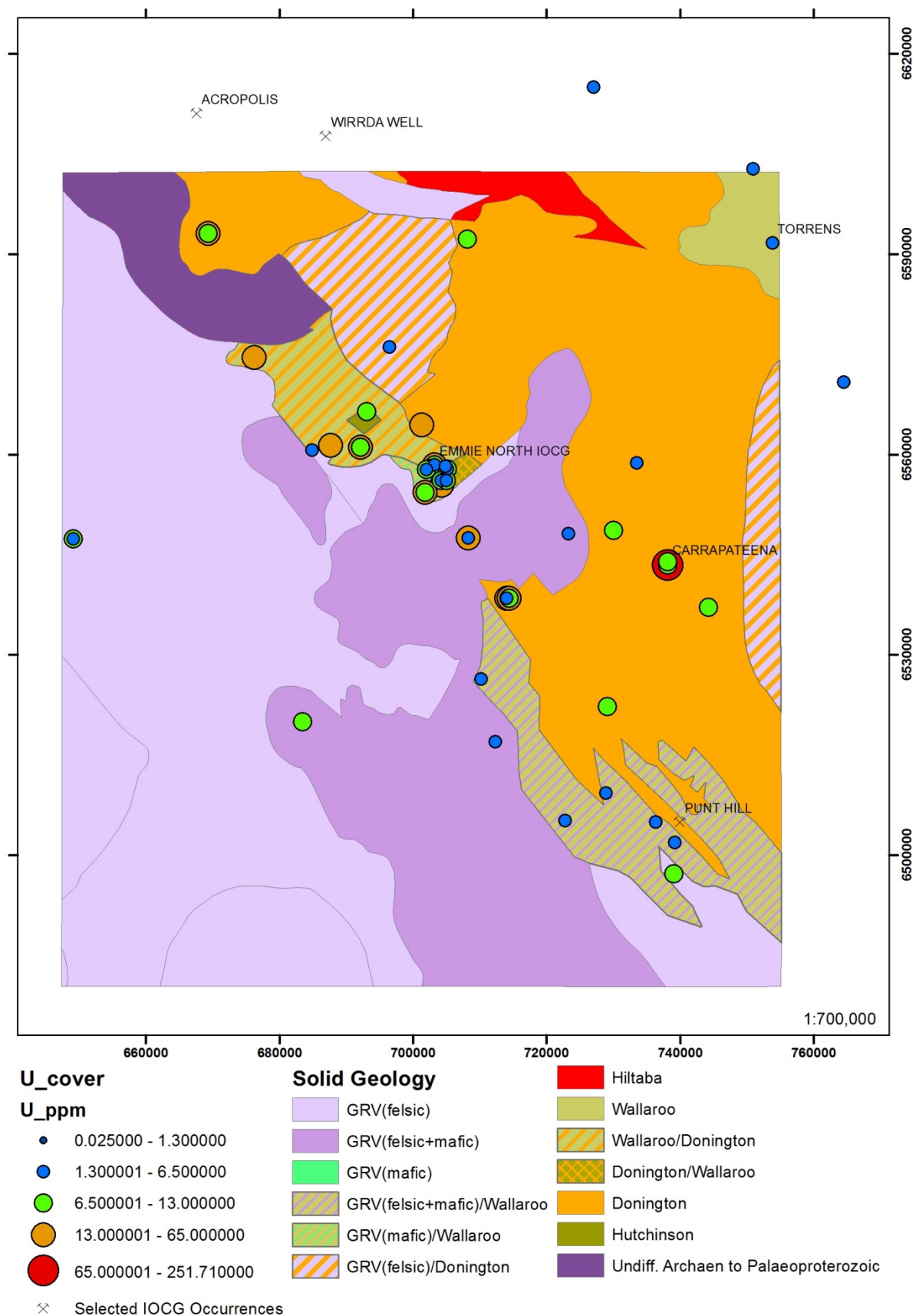


Figure 35. Plot of U in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

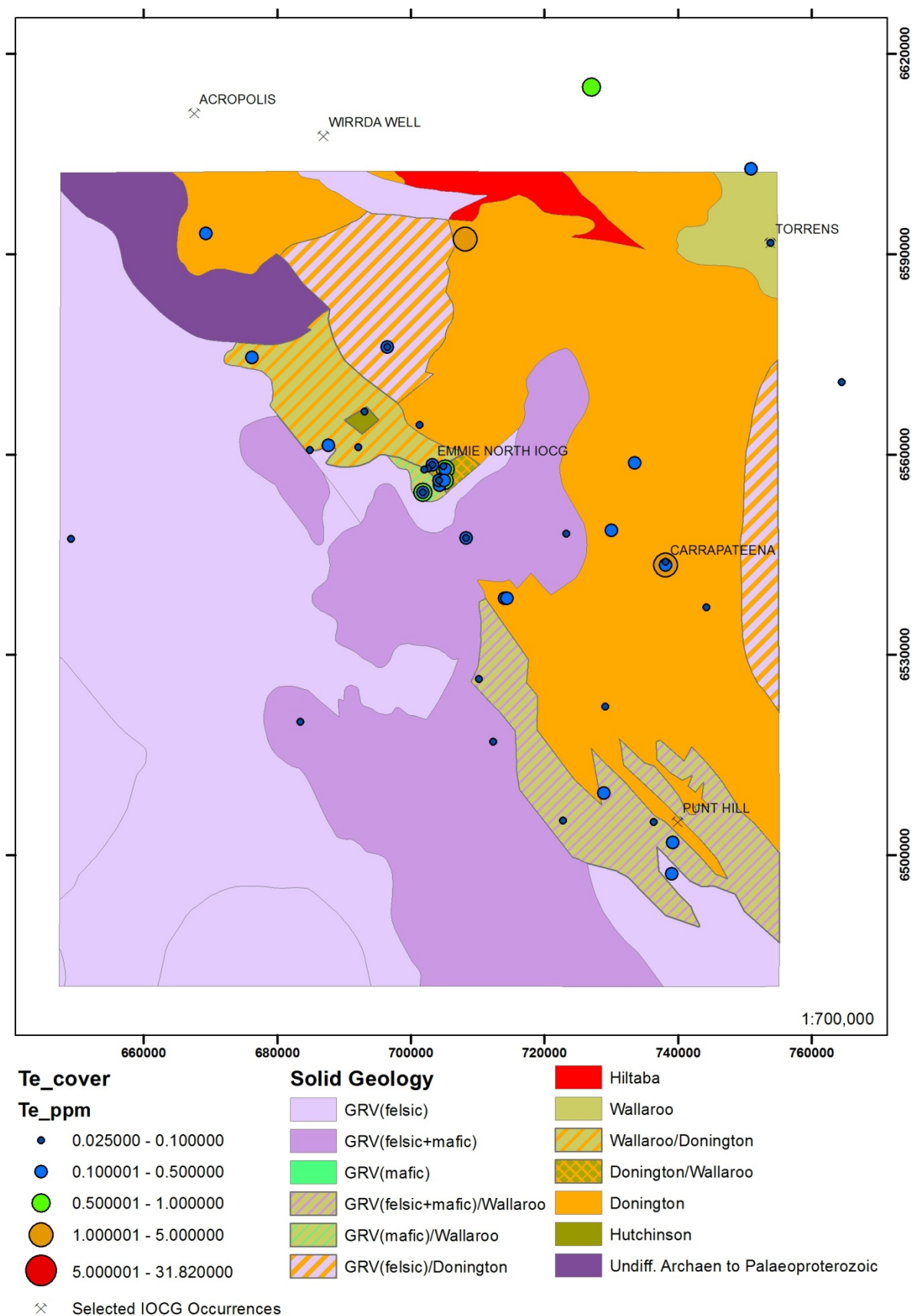


Figure 36. Plot of Te in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

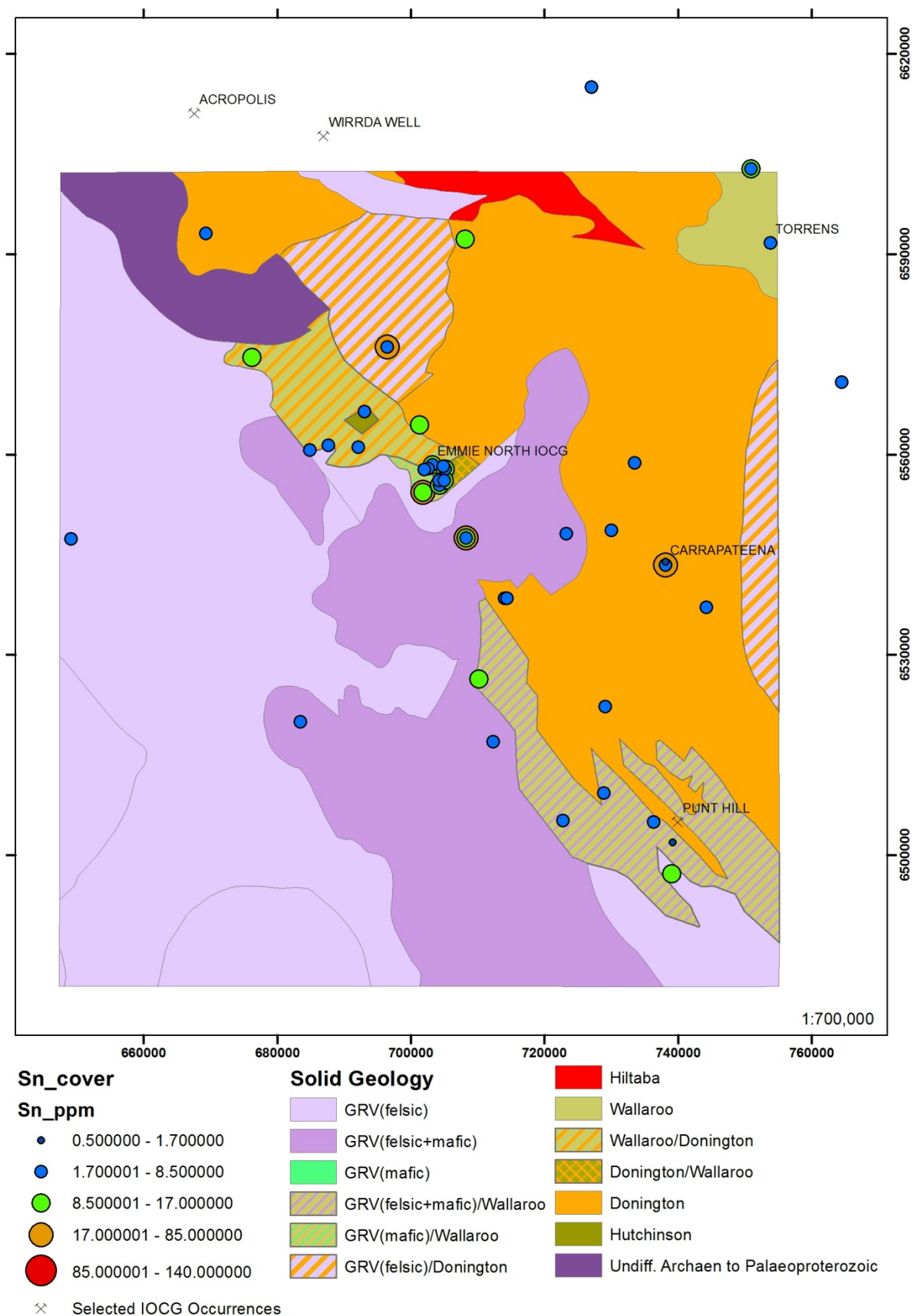


Figure 37. Plot of Sn in 'interface' samples from the central eastern Gawler Craton.
See Appendix 1 for sample details.

Specific comments are made below regarding the geochemistry of cover samples in relation to the main basement Cu occurrences:

- Conglomerate and breccia overlying the Carrapateena deposit were anomalous in all trace elements associated with the underlying mineralised basement rocks. The 'unconformity' sample gave a clear indication of significant mineralisation in basement rocks when values were greater than 10 times the average crustal abundance for Ag, As, Au, Bi, Ce, Cs, Cu, Fe, K, La, Mo, Se, Sn, Te, U and W. In particular, values of greater than 50 times the average crustal abundance for La and Se distinguished this site from all others in the region.
- A conglomeratic sample taken from drillhole CAR01, 500 m to the north of Carrapateena (CAR02), only contained high As and Cs values, even though ferruginous basement fragments were present in the sample. This is attributed to the landscape position at the time of deposition which was up-slope from the Carrapateena deposit (basement depth approximately 20 m less over CAR01). This illustrates the complexities of using transported sample media in exploration below deep cover and underlines the need to understand the relative landscape position in order to interpret results.
- High values of Bi, Cu, U and W $\pm$ Ag, As, Sb gave the best indication of underlying mineralisation at Emmie Bluff.
- There were high values (>10 times crustal abundance) for Cu and Se and moderate values (>5 times crustal abundance) for As, Au, Sb and W in the 'interface' sample over the Torrens prospect.

4.7 PORTABLE XRF

Portable XRF data collected as part of this study is included in Appendix 1. Interpretation of raw results are not included in this report and will be the subject of a separate report that compares the results with the laboratory multi-element data.

4.8 PETROPHYSICS

Based on alteration classifications given to each sample as described above, samples were subdivided into background and altered (i.e. all classifications other than 'background'). Magnetic susceptibility and density ranges were generated based on this classification for common stratigraphic units for the region (Tables 1 and 2). Increasing density was correlated broadly with increasing alteration and the presence of mineralisation (Fig. 38).

Table 1. Summary of magnetic susceptibility values for common stratigraphic units.

	Background			
	Range	Mode	Median	Mean
GRV	0.00001–0.409 n=48	0.00003	0.001025	0.007245
Walleroo Group	0.00021–0.00325 n=6	0.00031	0.00031	0.000814
Donington Suite	0.00003–0.00962 n=25	0.00019	0.00125	0.00072
	Altered			
	Range	Mode	Median	Mean
GRV	0.00001–0.383 n=161	0.00007	0.00032	0.011356
Walleroo Group	0.00004–0.988 n=601	0.0002	0.00013	0.02199
Donington Suite	0.00003–0.0659 n=167	0.000015	0.00001	0.001027

Table 2. Summary of density values for common stratigraphic units.

	Background				Altered			
	<i>Range</i>	<i>Mode</i>	<i>Median</i>	<i>Mean</i>	<i>Range</i>	<i>Mode</i>	<i>Median</i>	<i>Mean</i>
<i>GRV</i>	2.42–2.82 n=87	2.69	2.68	2.65	2.45–3.28 n=57	2.69	2.69	2.72
<i>Wallaroo Group</i>	2.71–2.77 n=5	2.72	2.72	2.73	2.55–4.38 n=181	2.63	2.84	3.03
<i>Donington Suite</i>	2.65–2.82 n=19	2.76	2.75	2.76	2.54–4.18 n=168	2.64	2.78	2.94

5. DISCUSSION

5.1 DISTINGUISHING BETWEEN ALTERATION RELATED TO MINERALISATION AND REGIONAL ALTERATION

Judging the degree of alteration by visual inspection can be challenging due to difficulties in identifying alteration minerals that don't dramatically change the appearance of the rock texture (e.g. feldspar and white mica alteration). Determining the degree and style of alteration can be done more accurately using geochemistry. The Feldspar Na-K GER diagram within ioGas is useful in distinguishing the major styles of alteration and in estimating the degree of alteration based on the Na:K ratio (see section 4.2, this report). The majority of samples analysed in this study were from the Wallaroo Group, GRV and Donington Suite. Donington Suite and GRV samples showed a relatively consistent Na:K feldspar ratio approaching 1:1 when unaltered (Fig. 14). No samples of unaltered Wallaroo Group were encountered in this study. It is important to note that many samples were analysed that showed no visible alteration, yet the geochemical results indicated strong Na-depletion and K-enrichment (i.e. intense K-feldspar alteration).

Based on Na:K ratios, the Feldspar Na-K GER diagram can be used to distinguish samples with minimal alteration (background and regionally altered). These plot towards the centre of the diagram. Those samples with alteration typical of an IOCG system plot towards the y axis of the diagram (intense potassic, muscovitic, chloritic and Fe alteration).

5.2 KEY INGREDIENTS AND MAPPABLE CRITERIA

Each mineral deposit is part of a much larger mineral system which results from a combination of a source, driver, fluid pathway and depositional mechanism (Wyborn et al. 1994). Mineral systems are commonly in the order of district to regional scale and therefore form much larger exploration targets than ore. Regional key ingredients for IOCG deposits in the eastern Gawler Craton (with particular reference to U-rich variants) have been defined by Huston and van der Wielen (2011). Ingredients considered in this report include those relating to deposit-scale alteration mineralogy and geochemistry. Specifically, these include:

1. Typical mineral alteration for IOCG deposits in the eastern Gawler — what minerals and mineral assemblages can be used to recognise the mineral system?
2. Geochemical anomalism associated with IOCG deposits — what are the key element associations with IOCG deposits in the central eastern Gawler Craton?
3. IOCG deposits are characterised by regional magnetic and density anomalism but what are the typical ranges in petrophysical properties?

Along with answering these questions, the large volume of regional data collected within the project and the integration of these data has identified several key mappable criteria relevant to IOCG systems in the central eastern Gawler Craton.

5.2.1 What minerals and mineral assemblages can be used to recognise an IOCG mineral system?

Alteration mineralogy was determined by a combination of spectral methods (HyLogger™), multi-element geochemistry and petrophysical properties. These methods do not provide a comprehensive list of minerals within a rock, however, they incorporate the dominant alteration minerals relevant to IOCG systems. These include K feldspar, albite, magnetite, hematite, chlorite, white mica, amphibole, biotite and carbonate minerals. Key minerals identified by thermal infrared methods such as garnet and pyroxene have not been incorporated into current alteration models. The thermal infrared data will be incorporated into future alteration models once sufficient data has been collected and confidence in the reliability of mineral determinations from these data is increased.

The alteration assemblages distinguished are tabulated below (Table 3). It is important to note that most assemblages are likely to contain minor proportions of many of the alteration minerals. Assemblages have been sub-divided into those that are typically associated with mineralised zones, those that are common within a broader alteration zone, and those that represent regional or background alteration where alteration may relate to regional metamorphism. Within these sub-divisions, granite and volcanic host rocks tend to be dominated by sericitic alteration whereas metasedimentary hosts are dominated by chloritic alteration assemblages. Further to this, magnetite dominates over hematite with increasing relative depth at each deposit, as does chlorite over sericite in granite-hosted deposits. Amphiboles are associated with early calc-silicate/skarn-type alteration.

Table 3. Alteration assemblages identified from multi-element geochemistry, petrophysics and spectral method on drill core samples from the Emmie Bluff region.

Mineralised zone	Proximal to distal alteration zone	Regional/background alteration zone
Chlorite-Fe oxide	Amphibole	Sericite
Chlorite-magnetite	Chlorite	Sericite-chlorite
Sericite-Fe oxide	Chlorite-K feldspar	
Sericite-magnetite	Chlorite-K feldspar-magnetite	
Fe oxide	K feldspar-Fe oxide	
Magnetite-rich	K feldspar-sericite	
Chlorite-amphibole-Fe oxide	K feldspar-magnetite	
	Sericite	
	Sericite-chlorite	

5.2.2 What are the key element associations with IOCG deposits in the central eastern Gawler Craton?

Elements associated with IOCG mineral systems were derived from correlations with the alteration assemblages outlined in Table 3 (Appendix 1.5). Elements associated with:

- Alteration assemblages within the mineralised zone – Au, Ag, As, Cd, Ce, Co, Cu, Dy, Er, Eu, Fe, Gd, Ho, La, Lu, Mn, Mo, Nd, Pr, Re, S, Sm, Tb, Te, Ti, U, W, Y, Yb ± Bi, Li, Pb, Pd, Sb, Sc, Se, Sn, Tm, Zn.
- Proximal + distal alteration zone – Au, Ag, Ba, Bi, Cs, Cu, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, S, Sb, Se, W ± Au, As, Cd, Cr, Pd, Re, Sn, Ti, U, Zn.

Elements with very high values exclusively within mineralised zones include Ce, Co, Dy, Er, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Tb, Y, Yb (i.e. REE + Co and Y). Elements exclusively associated with outer alteration zones are Ba (associated with K feldspar alteration) and Cs (associated with sericite alteration).

Based on the spatial distribution of trace elements (Appendix 2) in addition to the above mentioned correlations with major alteration assemblages, key elements include Cu, Au, Ag, As, Ba, Bi, Ce, La, Fe, Mo, S, Sb, Se, Te, W ± Co-Cd-Mn (note: Ce and La are used to represent LREE enrichment as they tend to be the most abundant; Cd, Co and Mn show inconsistent trends). The list of key elements can be subdivided based on the distance from significant Cu mineralisation (>10 times crustal abundance):

- Local – Ce, La, Te ± Co-Cd-Mn
- Moderate – Au, Ba, Mo, S
- Broad – Bi, Ag, As, Cu, Fe, Sb, Se, W.

5.2.3 What are the typical petrophysical property ranges in the central eastern Gawler?

Magnetic susceptibility and density values are summarised in Tables 1 and 2. Although Cu mineralisation is commonly hosted within hematite rather than magnetite in IOCG occurrences in the central eastern Gawler, the mineralised zone as a whole commonly contains magnetite. This is reflected by greater magnetic susceptibility values of 1 to 2 orders of magnitude in altered GRV, Wallaroo Group and Donington Suite over their unaltered occurrence. A combination of Fe alteration and skarnification are the dominant factors contributing the majority of bulk density increase. Values of >2.8 SI units are generally associated with highly altered, and often mineralised, samples (Fig. 38).

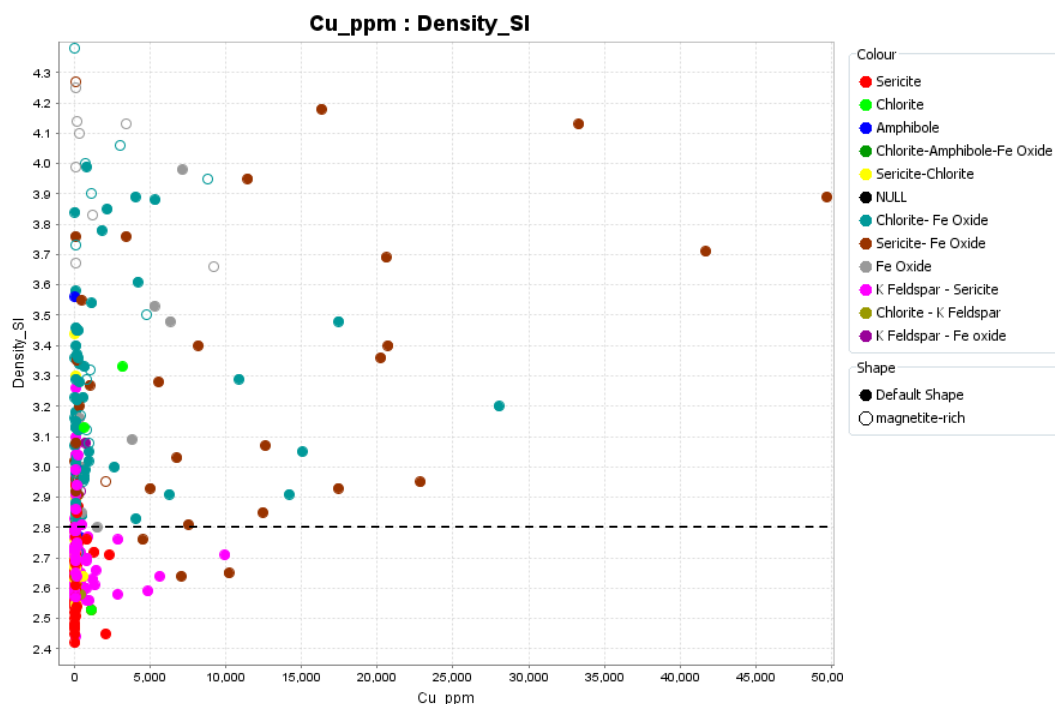


Figure 38. Density versus Cu values. Each sample is coloured by its dominant alteration assemblage. Values of >2.8 SI units are generally associated with highly altered and Cu mineralised samples.

5.2.4 Mappable criteria

From the integration of multi-element geochemical, spectral and petrophysical data sets, key mappable criteria have been developed for this region (Table 4). While not all mineralised samples meet every criteria listed in the table, the significance or prospectivity can be rated by how many of these criteria are met by the sample. A prospectivity index has been generated for all samples based on the geochemical criteria listed in Table 4 (Fig. 39; Appendix 1.7). Future iterations of this prospectivity index will include additional criteria including spectral and petrophysical data. A limitation of this index is where samples do not have information for every field e.g. Au assays and petrophysical measurements. A second geochemical index has therefore been generated that just includes pathfinder elements (Ag, As, Ba, Bi, Ce, La, Sb, Se, Te, Mo, W; Fig. 40; Appendix 1.7).

Table 4. Mappable criteria for exploring for IOCG-style deposits in the central eastern Gawler Craton. Key elements are listed where threshold values are 10 times the average bulk composition of the continental crust (Rudnick and Gao 2003).

<i>Geochemical</i>	<i>Spectral</i>	Mappable criteria	
		<i>Magnetic Susceptibility</i>	<i>Petrophysical</i> <i>Density</i>
Au>0.013 ppm	W2200 - 2206 to 2221 nm	Walleroo Group >0.01	Walleroo Group >2.77
Ag>0.56 ppm	W2250 - >2246 nm	Donington Suite >0.01	Donington Suite >2.82
As>25 ppm		GRV>0.0045	GRV>2.82
Ba>4560 ppm			
Bi>1.8 ppm			
Ce>430 ppm			
Cu>270 ppm			
La>200 ppm			
Sb>2 ppm			
Se>1.3 ppm			
Te>1 ppm			
Mo>8 ppm			
W>10 ppm			

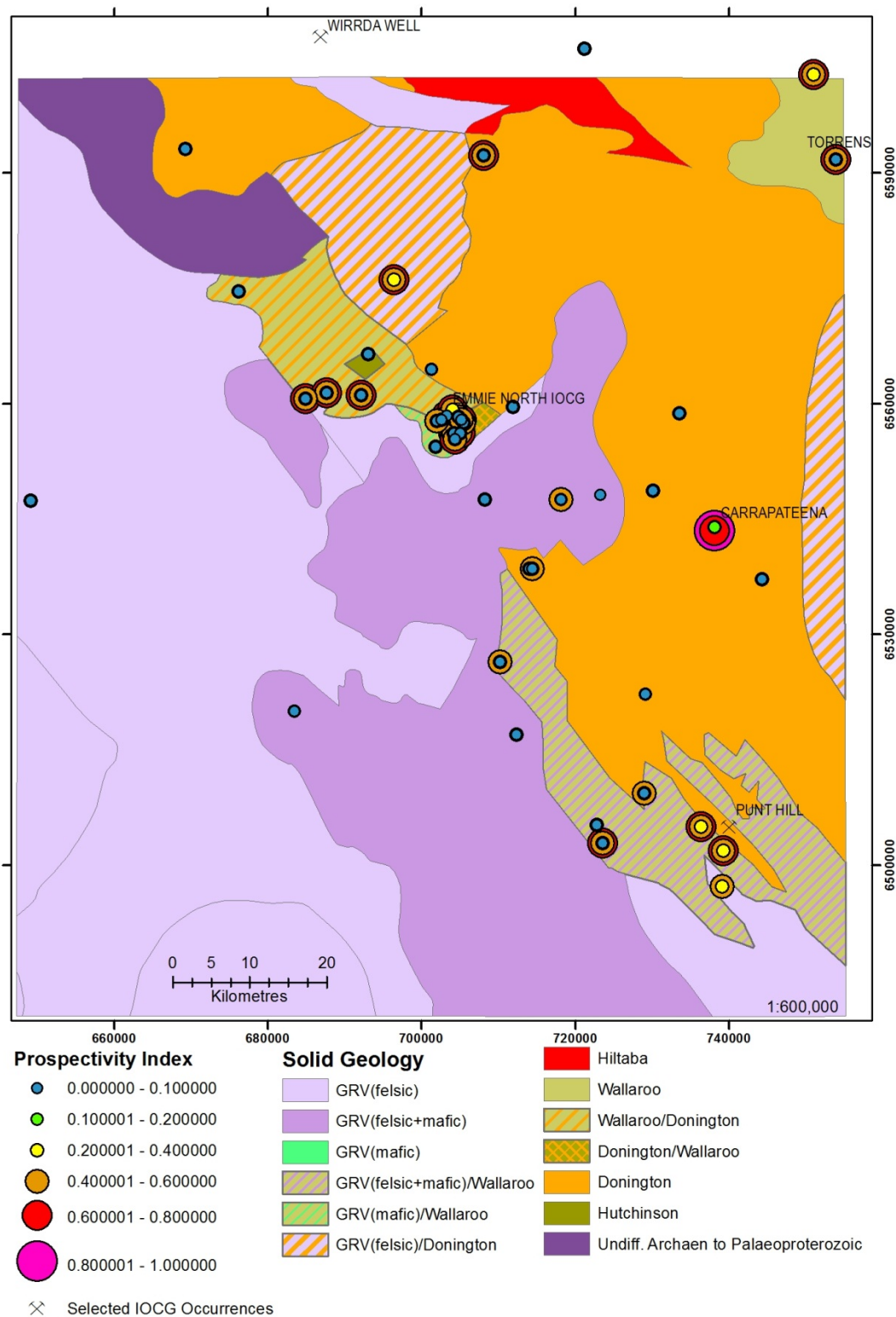


Figure 39. Geochemical prospectivity index based on values above a threshold for the elements Au, Ag, As, Ba, Bi, Ce, Cu, La, Mo, Sb, Se, Te, W.

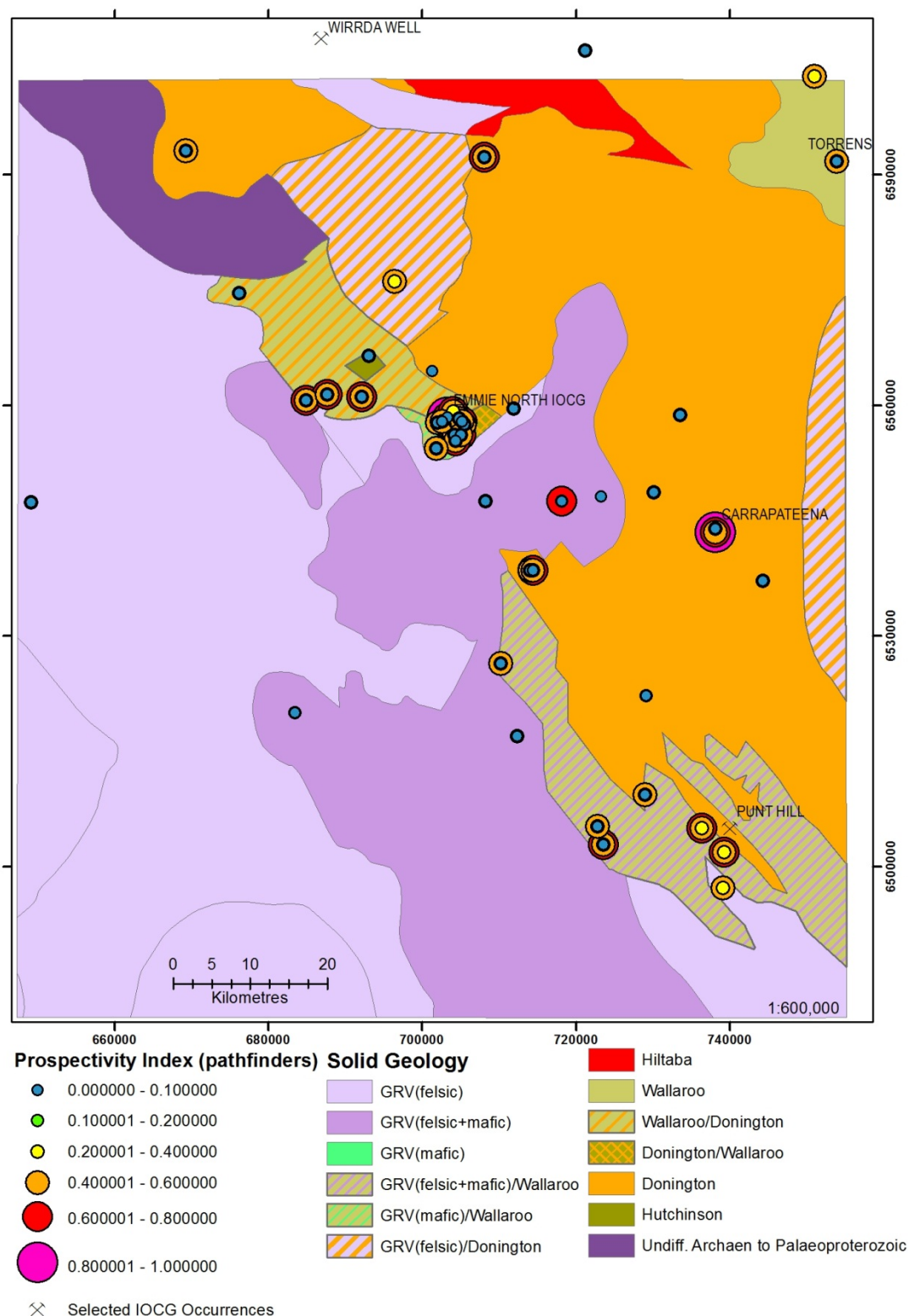


Figure 40. Geochemical prospectivity index based on values above a threshold for the pathfinder elements Ag, As, Ba, Bi, Ce, La, Mo, Sb, Se, Te, W.

5.3 ARE GRAVEL SAMPLES AT THE BASE OF COVER AN EFFECTIVE SAMPLING MEDIA?

Basement rocks hosting many known IOCG occurrences in the central eastern Gawler crop out at the cover-basement palaeo-surface. Consequently, samples taken just above the cover-basement unconformity commonly contain fragments of mineralised rock and offer the possibility of using this sample media to locate bedrock mineralisation. Beside mechanical transport, chemical transport along this zone of potential permeability provides an additional means of dispersion that extends the usefulness of this sample to give a broader expression of underlying mineralisation. However, variation in the origin of the sediment is one of the biggest challenges when interpreting results. When the samples are coarse-grained and include rock fragments, transport distance can be estimated from size, rounding and sorting. The likely source areas may then be readily identified by relating this information to basement topography. For fine-grained rocks, the source is much more difficult to interpret and this reduces their usefulness as a vector to mineralisation. Chemical transport along the unconformity requires some interpretation of the hydrological regime operating at the time of dispersion in order to trace the source.

Geochemical results from 'interface' samples from this study (Figs 24–37; Appendix 1.2 and 2) identify the two most significant areas of currently recognised mineralisation, Emmie Bluff and Carrapateena. Several key elements in the basement mineralisation are present at anomalous levels in the overlying sediment. Results from samples over less Cu-rich prospects tend to contain fewer elements with very high values. While not containing the same degree of anomalism as Carrapateena and Emmie Bluff, 'interface' samples from drillhole PSC 4 SASC 2, HHD1 (HHD1 W1) 1 and DRD1 contain regionally significant, multi-element anomalism. Of particular interest are high Ce and La values along with high Cu which are indicative of high grade occurrences. Drillhole PSC 4 SASC 2 is located next to the recent Khamsin prospect (www.ozminerals.com). Further investigation at these sites is warranted, particularly around HHD1 (HHD1 W1) 1 where there has been no locally significant basement mineralisation found.

In the majority of the Punt Hill region, prospective Wallaroo Group is overlain by unmineralised GRV. As a result, clasts within 'interface' samples are primarily composed of GRV. It is therefore not surprising that 'interface' samples from this region failed to highlight the underlying mineralisation. The only indicator was Bi, Se and W anomalism in the 'interface' sample over the Cu-poor drillhole WHD1 (~5 km south of Punt Hill).

In most cases, gravel samples from the base of cover are useful indicators of both local basement mineralisation (most mineralised holes have overlying gravels containing mineralised clasts) and regional geochemical patterns (prospective regions are highlighted in multi-element data). However, from a targeting point of view, it is difficult to vector to mineralisation based on individual samples. Landscape position during deposition of cover and exposure of mineralised rocks to erosion are controlling factors that determine whether or not 'interface' samples will give indicators of nearby mineralisation.

5.4 DOES HOST ROCK AFFECT ALTERATION MINERALS AND TRACE ELEMENT GEOCHEMISTRY?

The occurrence of IOCG mineralisation within the eastern Gawler is independent of host rock. This is shown by the variation in host rocks between major IOCG deposits. Olympic Dam is hosted by Hiltaba Suite granite, Carrapateena by Donington Suite granite, Prominent Hill by metasediments and GRV and Emmie Bluff, Punt Hill and Hillside by Wallaroo Group metasediments. While the host rock does not control the presence of mineralisation, it does play a factor affecting the geometry of deposits and the mineralisation style. Mineralisation within calcareous metasediments of the Wallaroo Group commonly result in well-developed skarn assemblages and mineralisation tends to be roughly stratiform. Mineralisation within a granite host is commonly within breccia-pipes. Irrespective of these differences, the main alteration minerals and trace element associations remain very similar regardless of host rock. This demonstrates a similarity in fluid chemistry and process in the development of IOCG-style mineralisation. The most significant difference is that the mineralised zone of granite- and volcanic-hosted deposits is associated with strong sericite-hematite alteration whereas in sediment-hosted deposits it is with strong chlorite-hematite alteration. Both systems have some degree of both assemblages. Gold and REE are more commonly enriched in granite-hosted mineralisation and As, Bi and Co values are generally greater in sediment-hosted mineralisation. Based on results from the central eastern Gawler, the same element suite should be used in exploration regardless of host rock.

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the collection of data from 43 drillholes in the central eastern Gawler Craton, the following conclusions can be made:

- Multi-element, spectral and petrophysical measurements in combination have been critical to the interpretation of the data and ability to characterise alteration and identify element associations within IOCG systems.
- Collecting a 1 m sample every 10 m has been sufficient to provide representative alteration for each drillhole for the purpose of regional alteration mapping.
- Key alteration minerals for characterising IOCG systems in the central eastern Gawler include Fe-oxides, chlorite, sericite, K-feldspar, albite and amphibole. These do not sufficiently characterise skarn-related alteration systems.
- Cu mineralisation is associated with chlorite and Fe oxide-dominated mineral assemblages where hosted by metasediments and sericite and Fe oxide-dominated assemblages where hosted by granite and volcanic rocks.
- Na and K analyses are crucial for defining alteration patterns.
- Elements associated with IOCG systems in the area of investigation include Au, Ag, As, Ba, Bi, Cd, Ce, Co, Cr, Cs, Cu, Dy, Er, Eu, Fe, Gd, Ho, K, La, Li, Lu, Mg, Mn, Mo, Na, Nd, Ni, Pb, Pd, Pr, Re, S, Sb, Sc, Se, Sm, Sn, Tb, Te, Ti, Tl, Tm, U, W, Y, Yb, Zn.
- Key elements for defining geochemical vectors include
 - Local-scale – Ce, La, Te ± Co, Cd, Mn
 - Moderate-scale – Au, Ba, Mo, S
 - Broad-scale – Bi, Ag, As, Cu, Fe, Sb, Se, W
- 4. Values of >10 times the average crustal abundance for trace elements can be used as a convenient threshold for identifying anomalies. This relatively high threshold diminishes the need to normalise against rock type.
- 5. Long wavelength chlorite (FeOH absorption features of >2246 nm; Fe-rich end member) is associated with Cu and Fe alteration.
- 6. Cu mineralisation is associated with AlOH absorption features of between 2206 and 2221 nm. This broad range between muscovitic and phengitic white mica compositions may indicate that the key ingredient is the transition in composition, related to changed chemical conditions.
- 7. Multi-element anomalism within coarse-grained interface samples commonly reflects underlying or proximal mineralisation. A few interface samples have high Cu and pathfinder element values but are not located close to known basement mineralisation and warrant further investigation.
- 8. Most IOCG occurrences in the region are associated with elevated magnetic susceptibility values and increases in density. Early stage alteration incorporating magnetite growth is associated with magnetic susceptibility value increases of 1 to 2 orders of magnitude over unaltered rock values. Highly altered and often mineralised rock density values are generally >2.8 g/cm³.

Recommendations for further work include;

- Broadening the sampling area to include a wider spectrum of IOCG systems and associated alteration. Focus should be given to the Mt.Woods region to incorporate some of this variation.
- Further sampling around Olympic Dam and other major deposits as relevant drillholes become available to improve their regional characterisation.
- Incorporate thermal infrared data from HyLoggerTM 3 to map silicate mineralogy including minerals relevant to skarn alteration.
- Verify association of long wavelength chlorite with Cu mineralisation and investigate compositions using microscopy.

7. ACKNOWLEDGEMENTS

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APPENDIX 1 DATA

A1.1 WHOLE ROCK GEOCHEMISTRY (BASEMENT) 

A1.2 WHOLE ROCK GEOCHEMISTRY (INTERFACE SAMPLES) 

A1.3 PORTABLE XRF GEOCHEMISTRY 

A1.4 COMBINED GEOCHEMISTRY, PETROPHYSICS AND SPECTRAL DATA 

A1.5 PROBABILITY PLOTS 

A1.6 CORRELATION MATRIX 

A1.7 PROSPECTIVITY INDEX 

APPENDIX 2 MAPS

MAPS OF BASEMENT AND COVER GEOCHEMISTRY, EASTERN GAWLER CRATON

