

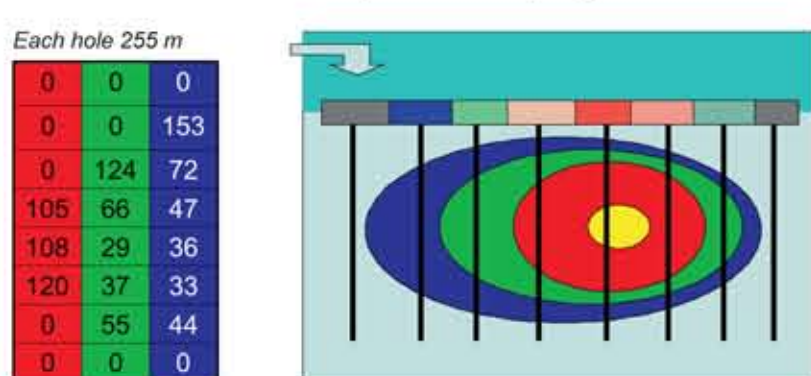
Regional Alteration Mapping Using Semi-Quantitative Spectral Mineralogy of Drillcore : Gawler Craton, SA

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The Gawler Craton is renowned for hosting the Olympic Domain, an iron oxide copper gold mineral system stretching 700km north south along the craton's eastern margin. Westwards, the character of the craton changes to one of hosting gold only systems. The Central Gawler Gold Domain exhibits different geochemistry. Mapping the alteration associated with these systems has potential for unravelling the relationship between the two domains thus enabling the prediction of the fertility of greenfields plays in less explored areas of the craton.

This poster promotes an idea of how hyperspectral data might be used to map alteration. The basic principle is that each drill hole samples the intersected mineral systems and scanning with HyLogger records how many metres of mineral are present in the hole. Using this value as a semi-quantitative indication of abundance at that location, each mineral can be gridded using the values from numerous drill holes to display its distribution in the geological domain. By selecting mineral pairs with known associated geochemical gradients a geochemical model can be established for exploration target generation.



The success of using mineralogy in this way hinges on the understanding of alteration mineralogy associated with target ore mineral systems.

As fluids travel through the substrate their own nature is changed. Pressure and temperature conditions change. Different wall-rock interactions/reactions take place.

Ions are added and removed. The effects of these changes can be observed as systematic changes in mineralogy and mineral associations over time and distance.

Minerals will precipitate when the fluid no longer retains the properties necessary for solubility

- Pressure has changed (dropped)
- Temperature has cooled
- pH has changed
- Oxidation state has changed

Fertility

Elements of the system that need to be considered when estimating the fertility of a region include:

- Eh/pH
- Redox boundaries / gradients
- Suitable repositories (reducing beds)
- Permeable conduits (sediments or tectonic fracturing)
- Source and movement of hot fluids of the right composition
- Two fluids mixing e.g. at the margins of the Gawler Range Volcanics
- Source for metals

Alteration Mapping

If the elements of the model can be mapped by spectrally visible minerals, hyperspectral analysis can be used to generate vectors to ore-bearing environments, or at least understand the architecture of a mineralised system.

When the use of hyperspectral (VNIR/SWIR) data to map mineralogy is examined it is found that a number of key "traditional" alteration minerals are not visible in the VNIR/SWIR part of the spectrum e.g. tectosilicates.

A study undertaken using PIMA II (which operates solely in the SWIR) established some useful relationships (AMIRA P435). The first finding was that most systems have only a few key SWIR responsive minerals to work with. Those key minerals however can often change abundance and composition along chemical gradients from barren material to ore-bearing environments. These changes can be measured using high resolution spectroscopy covering the VNIR/SWIR wavelengths.

Key Mineral Assemblages visible in VNIR/SWIR spectroscopy

- Kaolin
- White mica
- Smectites
- Chlorite
- Carbonate
- Iron oxides
- Sulphates
- Pyrophyllite and Topaz

HyLogger™ in conjunction with "The Spectral Geologist" software provides the means to measure these minerals. Therefore for the location of each scanned drillhole the number of metres of e.g. muscovite, phengite, siderite and magnesite, intersected by that hole are recorded.

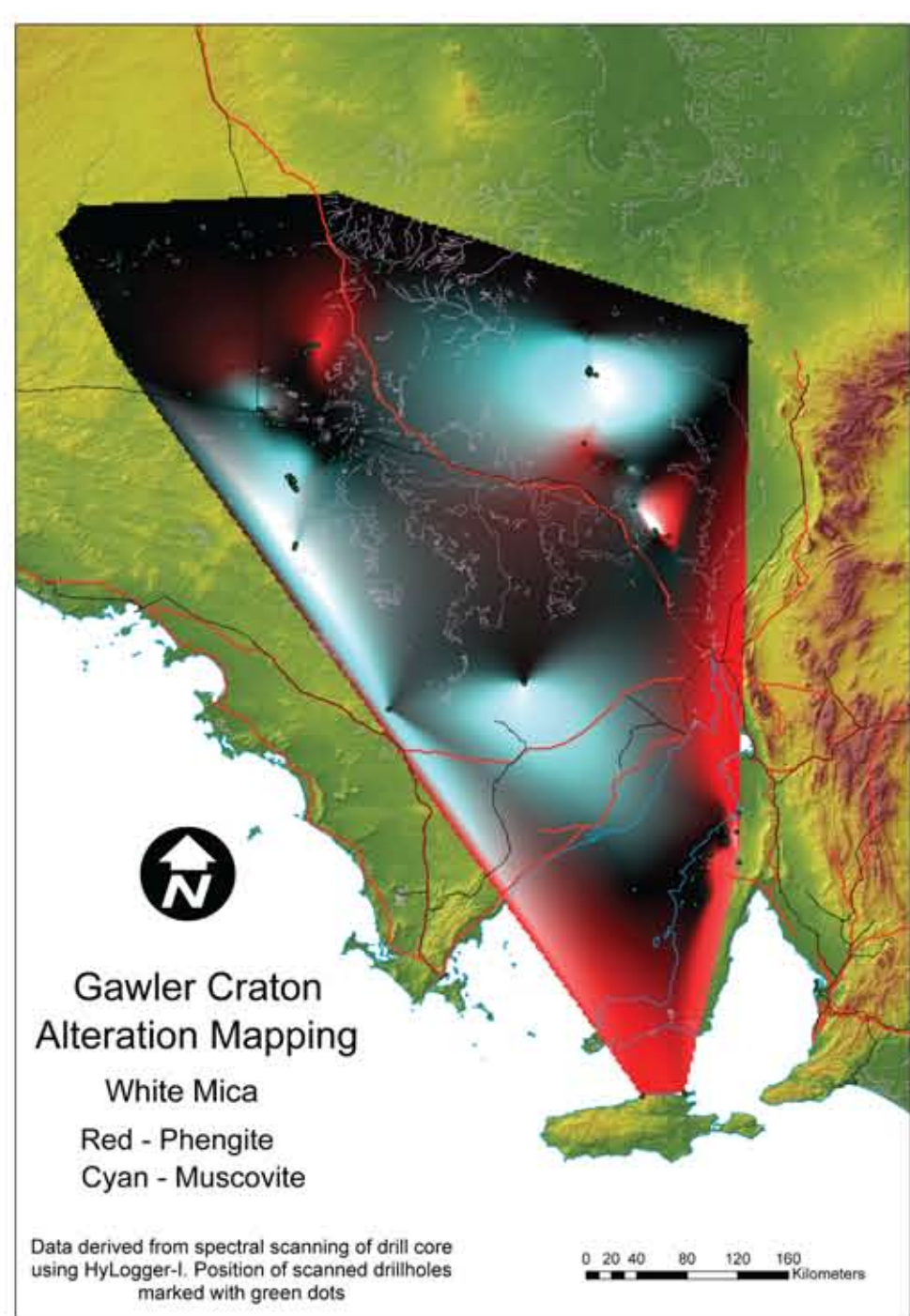
Gawler Craton

Over the Gawler Craton 316 drillholes have been scanned. Each recorded mineral (approximately 50 potential minerals) can be gridded. By combining two minerals in a cyan-red image regional trends in geochemistry can be established.

The four alteration vector diagrams are presented below. Even using binary vectors the patterns revealed are quite complex. Roxby Downs in the north east of the gridded region appears to contrast sharply with Pernatty Lagoon to the south but demonstrates a surprising affinity for parts of the Central Gawler Gold Domain e.g. Yarlbrinda Shear Zone and Lake Harris Greenstone Belt in the west. The Olympic Domain stretching from Lake Torrens down to York Peninsula does not display a uniform geochemical gradient and Roxby Downs appears to occupy a separate alteration environment within the domain.

Future Developments

The plots shown on this poster have not been filtered by geology. By introducing stratigraphic, lithological or depth control, a greater consistency in alteration trends may become apparent. In addition district level plots where localised alteration patterns can be examined in detail could provide greater insight when compared to the regional generalised patterns displayed here. Above all sampling density needs to be increased. This can be achieved by a two fold approach – first scanning more of the holes that already exist in the core library and second by undertaking more drilling especially in previously unexplored areas.



WHITE MICA

Muscovite
Phengite

Al depletion of muscovite (Mv)

The Muscovite to Celadonite solid solution involves the depletion of Al and substitution of Fe and Mg. Phengite is the general term for Al – poor, Fe – rich Muscovite approaching the Celadonite end-member chemistry. It has been observed that the proportion of phengite increases in proximity to mineralisation even as the abundance of muscovite might be decreasing.

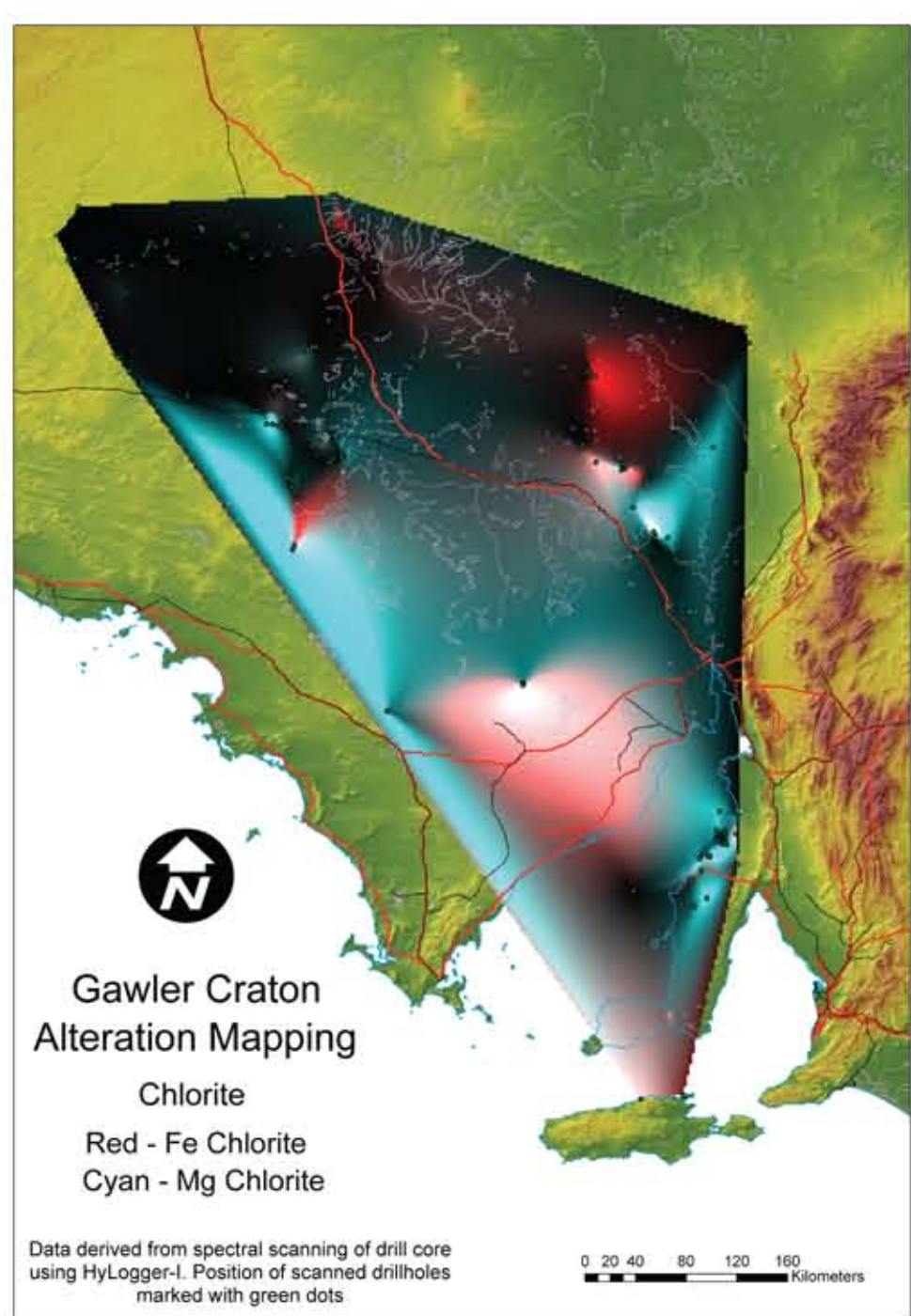
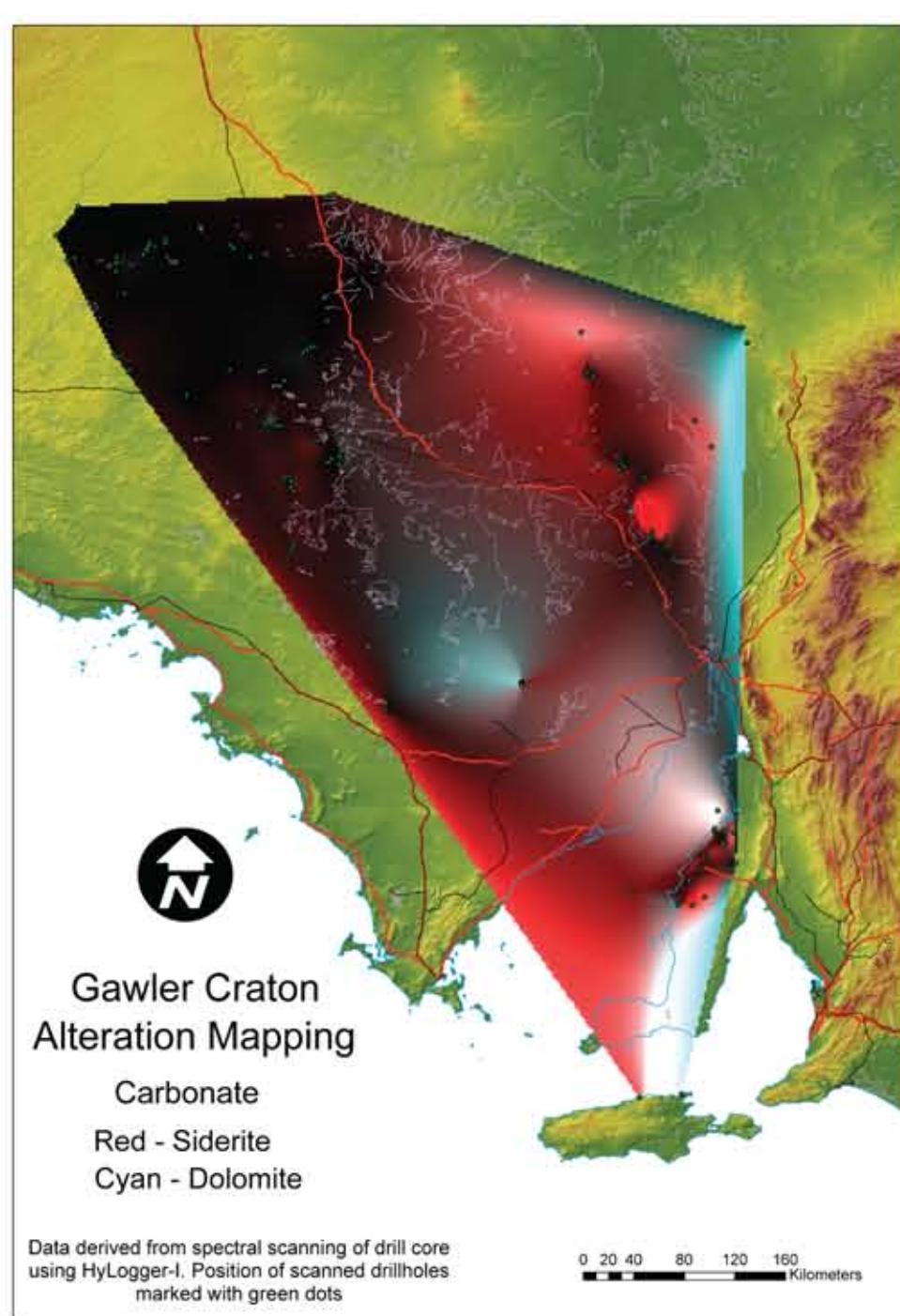
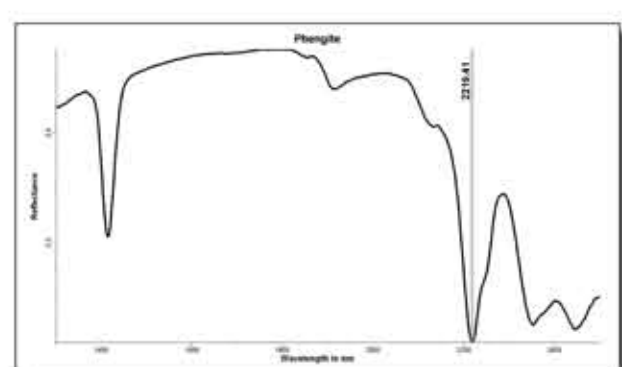
The transition can be measured by the wavelength of the ~2200nm absorption feature.

CARBONATE

Dolomite
Siderite

Fe-Mg gradient and abundance of carbonate

Fe – Mg substitution in carbonate measured by the wavelength position of the ~2350nm absorption feature



CHLORITE

Mg Chlorite
Fe Chlorite

Fe-Mg gradient in chlorite

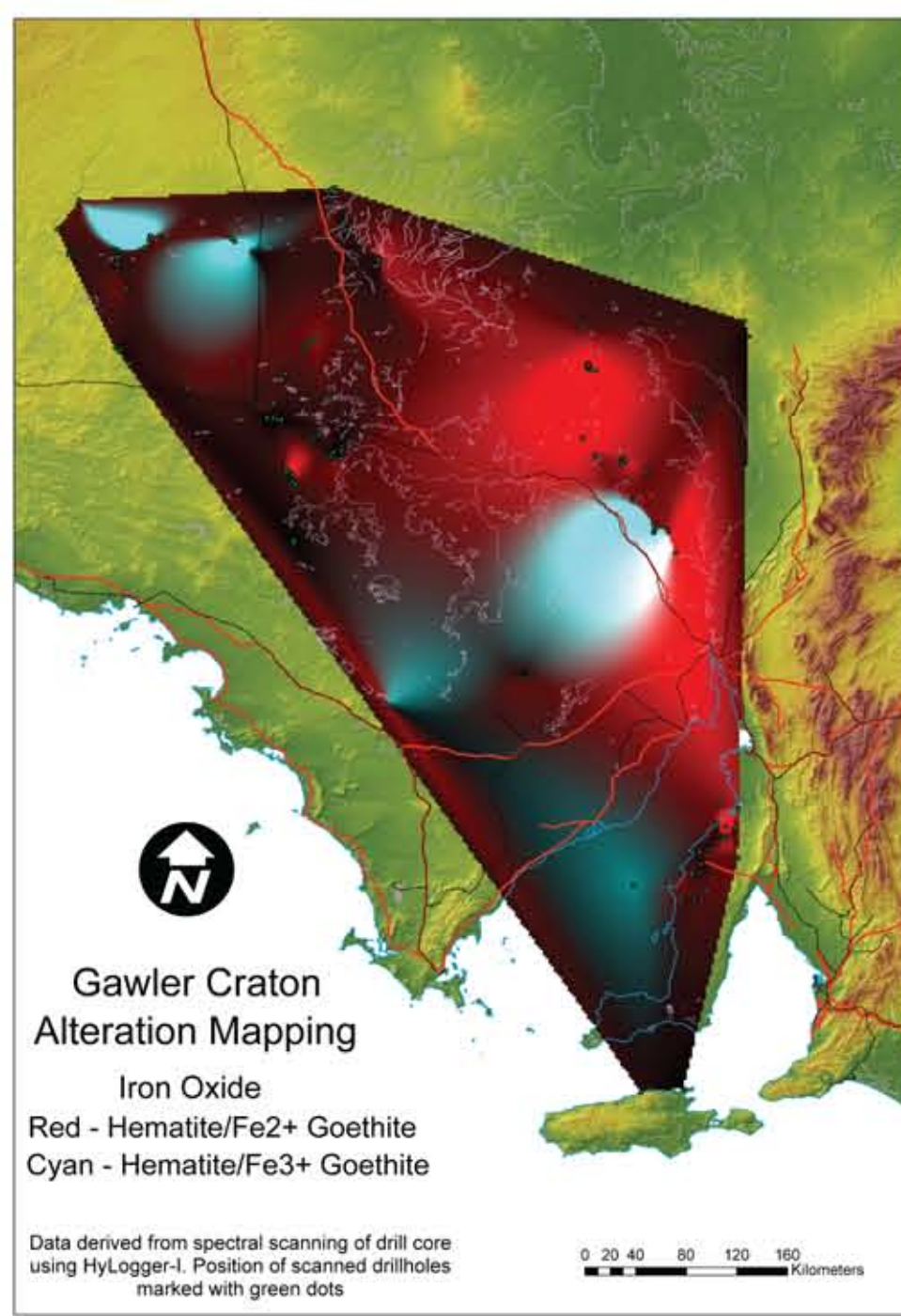
Fe – Mg substitution in Chlorite is measured by the wavelength position of the ~2350nm absorption feature

IRON OXIDE

Haematite/Fe3+ Goethite
Haematite/Fe2+ Goethite

Hematite and Goethite spectral signatures are distinctive in VNIR. Goethite empirically has two spectral signatures from laboratory studies identified as:

- Fe2+ Goethite vs Fe3+ Goethite
- Fe3+ Goethite interpreted as after hematite
- Fe2+ Goethite interpreted as after pyrite (Fe2+ Sulphide)



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PACE

plan for accelerating exploration

HOT PROSPECTS

