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# How do you rank 75 under-cover Cu-Au targets for drilling in the Delamerian?

**Peter Rolley**
Chief Geologist & Exploration Manager

SAEMC 2 December 2022

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The information in this release that relates to Exploration Results, Exploration Targets and Mineral Resource Estimates is based on information compiled by Mr Peter Rolley, who is a Member of The Australian Institute of Geoscientists. Mr Rolley is a full-time employee of Hillgrove Resources Limited and has sufficient experience relevant to the styles of mineralisation and type of deposit under consideration to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code)'. Mr Rolley has consented to the inclusion in the release of the matters based on their information in the form and context in which it appears. All exploration drill results, soil sampling images, and rock chip results have previously been reported to the ASX by a Competent Person at the time.

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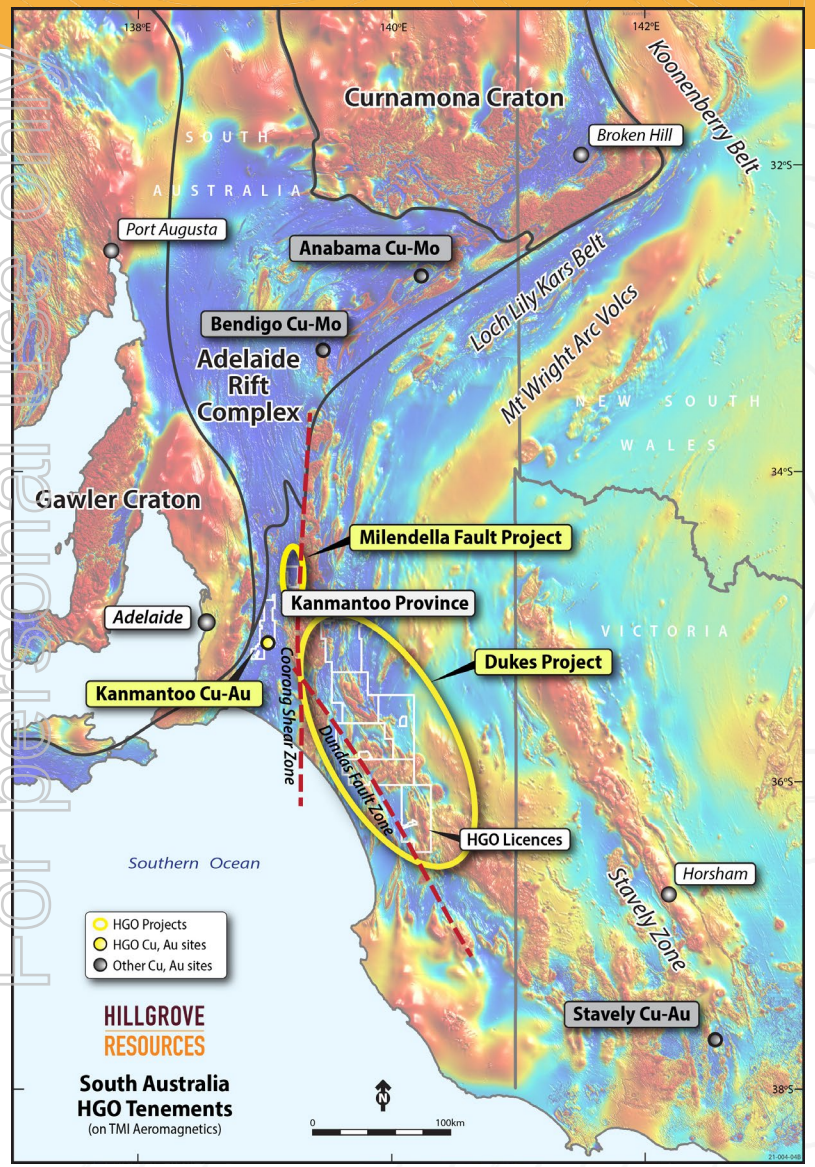
This announcement is authorised for market release by Hillgrove Resources' Managing Director and CEO, Lachlan Wallace.

# Todays Presentation




- Regional Exploration Summary
- Regional Prospects
- Kanmantoo UG

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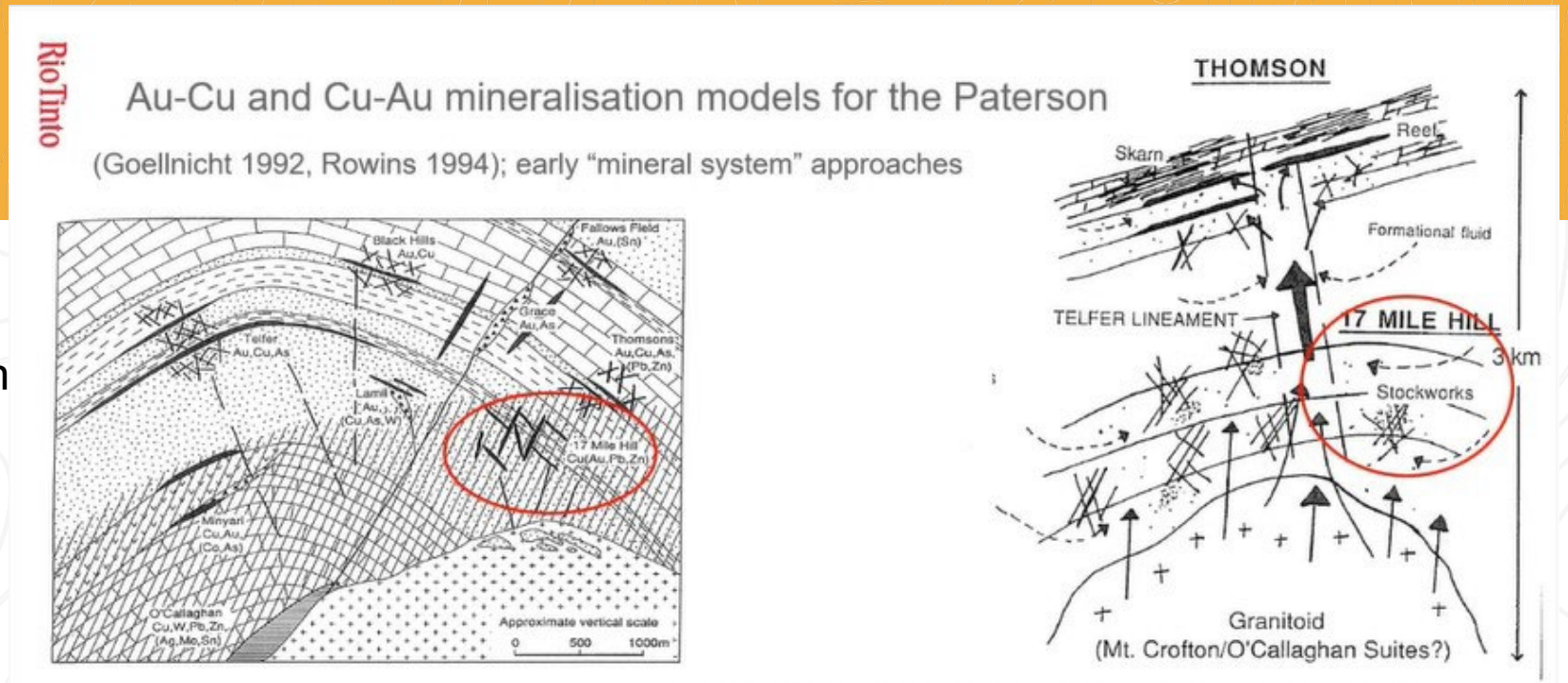
# Winu

The Winu copper system in NW WA was recently described by RTZ at an AIG meeting in Perth, now available on YouTube (18-05-2022).

Winu is reported as
Indicated ~ 249 Mt at ~0.55% CuEq
Inferred ~358 Mt at ~0.46% CuEq
(ASX:RTZ 23 February 2022)




RTZ was attracted to 17 Mile Hill story in the Paterson Province Mineral System Model because it is copper rich not gold rich. And so selected projects with that filter.

In a sedimentary sub-basin
Close to granite, but granite is not at the deposit (right type)
In the "right" stratigraphy
Near major lineament
In contact metamorphic halo from granites which overprints the regional metamorphism
Retrograde thermal system of veins and alteration
Cu, Ag, Au, Bi, Te, Mo, W

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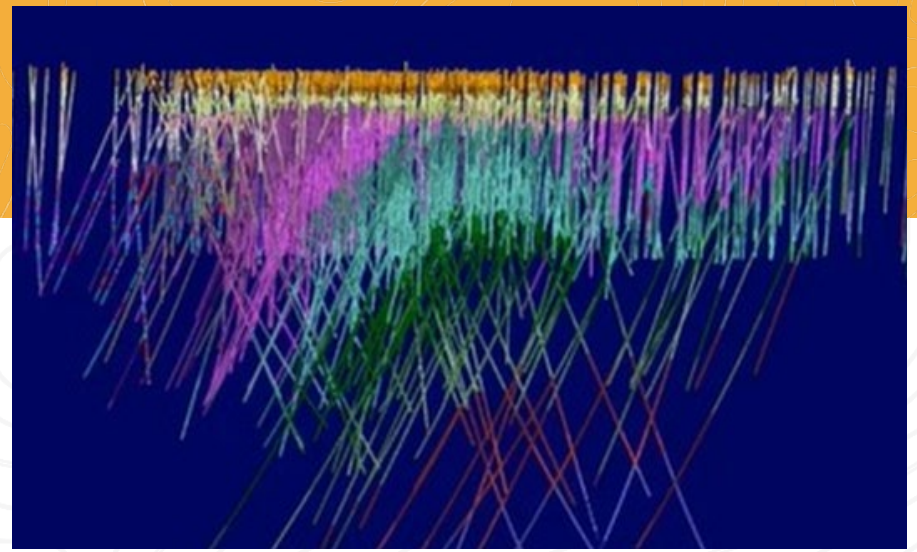
# Winu



Coarse grained andalusites overprinting earlier sillimanite

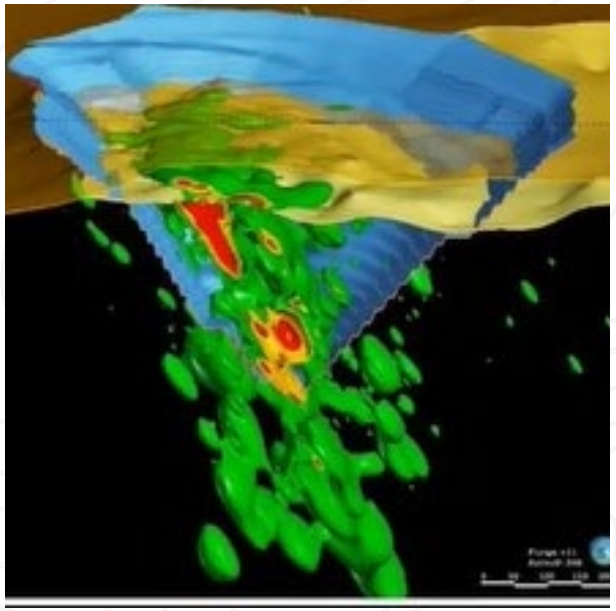
Cu is open space infill and is late.

Gold occurs as electrum with bismuthinite

Sulphides overprint early quartz, biotite, andalusite

Alteration sequence (early to late) is retrograde

1. Early unmineralised qtz veining
2. K-spar-sericite-albite veins
3. K-spar, biotite, minor sulphide veins
4. Strong bismuth – gold association (Corr.Coeff ~ 0.6)
5. Sulphides – main event – open space and overprint all other veins
6. Sulphides with lower temp chlorite/anhydrite
7. Late stage quartz, carbonate, galena, marcasite



Cu is best within a certain stratigraphic unit, so grades appear stratabound, but all Cu is in steeply dipping veins, and breccias

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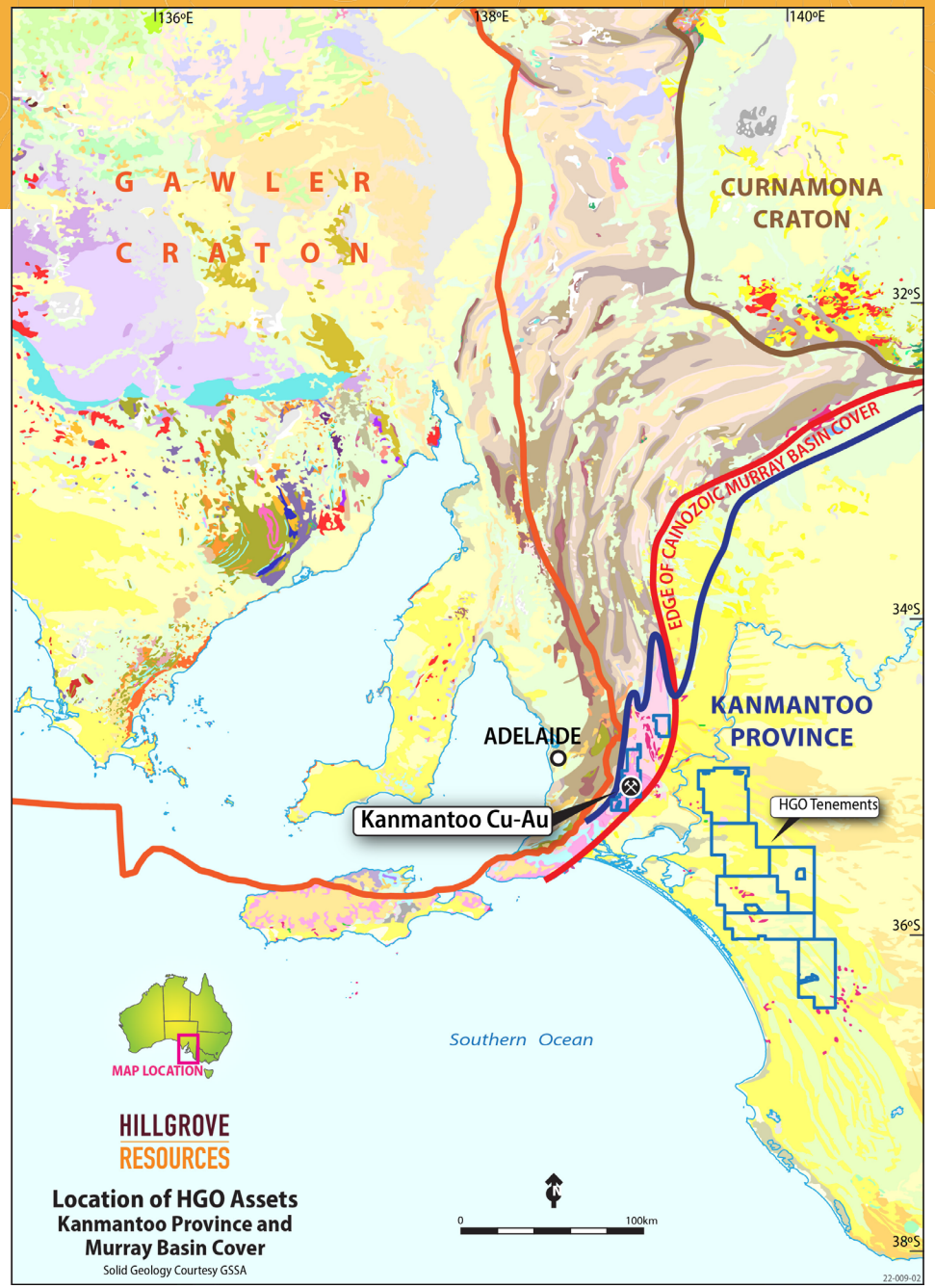
# Where is Hillgrove Exploring?

- Kanmantoo Province is a large Cambro-Ordovician sedimentary/volcanic basin on the margin of the Adelaide Fold Belt and the Gawler and Curnamona Cratons
- The Kanmantoo Province has been deformed by the Delamerian Orogen
- Geology of the Kanmantoo Province is mostly covered by the Cainozoic Murray Basin sediments to varying depths to over 300m depth
- Only 5% of the Kanmantoo Province is exposed
- Therefore we have used the geological observations from Hillgrove's Kanmantoo Cu-Au mine and surrounds, as windows to processes that have affected the Kanmantoo Province.
- HGO hold seven Exploration Licence's covering 6,125 sq kms in the south-east of the Province

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# Copper System at Kanmantoo

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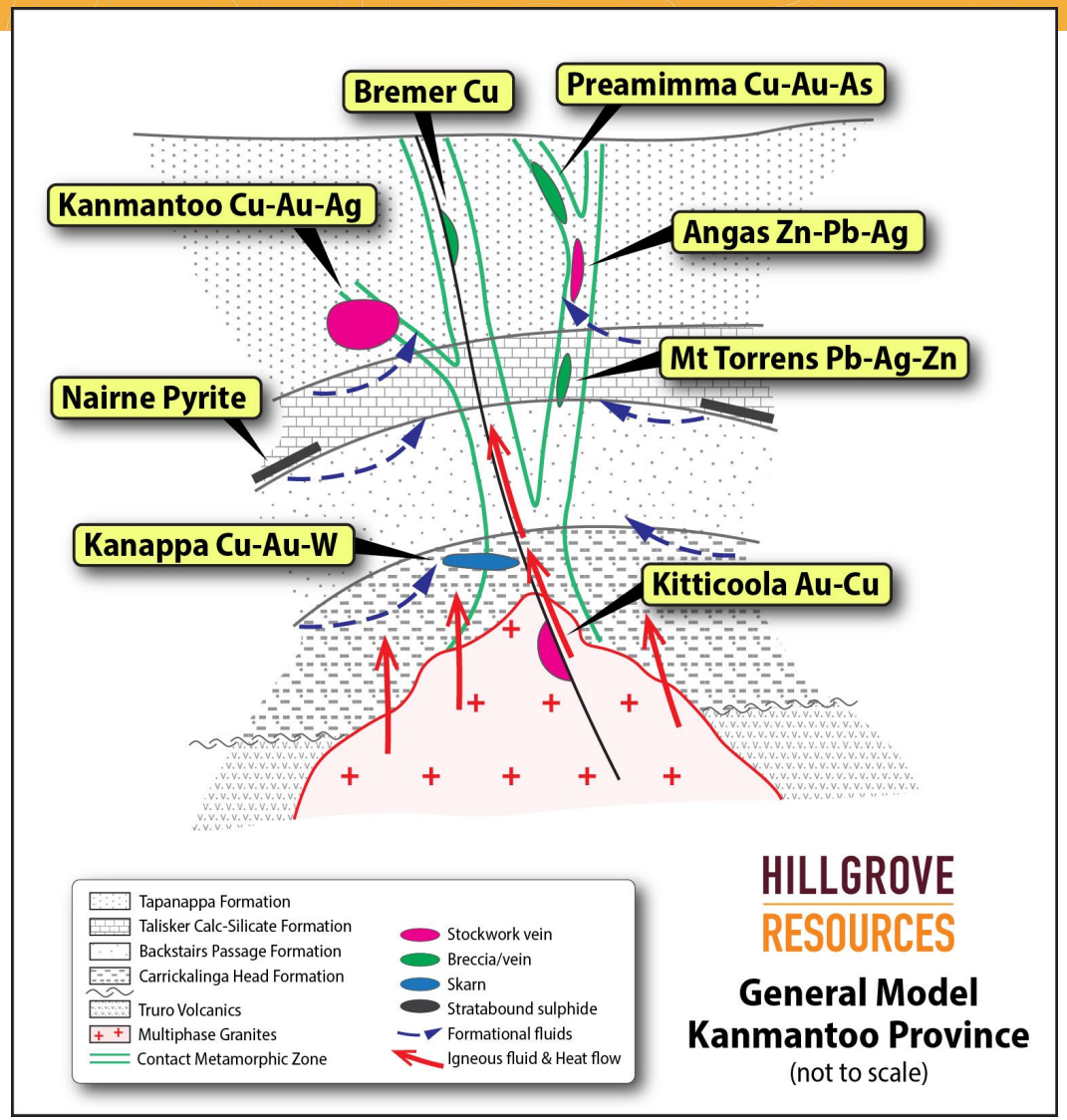
The processes observed at the Kanmantoo Cu-Au mine are also evident at numerous Ag-As-Au-Bi-Cu-Fe-Mo-Pb-W-Zn occurrences in the Kanmantoo Province. The following observations are consistent for the vast majority of these occurrences

1. Occur in sediments
2. Sediments deformed by 2 or more dynamic deformation phases
3. Occur with variations of “contact metamorphic” mineral assemblages e.g. coarse grained andalusite schists, biotite schists, garnet andalusite schists, et al
4. Sulphides occur late and in structurally prepared infill zones within these contact metamorphic zones
5. Alteration and mineralisation occur predominantly as retrograde thermal systems i.e. from early high temperature alteration/veining to lower temperature late alteration/veining



# Copper System at Kanmantoo

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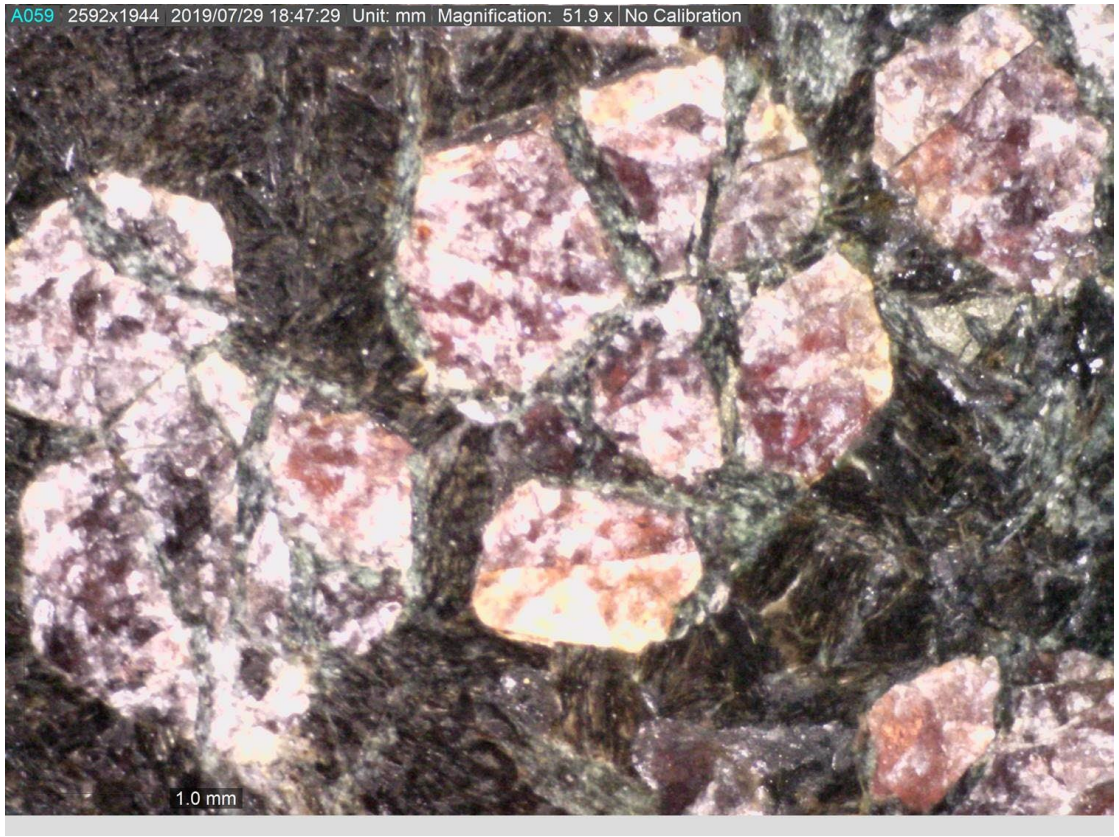


Garnets proximal to ore are now Fe rich and fractured with chlorite, chalcopyrite infill

Garnets/andalusites depict the bedded layers, which are truncated by veins infilled with Cpy and Po

# Kanmantoo is a Hydrothermal Cu Breccia System

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## High grade copper mineralisation in Central Kavanagh

The mineralisation is typified by Chalcopyrite-pyrrhotite veining within a strongly altered Andalusite schist. The andalusites in this image are poikiloblastic. The alteration is garnet, biotite, chlorite, staurolite, magnetite. Quartz veins are pre-mineralisation and are deformed by D2 deformation.

# Gold-Bismuth System at Kanmantoo

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1. Gold is most commonly spatially associated with
   a) bismuthinite and Bi-complexes, and
   b) chalcopyrite/pyrrhotite
2. Correlation co-efficient for
   a) Cu:Au is ~0.2
   b) Bi:Au is ~0.7
3. Gold is dominantly 5 – 20 µm in size, and detected as nano-particles within chalcopyrite, magnetite, pyrrhotite and bismuthinite
4. Gold occurs as electrum
5. Bismuth sulphides overprint all other minerals
6. SEM confirms a Au:Ag:Bi:Hg association and timing
7. Booth(2018) suggests a Bismuth melt model for the bismuth associated gold and post the main copper mineralising event

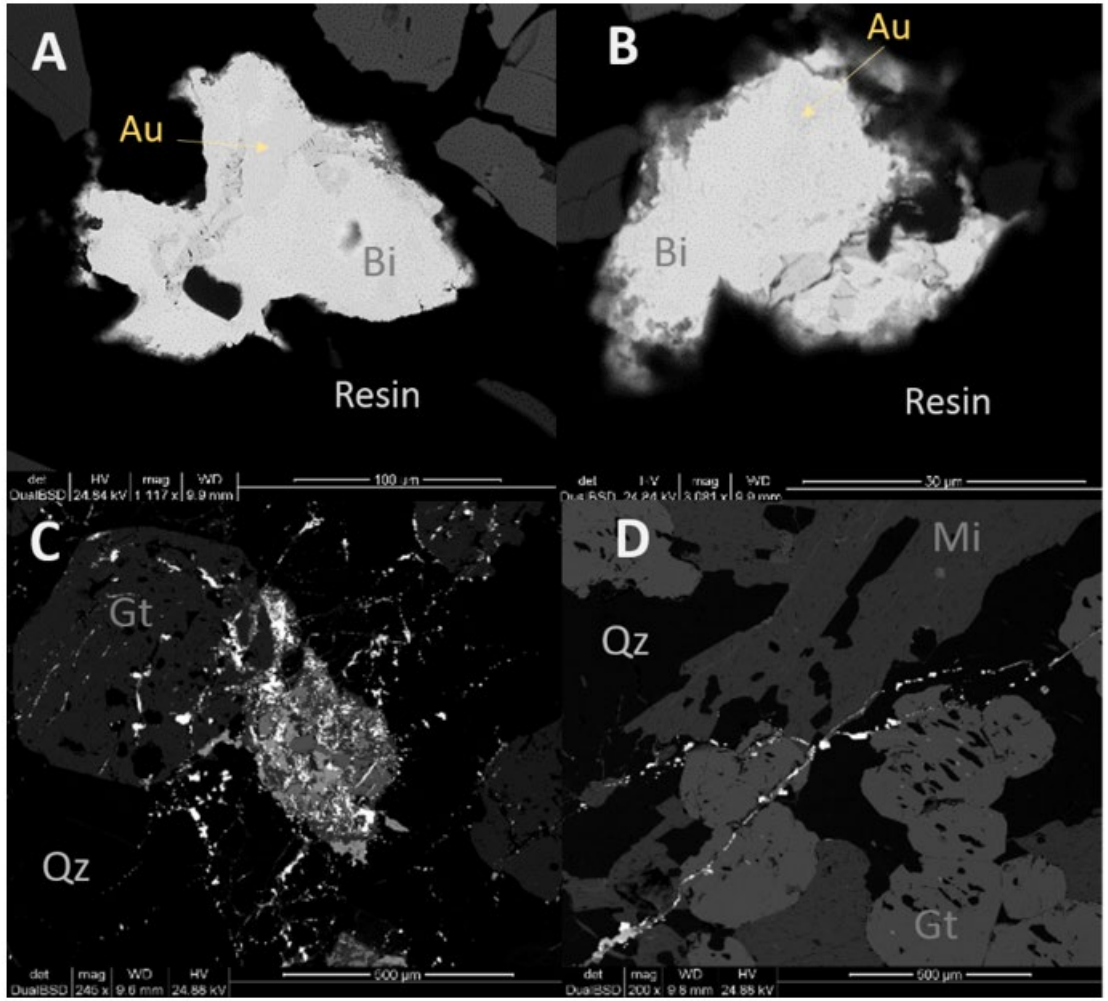


**Figure 9: SEM images taken in BSE mode showing distribution of Bi within the sample suite. (A & B) Au intergrowth with Bi, where Bi is more dominant (TC300B). (C & D) Bi (bright grains) cross-cutting existing mineral phases, suggesting Bi-associated Au and Bi-rich fluids are late in the paragenetic sequence.**

# Kanmantoo Cu-Au is a multi-stage magmatic driven hydrothermal mineral system

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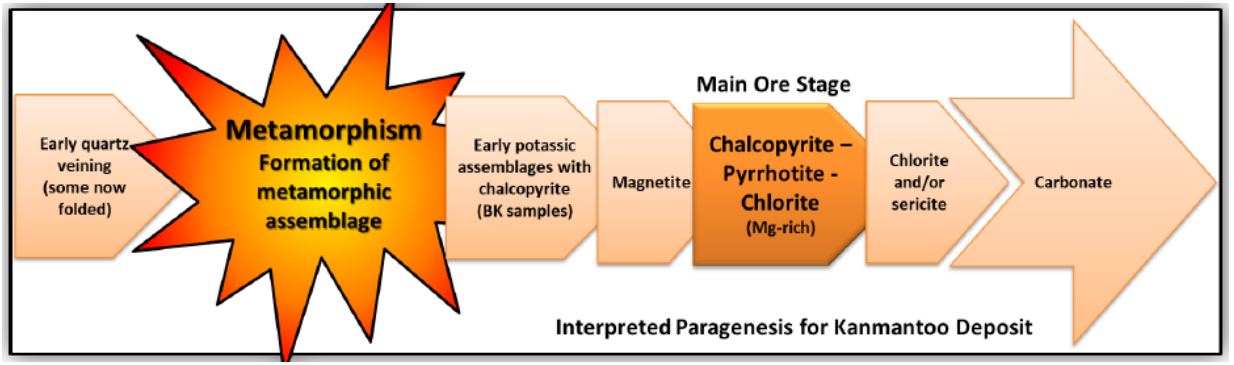
Paragenetic sequence proposed as:
o Early quartz veining (some now folded)
o Metamorphic assemblage (andalusites et al)
Post metamorphism:
o Early potassic assemblages with minor chalcopyrite
o Magnetite
o main event - Chalcopyrite – Pyrrhotite - Chlorite
o Chlorite and/or sericite
o Carbonate/zeolite




Main sulphide assemblage (chalcopyrite-pyrrhotite) is nearly always observed transgressing bedding and infilling both D2 and D3 structures, and at the microscope scale tiny vein networks cut and fracture quartz, garnet and magnetite

The sulphide mineral stage post-dates the metamorphic assemblage and is dominantly infill in character

These observations are based on over 100 thin/polished sections from all lodes/zones at Kanmantoo

# Sherlock Cu-Zn System: Validation of Mineral System Model

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As previously noted, >95% of the Kanmantoo Province is under cover of the Cainozoic Murray Basin Cover.

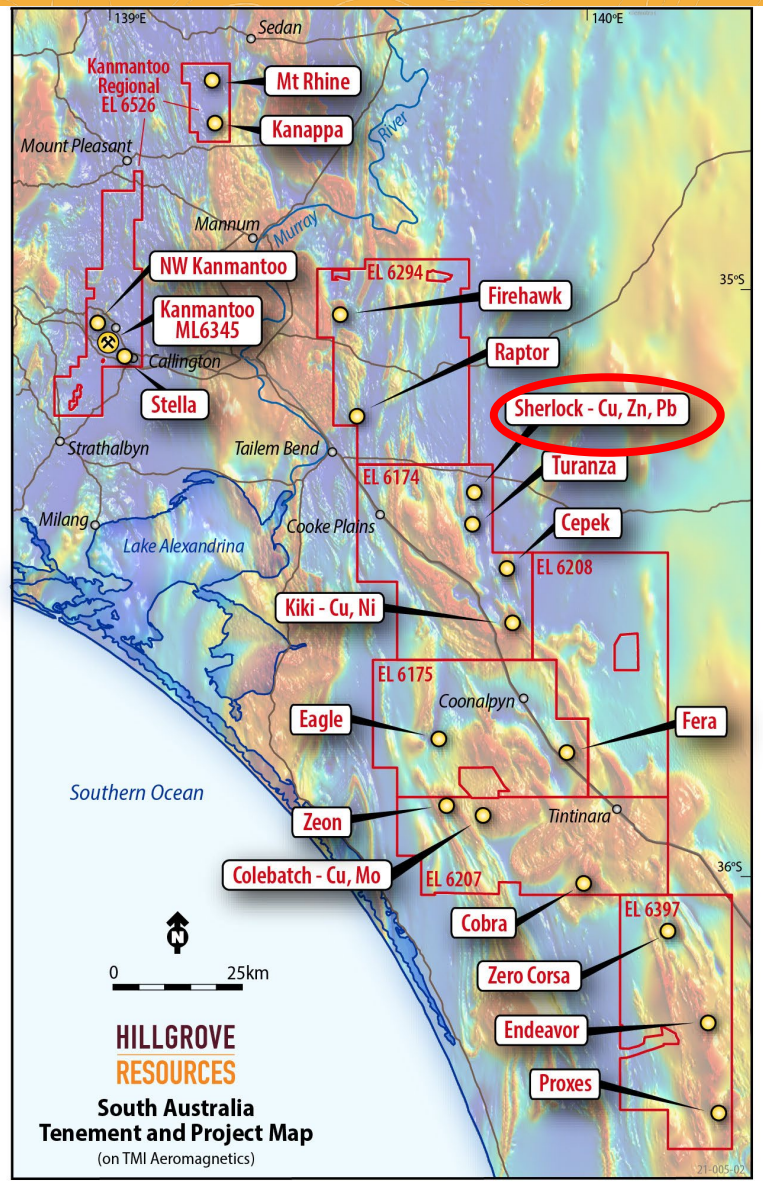
Question: Is the Kanmantoo Cu model valid for the Cambro-Ordovician terrain under the Murray Basin?

The Sherlock Cu-Zn-Ag-Bi-W system occurs under the Murray Basin

Sherlock is within a sedimentary sub-basin dated by GSSA as similar (or younger) to the Kanmantoo Group at Kanmantoo (Wise, 2021)

Sherlock is covered by >70m of Cainozoic cover

Sherlock has 15 core holes, not all fully assayed or with complete elemental suites (e.g. gold missing)



# Sherlock Cu-Zn Prospect: Validation of Kanmantoo Model

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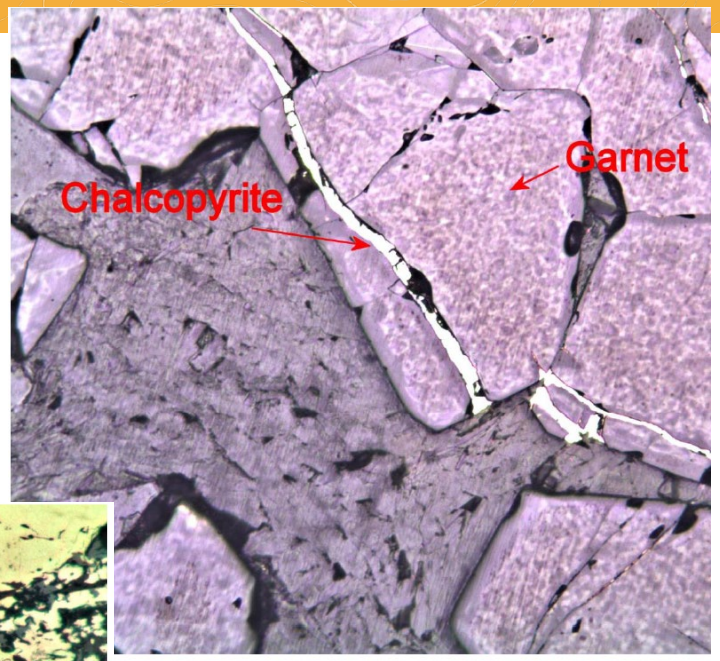
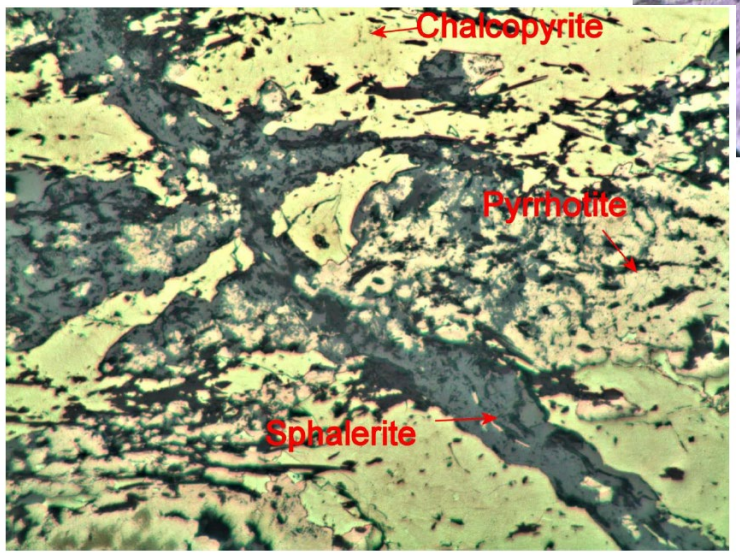
Petrology of the alteration and veining from 15 core holes has identified the following characteristics of the Cu-Zn-Ag-Bi-W mineralisation

- The Sherlock system is hosted in quartz-biotite schists, marbles and mafic volcanics
- Early contact metamorphism to lower Amphibolite facies
- Garnet in sediments proximal to the mineralisation
- Chlorite alteration system is dominant
- Sulphides are infill, late and cross cut bedding
- Mineralisation is Post peak-metamorphism
- Retrograde thermal paragenesis
  - Pyrrhotite, chalcopyrite
  - Sphalerite, galena
  - Pyrite, carbonate




2917195b. Garnet cut by chalcopyrite.




'e 19. 2917183. Chalcopyrite cut by sphalerite vein. RL. WOF 2.20mm.

**We suggest that Sherlock is a hydrothermal system similar to Kanmantoo**

# Prospects, prospects, prospects

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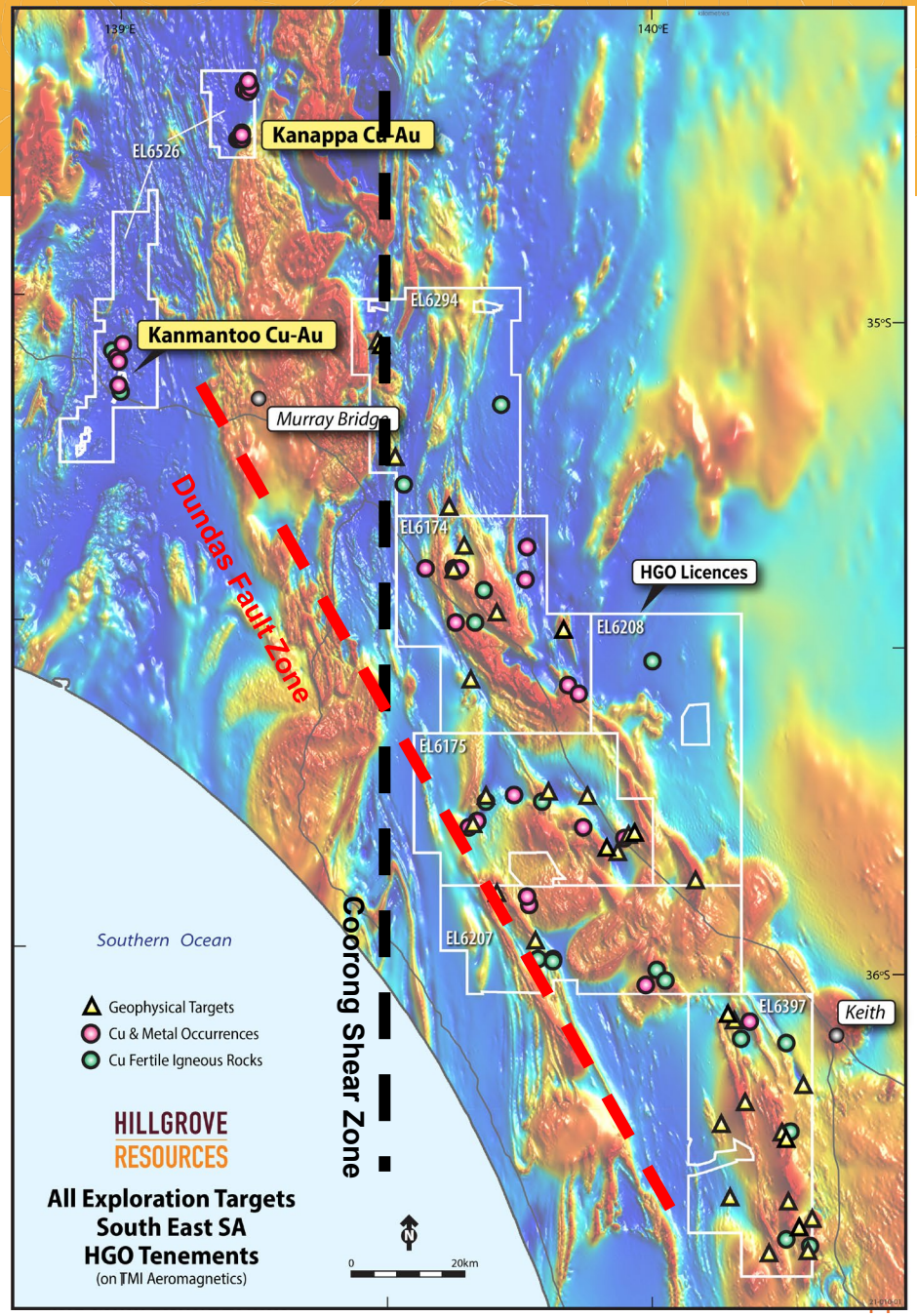
HGO have undertaken a grass-roots approach to the exploration of its tenements in the Kanmantoo Province.

- Compilation of past exploration activities
- Entry of drill hole and outcrop geochemical data from
  - Uni Adelaide (Foden), GSSA (Curtis), Exploration Companies HGO own sampling at Tonsley Library & outcrop
- Age dating (Uni Adelaide)
- Depth to basement data and modelling (Passive Seismic)
- Infill regional gravity data and inversion modelling
- Regional soil geochemistry
- New basement geology interpretation
- Drilling at Kanappa
- Large number of new petrology reports from drill holes and outcrop from Mannum to Keith looking at the alteration and veining



# Prospects, prospects, prospects

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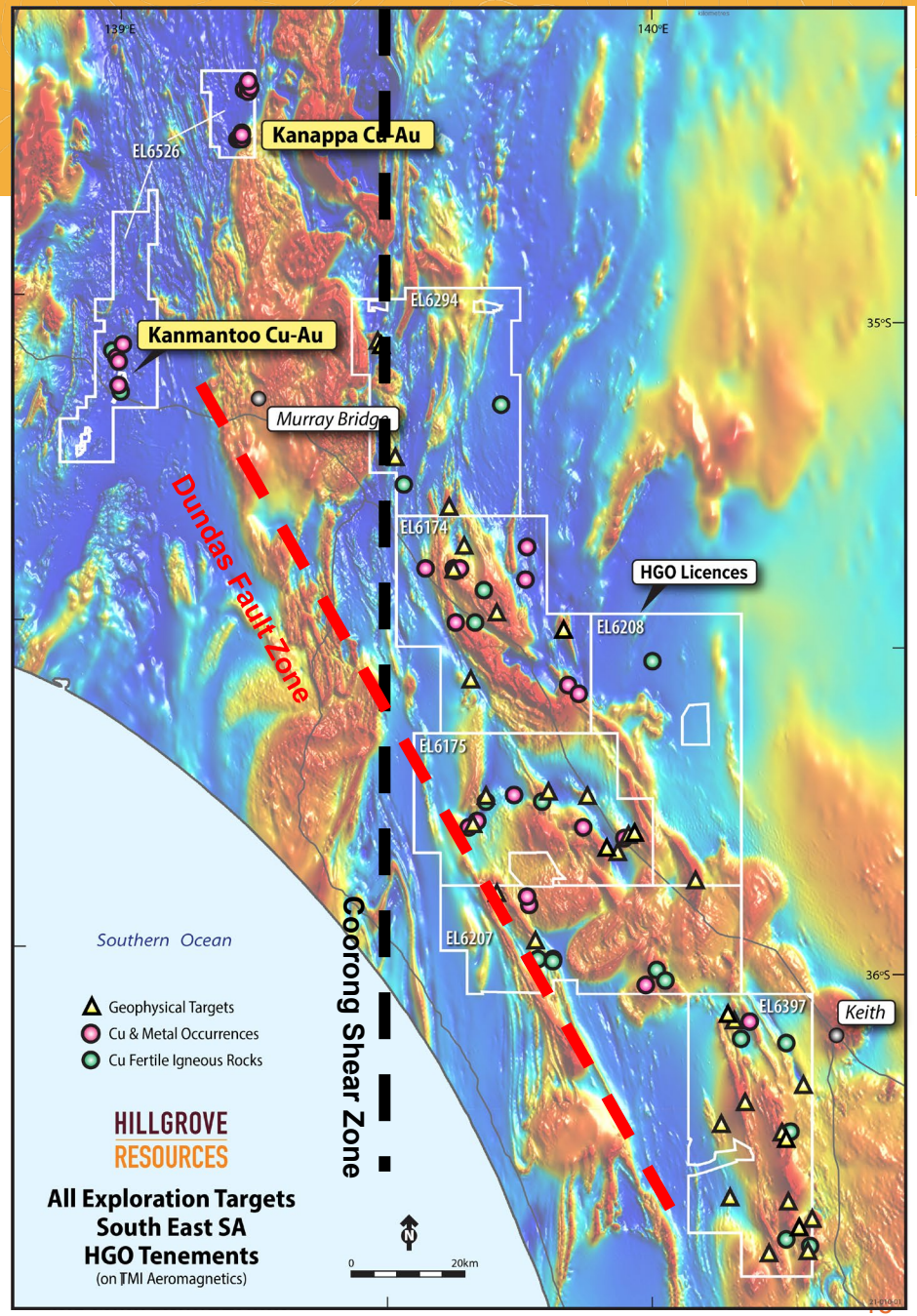
What did we find within the Kanmantoo Province after all the compilation and grass roots work?

A past drill hole with 75m of garnet-chlorite-magnetite alteration with attendant po-py-cpy sulphides to 15% and ~6000ppm Zn+Pb with minor Cu and Au (SARIG Env03729)

(which we believe to be indicating that the drill hole is possibly proximal zone to a copper zone, but previously ignored because the explorers were looking for syngenetic base metals).

Furthermore, the petrology by HGO has shown that the retrograde thermal alteration system with Fe/Cu sulphides exists from Kanmantoo to Mannum and down to Keith and in-between. The style is repeated across the entire district.



# Prospects, prospects, prospects

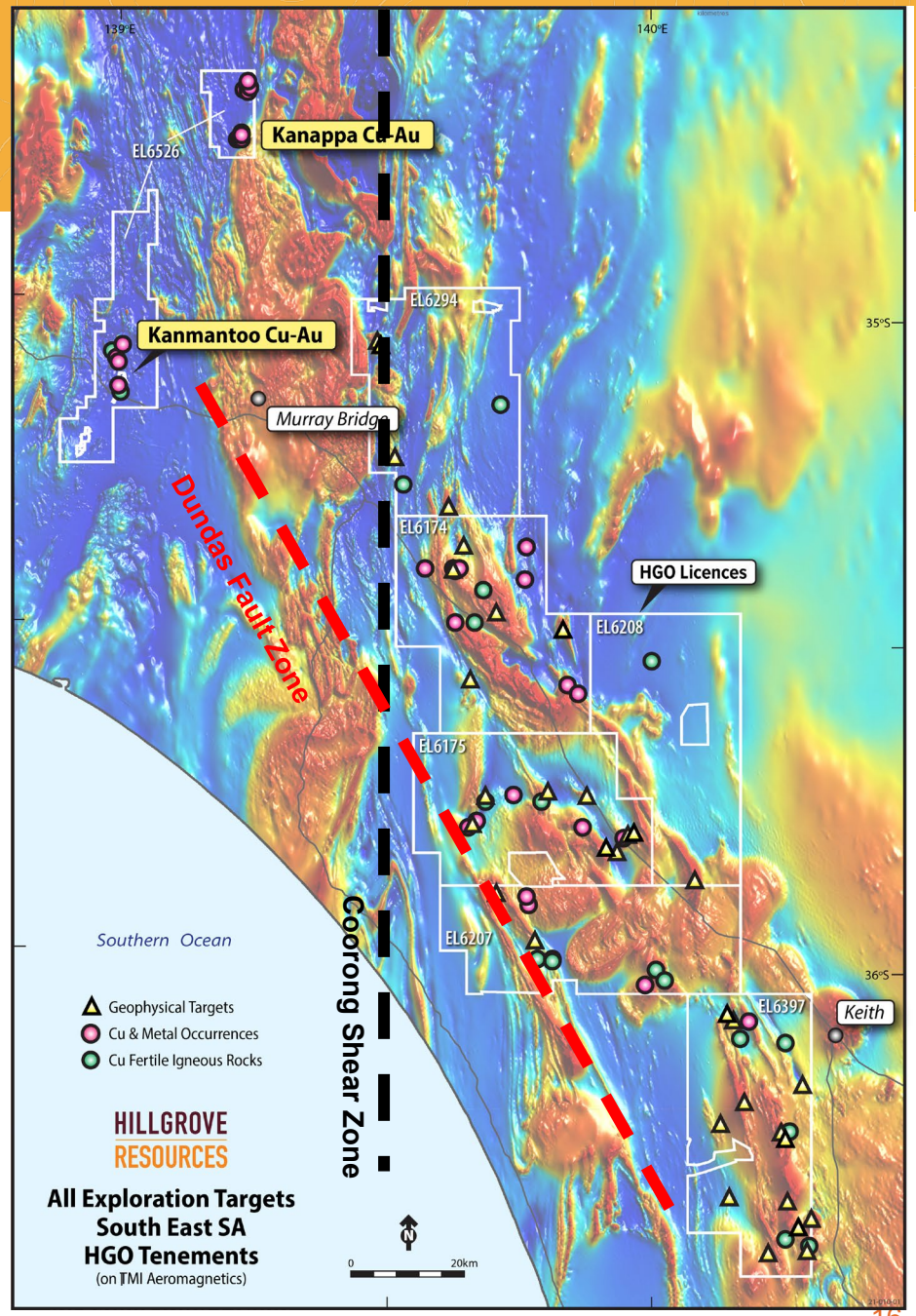
What do you do to try to justify which prospect is worthy of drilling?

In the south-east HGO's ranking is based on looking for sediment hosted copper system derived from processes that are now understand as operating in this Province.

This is contrary to practice in the south-east over the past 25 years, which has been to:

- Drill next to a previous drill hole with something in it (e.g. Sherlock), or
- Drill a mag anomaly because everything is under cover

Which has created a huge bias in the understanding of the basement geology, and a bias against finding any endowment within the sedimentary sequences.

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# Sherlock Soil Geochemistry

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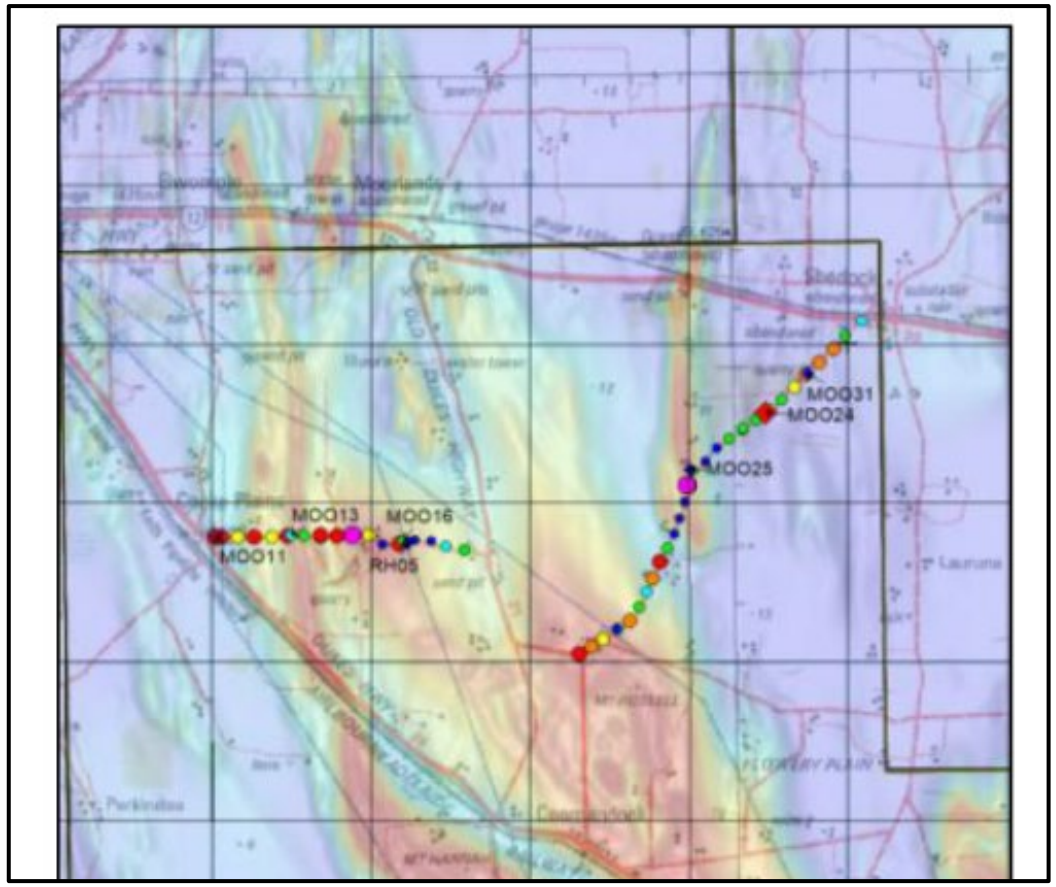
HGO have also tried to use soil/auger sampling to identify sediment hosted prospects. In the past year an ADI was granted to assist HGO with this concept where the Cainozoic cover is 1 – 300m thick.

Stage 1

Sherlock was chosen as the trial case for soil geochemistry, knowing the basement endowment existed and cover is >70m.

UNSW conclusion is that soil geochemistry is effective and at 500m spacing identified the Sherlock, MOO15 and MOO11 prospects



# Regional Soil Geochemistry

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Stage 2 – 4-acid analysis of a number of auger traverses (to 1.2m depth) and past “RAB” holes to 10m depth

We also looked at using a pre-leach of ammonium acetate to remove the calcrete from the samples and then use a 4-acid on the residue – same results – just stronger.

Data analysis suggests the following five associations

- Bi, Tl
- Cu, Mo, Sb, Sn, W
- Sb, As, Sn, W
- Sn, Te, Se
- Sn

HGO also looked at halogen assays from the auger samples.

These were also effective at identifying the locations of known mineralisation under cover.

# Raptor (near Tailem Bend) – A “Kanmantoo” style prospect?

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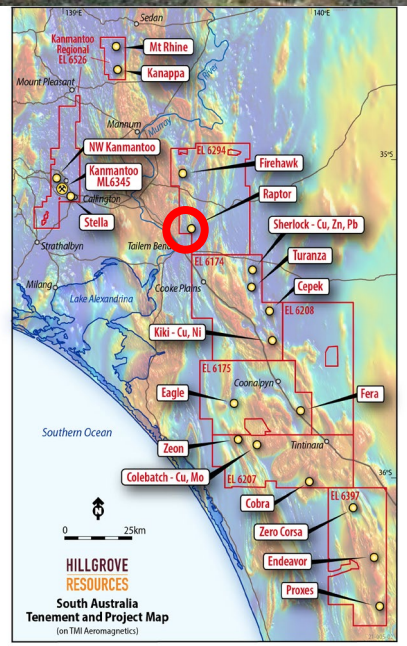
- Strong Cu-Mo-W-Pb-Zn anomalism in past drill hole
- Hosted in mafic and biotite schists
- Retrograde thermal alteration/veining by
  - K-spar, sericite
  - chlorite, sulphides
  - epidote, carbonate, pyrite.
- Proximal to Coorong Shear Zone

Drill core petrographic slide from COP56



# Cooke Basin – Another "Kanmantoo" style prospect?

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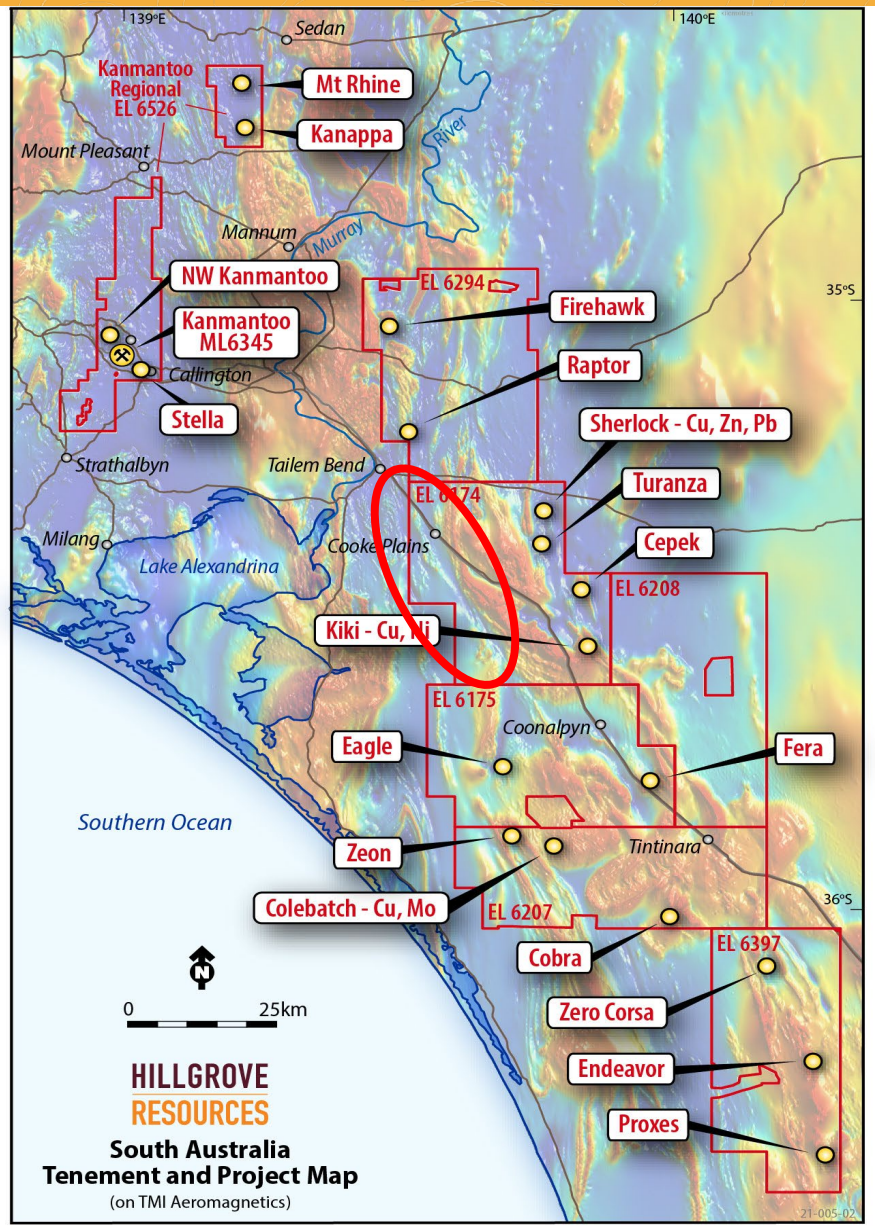
- The Cooke Basin is named after a sub-basin that is ~50 kms in length
- Nearest drill holes are along its margin, with past explorers chasing magnetic zones
- MOO11 (sediments), MOO18 (basalts) have both been identified as strongly anomalous geochemistry including Cu, Pb, Mo, As, Sb, Ag, Au
- Soil geochemistry has also identified the basin as distinctly anomalous in halogens and in As, Hg, Cu



# Cobra (near Keith) – Another “Kanmantoo” style prospect?

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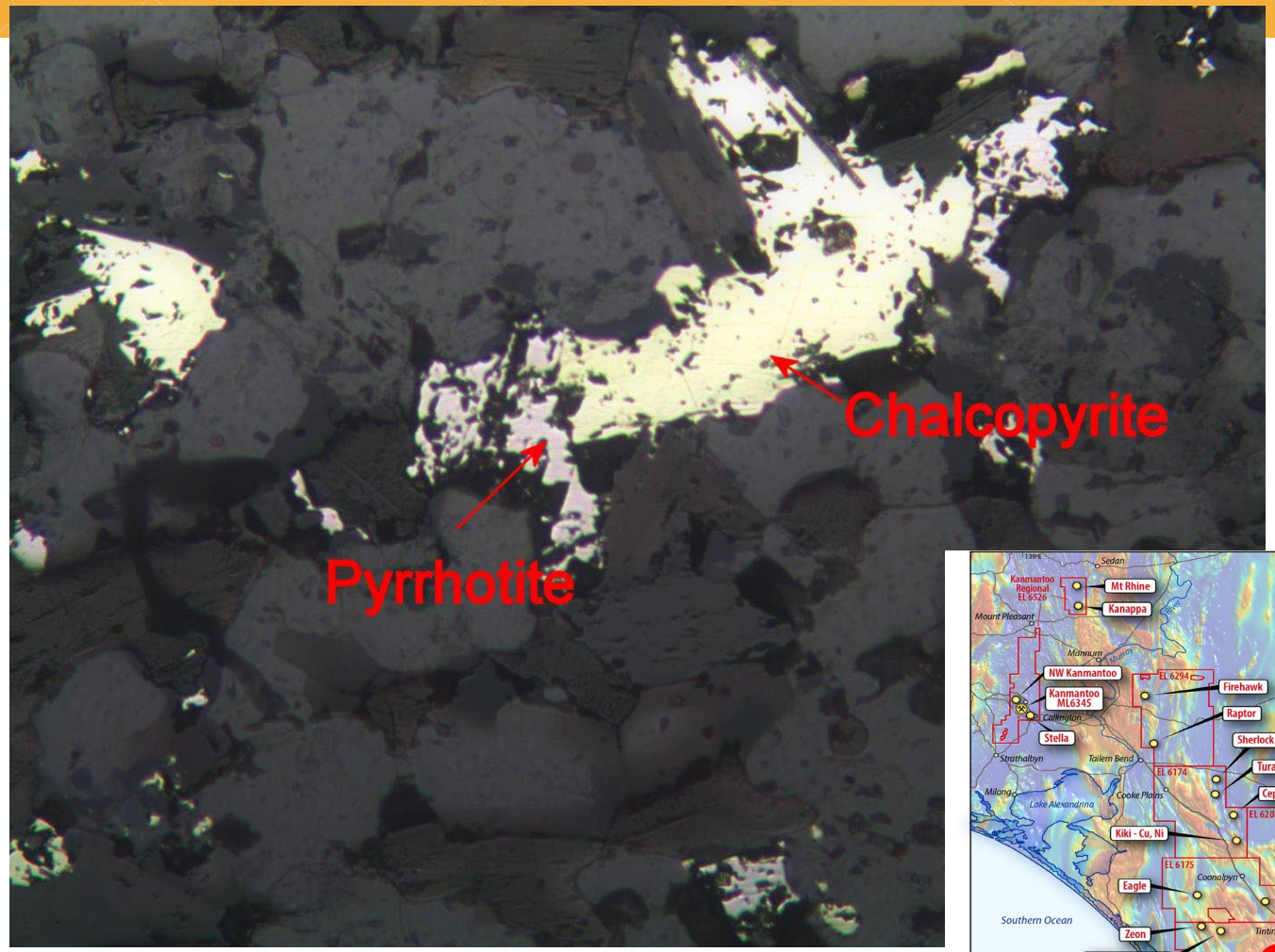
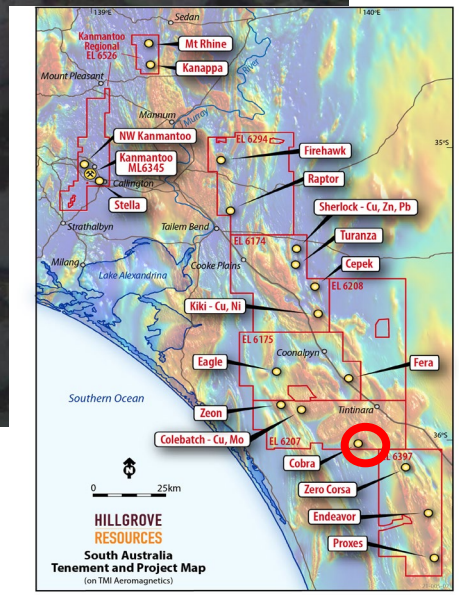
- Metasediments to biotite schist
- Garnet proximal to sulphides
- Retrograde thermal system including:
- K-feldspar
- Sericite (minor)
- Chlorite
- Epidote (major)
- Sulphides (pyrite, pyrrhotite, chalcopyrite)
- Carbonate
- Zeolite (Stilbite)



# Using the "Kanmantoo" style as a prospect ranking tool

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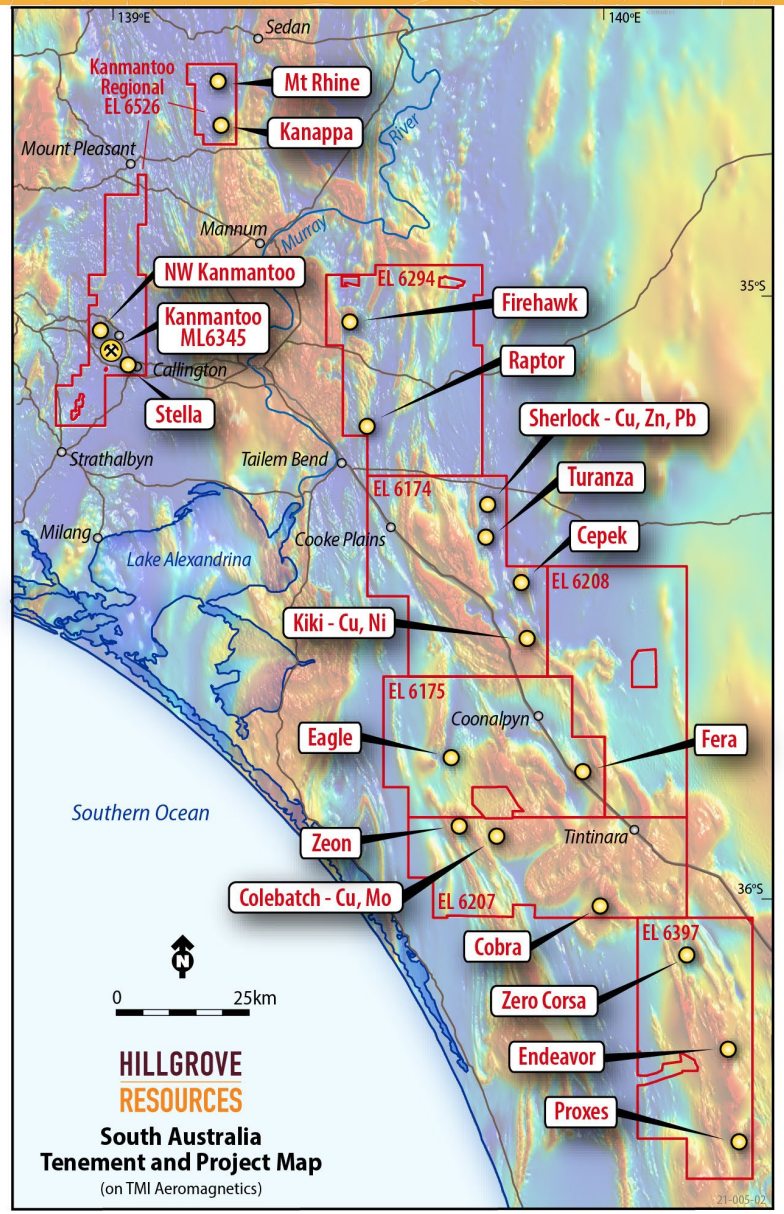
- Petrology has identified a number of prospects throughout the Kanmantoo Province with the same vein/alteration paragenesis
- The "Kanmantoo" model does explain the majority of the sediment hosted copper occurrences in the Kanmantoo Province
- There are many more sediment hosted prospects that are now prioritised by the application of this mineral model
- Some of these would not have been prioritised if based solely on Cu-Au-Zn-Pb assays of the auger/RAB/drill data
- Some of these prospects would not have been prioritised if prospects are weighted only by magnetic anomalism



# Are there other Cu-Au mineral styles possible?

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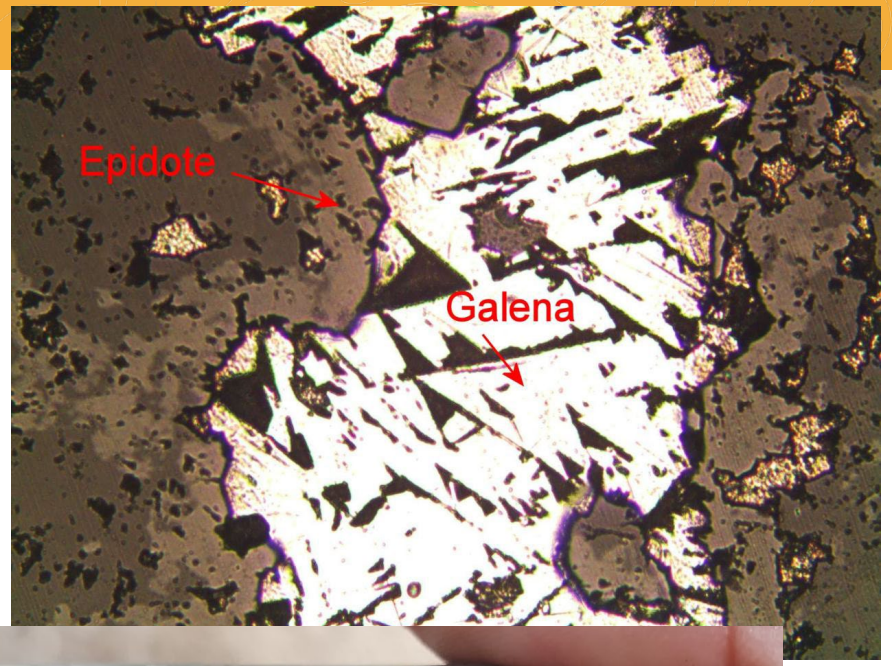
Not only has the Petrology has identified a number of prospects throughout the Kanmantoo Province with the same vein/alteration paragenesis as Kanmantoo, the petrology has also identified

- an Epithermal system in a diorite complex with
  - A paragenesis of K-feldspar, epidote, carbonate, galena
  - Low temperature textural characteristics

- an albite-carbonate vein system with Cu-Au (no Bi) in sediments
  - Post deformation, post metamorphism, post main Po/Cpy



# Kanmantoo Cu-Au UG Progress

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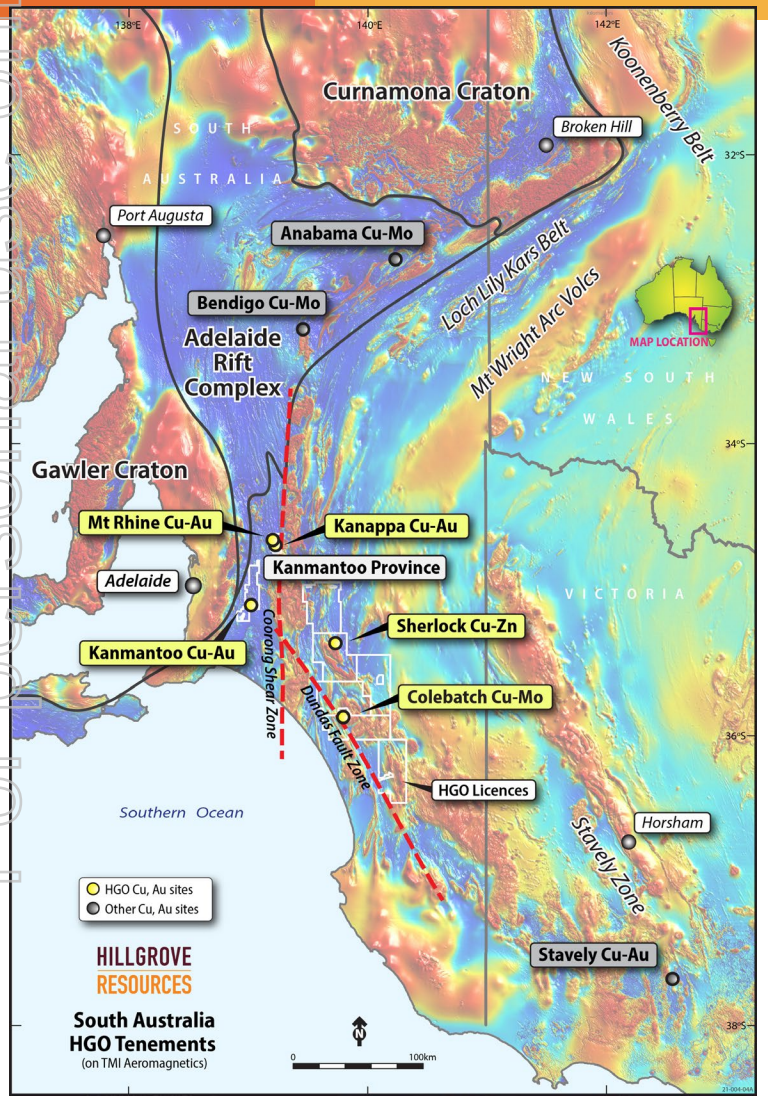
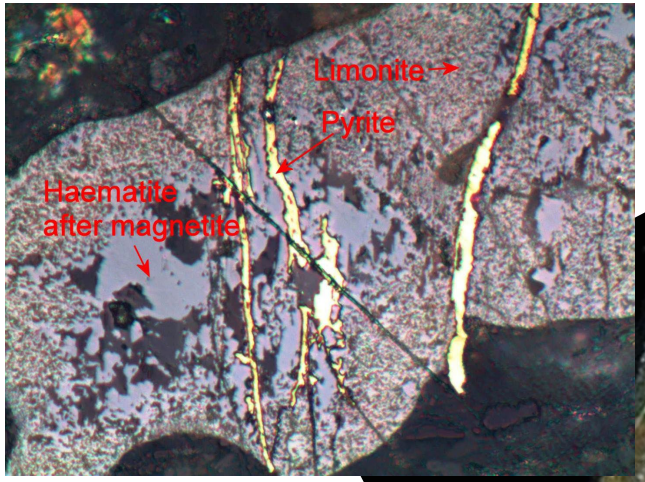
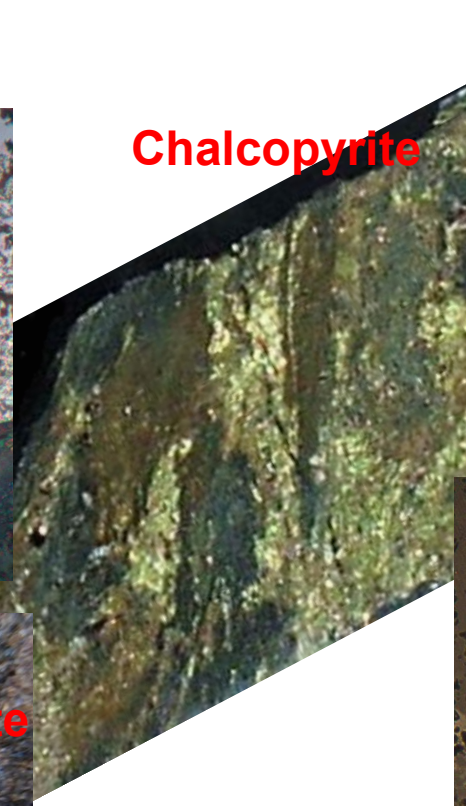
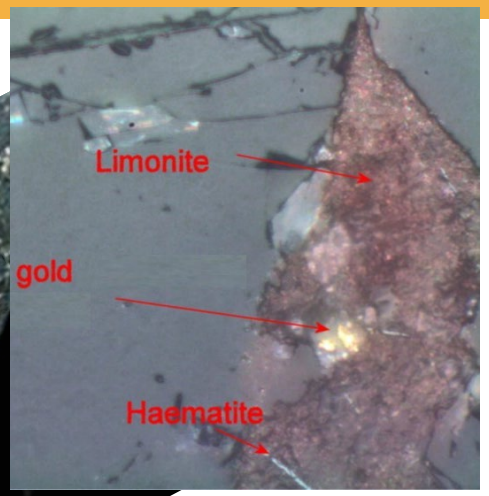
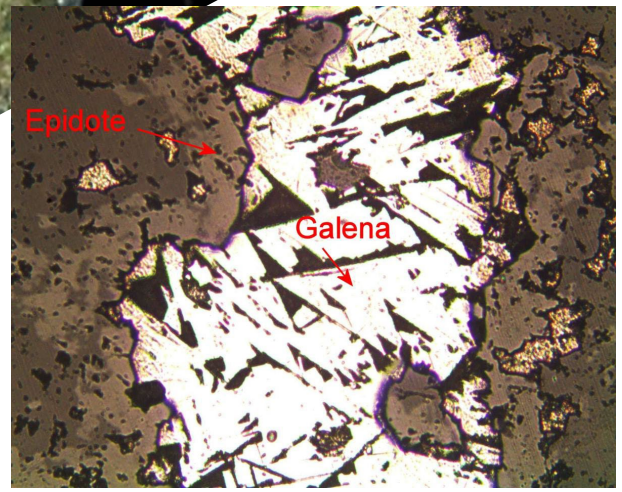
For the latest update see Lachlan Wallace' presentation to the Noosa Mining Conference of 10 November 2022

In the past year we have

- Increased Cu metal in resources by 120%
- Commenced both a decline and a ventilation drive
- Developing a face/core scanning system for predicting copper grades in production grade control
- Still drilling additional Cu-Au lodes at Emily, North Kavanagh on the Mine Lease and adjacent to existing UG resources

**Positioned to be Australia's next copper mine**

# THANK YOU

HILLGROVE RESOURCES

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