Regolith-Landforms and regolith geochemistry of the 'Tomahawk' Au-in-calcrete anomaly: Tunkillia, Gawler Craton, South Australia.

SMEDG/AIG Honours Bursary

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25th February 2010

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MINOTAUR

The Challenge:

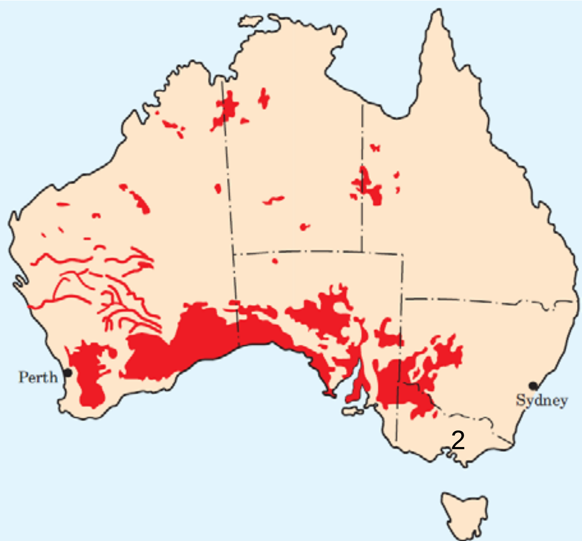
1. Aeolian Dunefields geochemistry is exotic to underlying substrate targeted in surficial mineral exploration

2. Calcrete exploration “Feeding Frenzy”

   - ❑ Not understanding the chemistry behind
   - ❑ Not always sampling true calcrete

3. Pedogenic carbonates cover ~21% Australia’s land surface

   - ❑Economically important deposits:
     - ❑Challenger
     - ❑>10 ppb Tunkillia Au-in-calcrete anomaly



The distribution of calcrete (red) and associated soils in Australia (Lintern 1997).

The Challenge:

'False anomalies'

- high Au content in carbonates
- NO underlying source of mineralisation

- At Tomahawk Au-in-calcrete anomaly:

  Previous exploration drilling programs, have failed to identify significant underlying mineralisation

This is an ideal setting to try and better constrain linkages between Au-in-calcrete and adjacent mineralisation sources

Findings

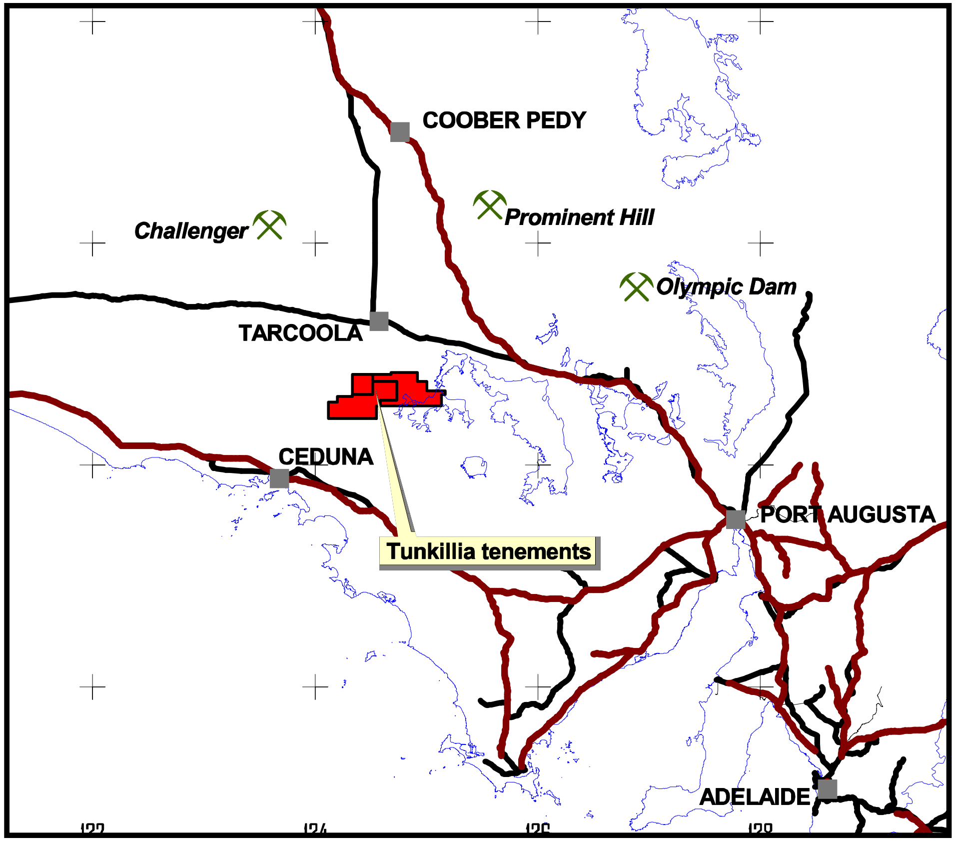
1. Palaeo- and contemporary landscape setting is CRUCIAL!

2. Multi-element calcrete analyses “optimises” this particular sampling technique

3. This ‘Tomahawk’ study **INTEGRATES** landscape setting and multi-element calcrete geochemistry to show a large component of the ‘Tomahawk’ Au-in-calcrete anomaly is transported

Tunkillia tenement Location & Land use

- ~660 km northwest of Adelaide, ~70 km south-southeast of Tarcoola
- Moderate access, 4WD vehicles essential
- Covered by well vegetated Pleistocene sand dunes



(Lowrey 2007)

Tunkillia Geological Setting

PALAEOPROTEROZOIC

~1730-1690 ma Yarlbrinda Shear Zone formation →Kimban Orogeny

~1690-1670 ma Host rocks: Tunkillia Suite granitoids intruded the crust

→Kararan Orogeny

MESOPROTEROZOIC

~1590-1575 ma Reactivation of the Yarlbrinda Shear Zone

Shearing and brecciating host rocks

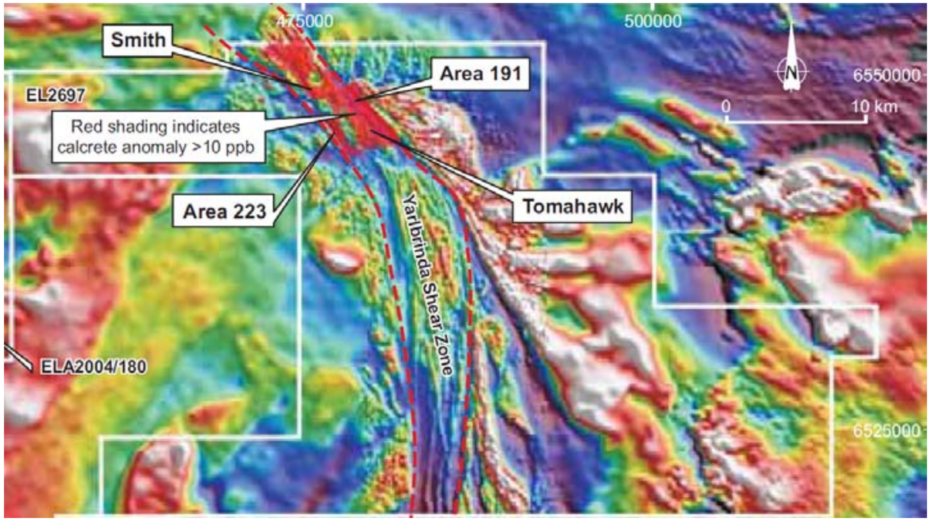
Mineralisation and demagnetisation is syn-deformational to main shearing event:

Most likely associated with a fluid influx from the syn-tectonic emplacement of Hiltaba Suite granites (~1590-1575 Ma) within the active YSZ

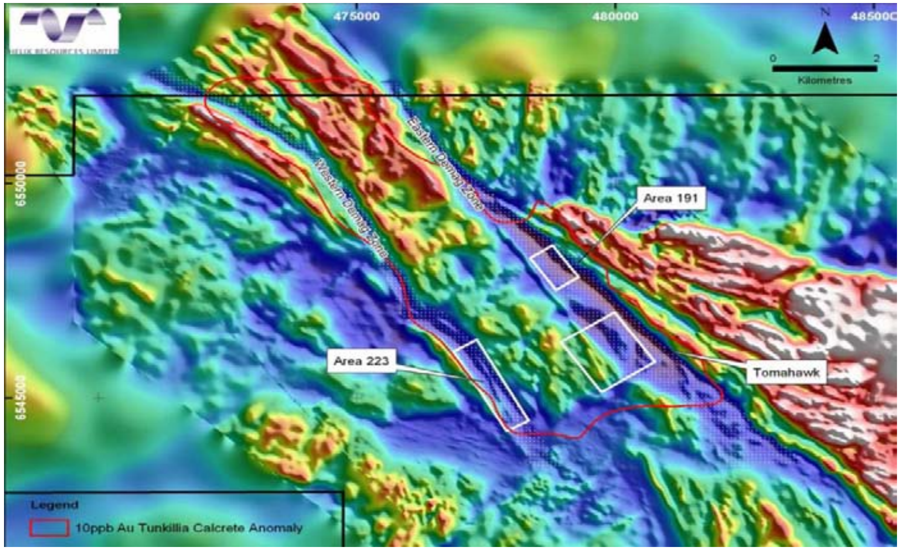
Fluids derived from granite mixed with low salinity metamorphic fluids at depth, and trapped at sites of fault intersections within the shear zone

Tunkillia known Mineralisation

- Gold is associated with pyrite and minor galena
- Hosted in striking 325^{o}/steep west dipping quartz-sulphide veins
  - Within chlorite-sericite alteration



(Martin & Wilson 2005)



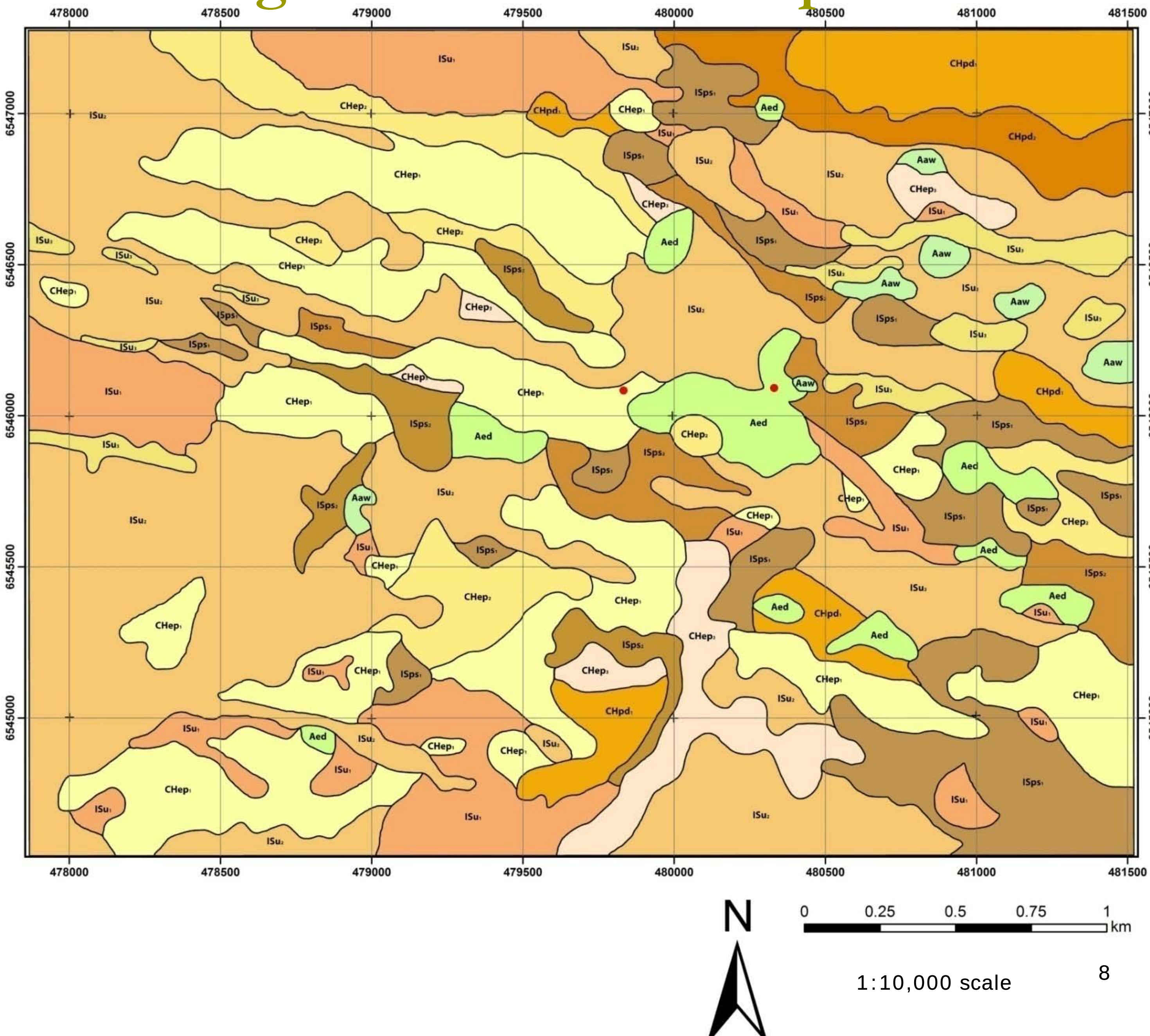
(Ferris & Wilson 2004)

- YSZ: Gravity LOW
- Eastern Demagnetised zone
- Western Demagnetised zone

Structure appears to be the dominant control on mineralisation

‘Tomahawk’ Regolith-Landform Map: Outcome

- Interpret surficial transport pathways
- Constrain dispersion/ deposition occurring
- To be used later to plot calcrete assay results spatially



1:10,000 scale

Aeolian Sediments

Dunefields	ISu₁	Red-brown, well sorted, fine to medium-grained quartzose sands with iron-oxide and clay cutans on a low relief, longitudinal dune. Open woodland dominated by *Acacia anuera, Eucalyptus socialis, Acacia ramulosa* and *Acacia ligulata* . Occasional *Eucalyptus concinnia* and *Casuarina pauper* with extensive, well developed surficial cryptogram crust on the soil surface.
	ISu₂	Light red-brown, well sorted, fine to medium-grained, quartzose sands with iron-oxide and clay cutans on a moderate relief, longitudinal dune. Open woodland dominated by *Eucalyptus socialis, Triodia irritans, Acacia ramulosa, Bossiaea walkeri* and *Triodia scariosa, Acacia ligulata* and *Acacia burkittii*. Moderate cover of surficial cryptogram crust on the soil surface.
	ISu₃	Brown to light red-brown, well sorted, fine to medium-grained quartzose sand with iron-oxide and clay cutans on a high relief, longitudinal dune. Mobile crests impinge on older ISu_1 and ISu_2 landforms, and therefore vegetation is partially covered by sand and characterises older landforms: Open woodland dominated by *Acacia ramulosa, Casuarina pauper, Bossiaea walkeri, Acacia aneura* and *herbs and tussock grasses.*
	ISps₁	Red-brown, moderate to poorly-sorted, fine to medium-grained, quartzose sand with iron-oxide cutans on a low-relief sand plain/dune swale. well developed cover of cryptogram crust on the soil surface. Open woodland dominated by *Eucalyptus concinnia* , *Maireana sedifolia* and *Cratystylis conocephala* . Occasional *Casuarina pauper* , *Acacia anuera* and *Acacia ligulata* .
	ISps₂	Red-brown, moderately to well-sorted, fine to medium-grained, quartzose sand with iron-oxide cutans on a low-relief sand plain/dune swale. Iron-oxide, lithic and quartz lag of <0.2cm. Open woodland dominated by *Casuarina pauper, Maireana sedifolia and Cratystylis conocephala.* Occasional *Eucalyptus concinnia, Acacia birkittii* and *Acacia ligulata.*
Alluvial Drainage	Aed	Red-brown, very fine to fine-grained, well sorted and well rounded consolidated clayey/silty soils, on a flat lying erosional drainage area. Minor medium-grained quartz and very high cover of cryptogram crust on the soil surface. Occasional minor calcrete and silcrete nodules, well rounded-sub rounded <2.0cm. Open woodland of dense thickets of *Acacia aneura* with occasional *Casuarina pauper* . Chenopod understorey of *Maireana sedifolia* , and *Acacia ligulata* .
	Aaw	Red-brown, very fine to fine-grained, well sorted consolidated clayey soils with very well developed cryptogram crust on the soil surface. Occasional rounded to sub-rounded calcrete and silcrete nodules <3.0cm. Chenopod shrubland of *Casuarina pauper* and *Acacia ligulata* , occasional *Acacia anuera* , *Maireana sedifolia* and well developed cover of cryptogram crust on the soil surface.

Age
Sorting
Relief
Vegetation

Vegetation
Crust cover

Sheetflow Sediments

Erosional Plains	CHep₁	Light brown to red, moderately sorted, fine to medium-grained quartzose sand with medium-grained sub-rounded quartz, iron-oxide <1.0cm and silcrete <2.0cm. High occurrence of sub-rounded to rounded 0.5-8.0cm nodular calcrete lag on a low relief landform dominated by sheetflow sedimentary transport and well developed cover of cryptogram crust on the soil surface. Open woodland dominated by *Casuarina pauper* and occasional *Eucalyptus concinnia* and *Acacia aneura* thickets, with chenopod shrubland understorey dominated by *Maireana sedifolia* , *Cratystylis conocephala* and *Senna artesmaides* .
	CHep₂	Red-brown to brown, moderately sorted, fine to medium-grained quartzose sand with angular to rounded silcrete lag <8.0cm on a low relief landform dominated by sheetflow sedimentary transport. Sub-rounded to rounded nodular calcrete lag <5.0cm, iron-oxides <2.0cm and a moderate cover of cryptogram crust on the soil surface. Chenopod shrubland dominated by *Maireana sedifolia, Cratystylis conocephala* and occasional *Casuarina pauper, Senna artesmaides* and *Acacia anuera.*
	CHep₃	Brown-red, well sorted, fine to medium-grained quartzose sand. Low relief landform dominated by sheetflow sedimentary transport with a well developed cover of cryptogram crust on the soil surface. Angular to sub-angular calcrete <5.0cm and shallow <50cm hardpan carbonates. Rounded iron-oxide and sub-angular to sub-rounded silcrete grains <1.0 to 6.0cm cm and sub-angular to sub-rounded vein quartz <3.0cm. Chenopod shrubland dominated by *Maireana sedifolia* , *Cratystylis conocephala, Casuarina pauper* , *Senna artesmaides* and *Acacia anuera* .
Depositional Plains	CHpd₁	Brown-red, well sorted, very fine to fine-grained, quartzose sand with coarse sand sized grains of sub-angular to rounded quartz, iron-oxide, lithic and carbonates on a colluvial sheetflow depositional plain. Occasional angular to sub-rounded carbonates from 1-5cm. Very well developed cover of cryptogram crust on the soil surface. Open woodland dominated by *Casuarina pauper* with occasional *Eucalyptus concinnia* . Chenopod understorey of *Maireana sedifolia* , *Cratystylis conocephala* , *Acacia ligulata* and *Senna artesmaides* .
	CHpd₂	Light brown to red, moderate to well sorted, very fine to fine-grained quartzose sand with medium sized grains of iron-oxide, quartz and sub-angular carbonates on a colluvial sheetflow depositional plain. Medium cover of cryptogram crust on the soil surface. Open woodland dominated by *Eucalyptus concinnia, Acacia ligulata, Senna artesmaides* and *Cratystylis conocephala* . Occasional *Eucalyptus socialis* , *Casuarina pauper* and *Maireana sedifolia* . More dense low lying vegetation than $CHpd_1$.

Colour
Vegetation
Surficial Lag

Saprolith

Saprolith	SMep	Small exposures of moderately weathered, *in situ* Quartz vein.

Regolith Profiles

- 11 detailed regolith profiles were logged along ‘Tomahawk’ anomaly transects to establish:
  - Typical weathering profile of ‘Tomahawk’ / Tunkillia
  - If weathering profile vary with depth and composition, and between aeolian dunes vs. palaeo/contemporary drainage

Did previous drilling achieve their target of reaching fresh basement?

- Drilling in some landform types finished short of fresh bedrock.
  - Ceased in saprock OR saprolite (Au-depleted zone above mineralisation)

Suggesting possibly that previous RAB drilling conducted in this area may not have sufficiently tested the anomaly.

Of the total 11 holes logged, 7 did not reach basement.

HOWEVER: Over time rock chips are subject to disintegration / degradation via weathering and climate controls, several metres may be missing due to wind or water erosion at surface

Previous Exploration:

1. Largely based on Au-only geochemical results.

- Limited consideration of multi-element expressions of mineralisation using:
  - Accessory and pathfinder elements
  - Major / secondary mineral host elements

Total of 98 RC's collected from surface on opportunistic basis

→ prepared and sent to Genalysis Lab Services, Adelaide

2. The only study at 'Tomahawk' to analyse full geochemical multi-element suite

12 Elements of Interest: Importance of multi-element analyses

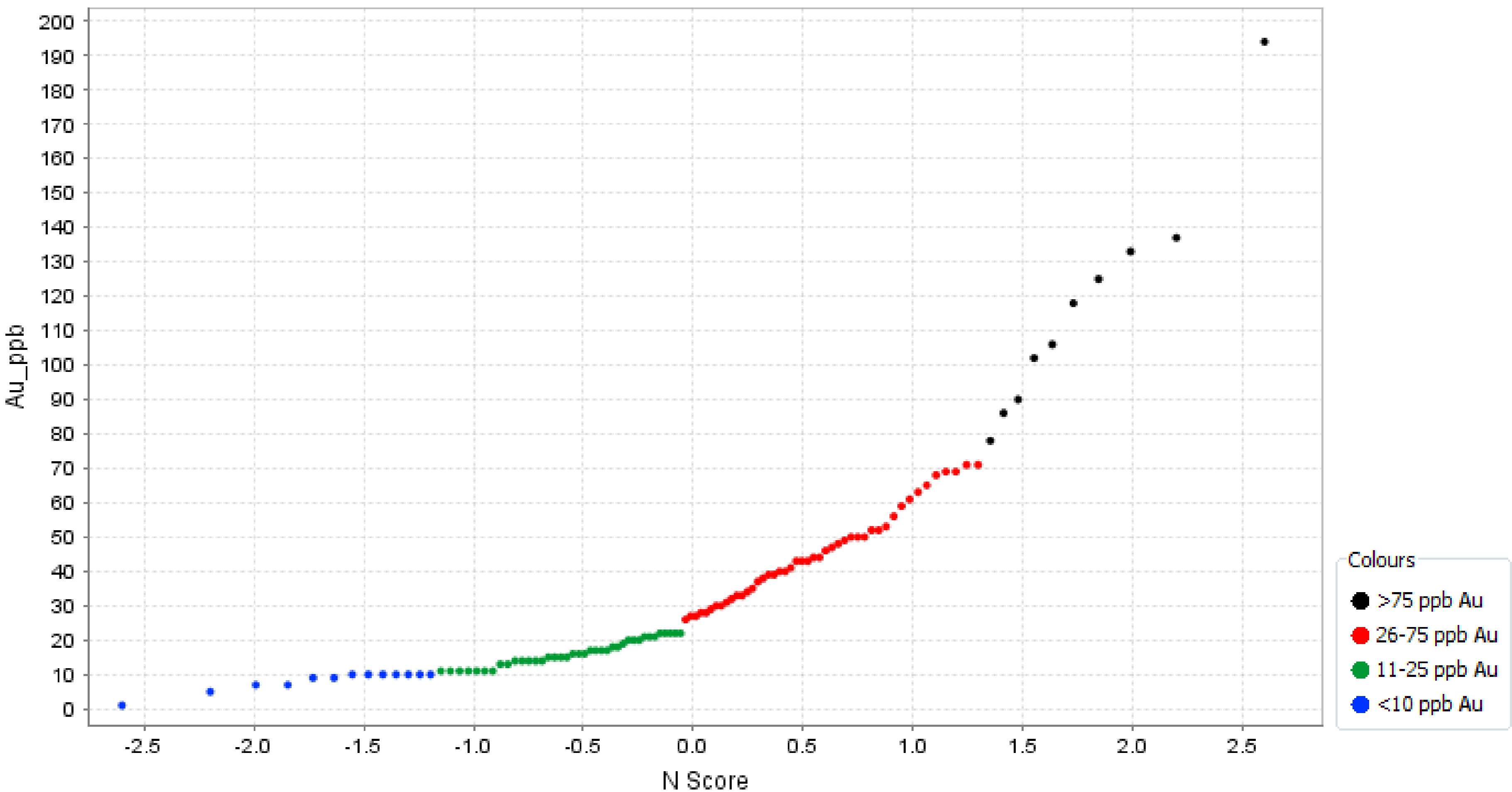
- Associated with mineralisation and known indicator elements (Au, Ag, Pb, Zn, Sb and La);

- Secondary trace element host minerals (Ca, Fe and Al);

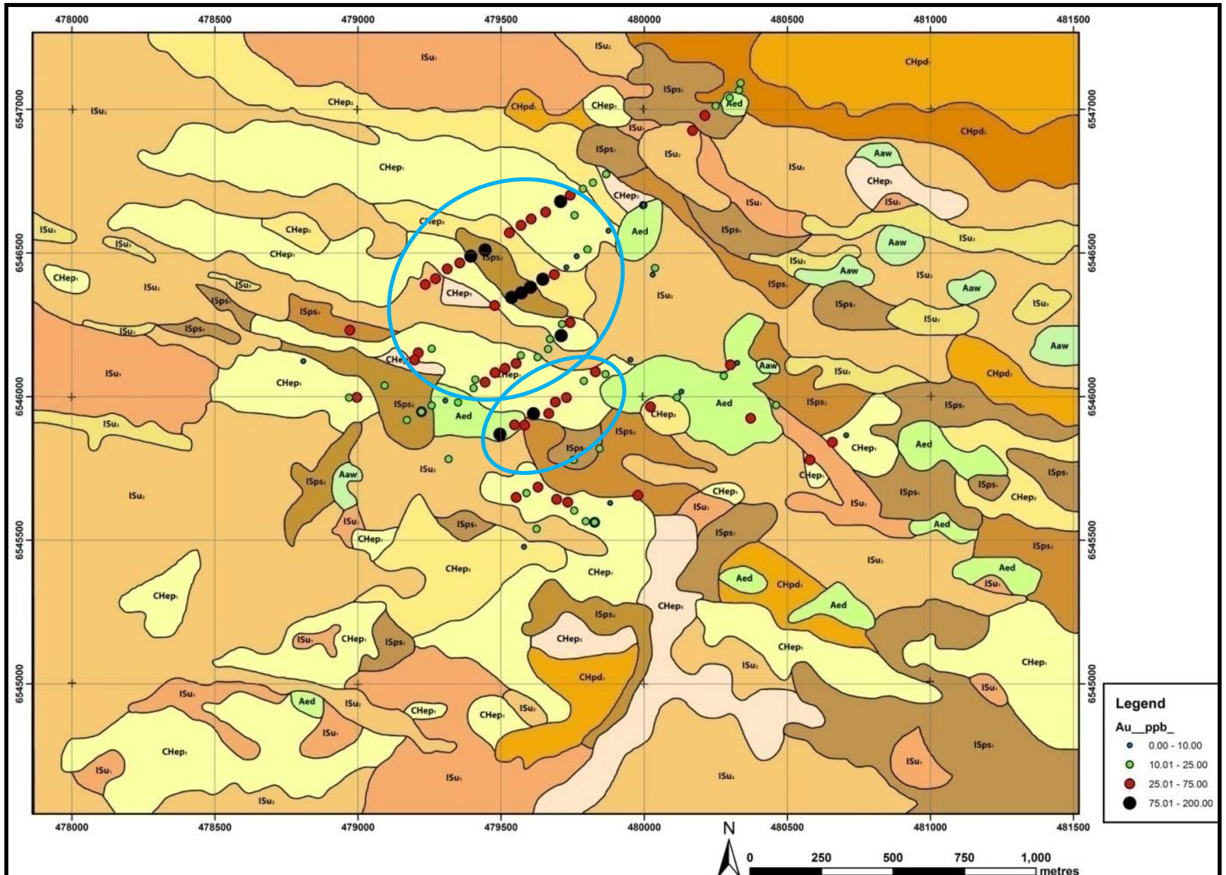
- Traditional pathfinder elements for Au from previous studies (As); and,

- Other commodities that could be prospective in the area (Cu and U).

Sub-populations for data analysis



Gold (Au)

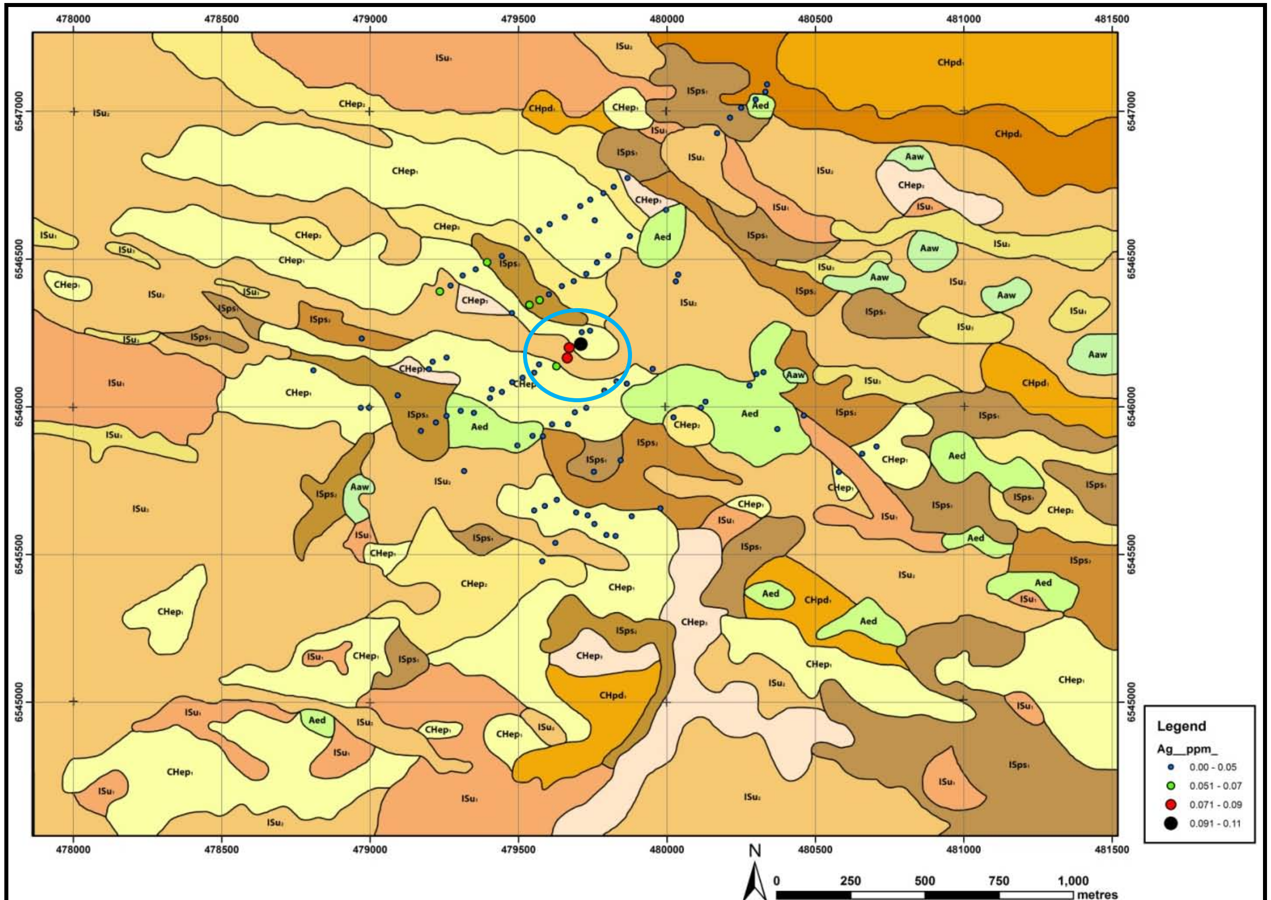


- Highest Au in $ISps_2$ unit surrounded by CHep
  - Lower margins of topography
  - Recently formed landforms revealing remnant underlying landform

→ **Palaeodrainage System**

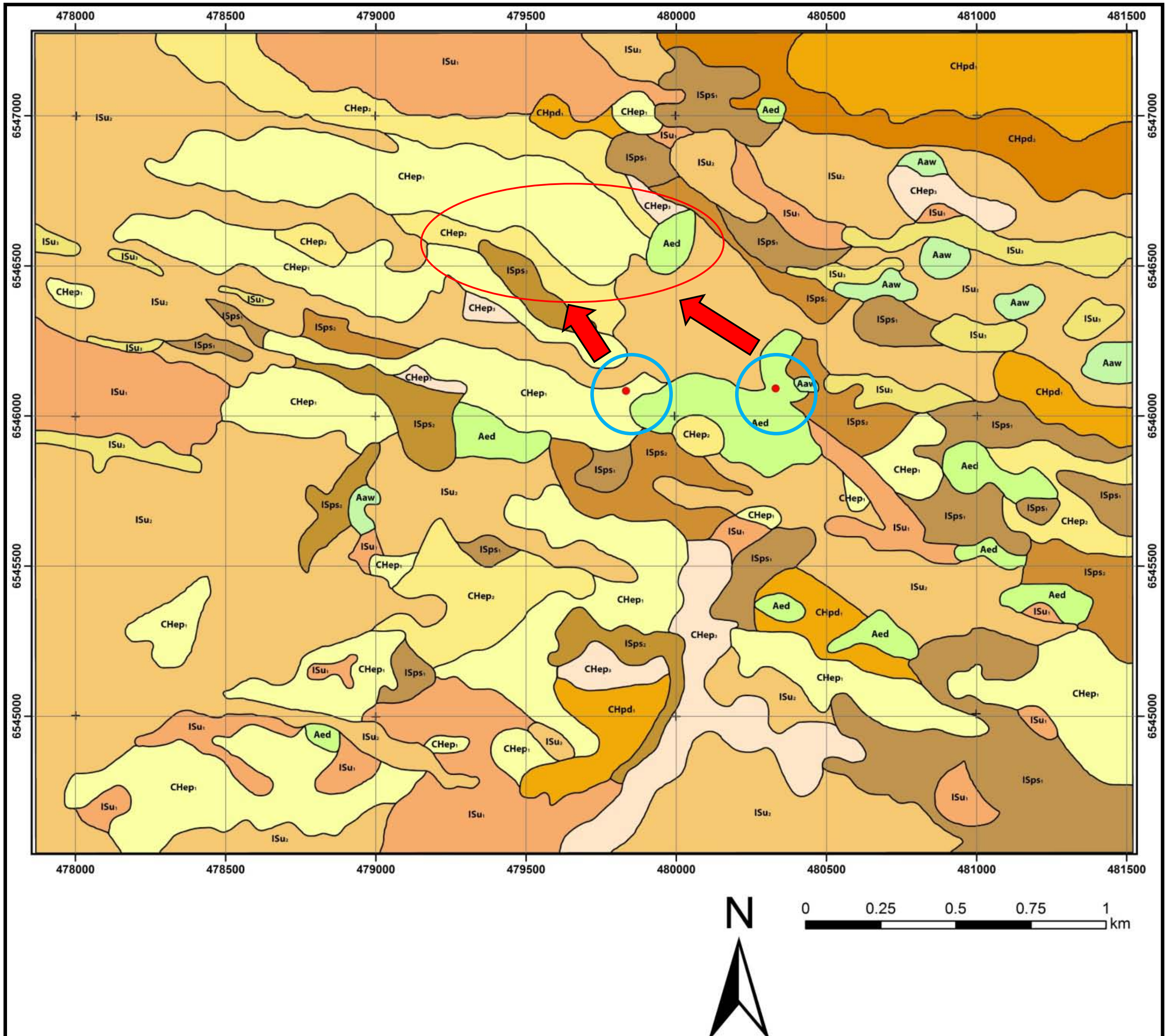
- Au mobilised/redeposited in the secondary environment

Silver (Ag)



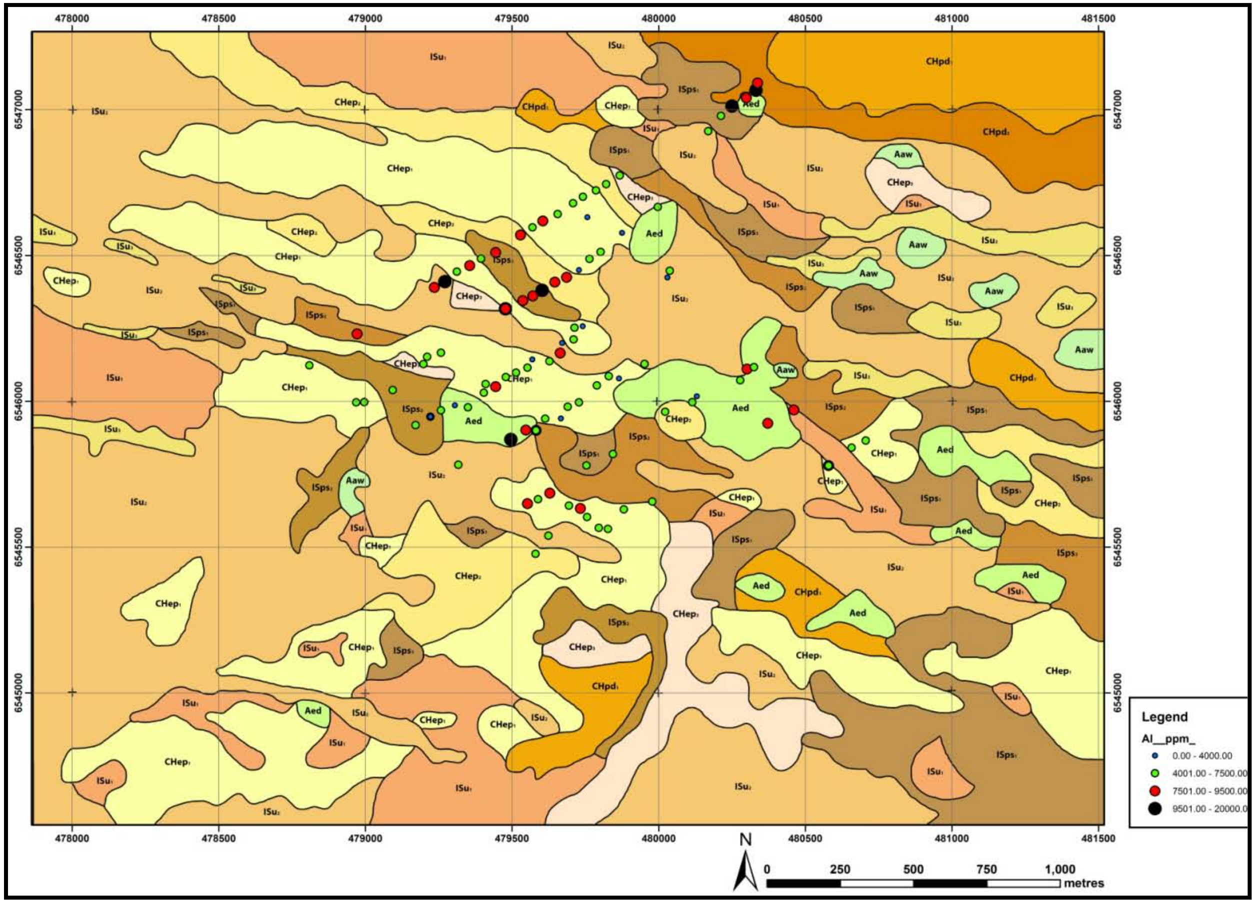
- Majority below analytical DL
- High Au and Ag CHep1
- Flanking to the SW:
  - Alteration halo associated/ surrounding Au mineralisation?
- Low Ag in calcrete samples is consistent with preferential leaching of Ag from primary mineralisation.

Ag has most likely been mobilised further north via palaeodrainage channels.



- Small exposures of weathered in situ quartz vein detected:
- Could be a source for the high Au and Ag values detected downslope

Aluminium (Al)



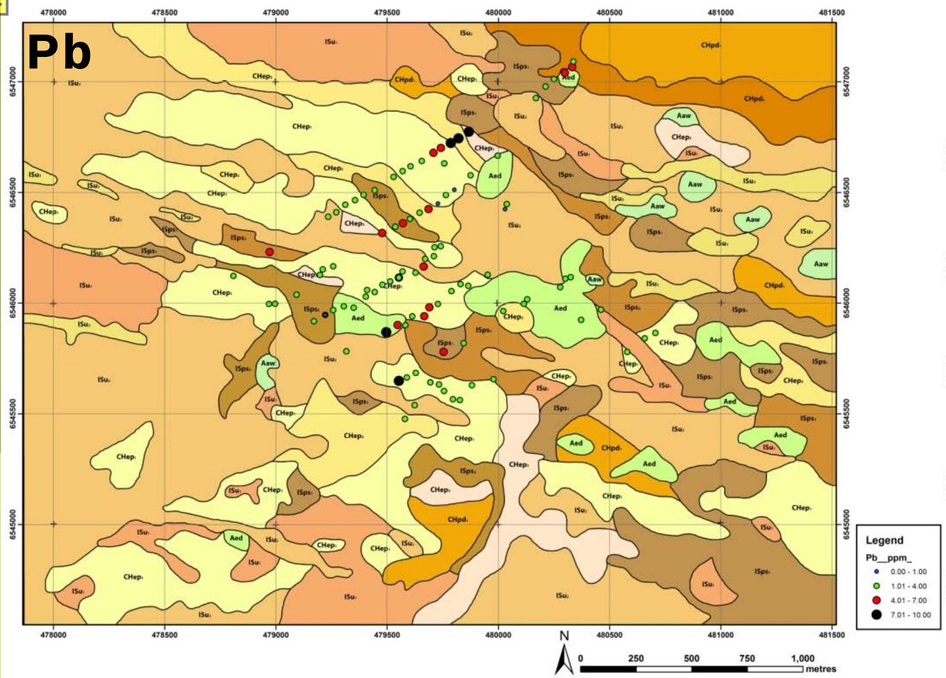
- Al in the secondary environment can be physically mobilised as Al-oxides (clay minerals)

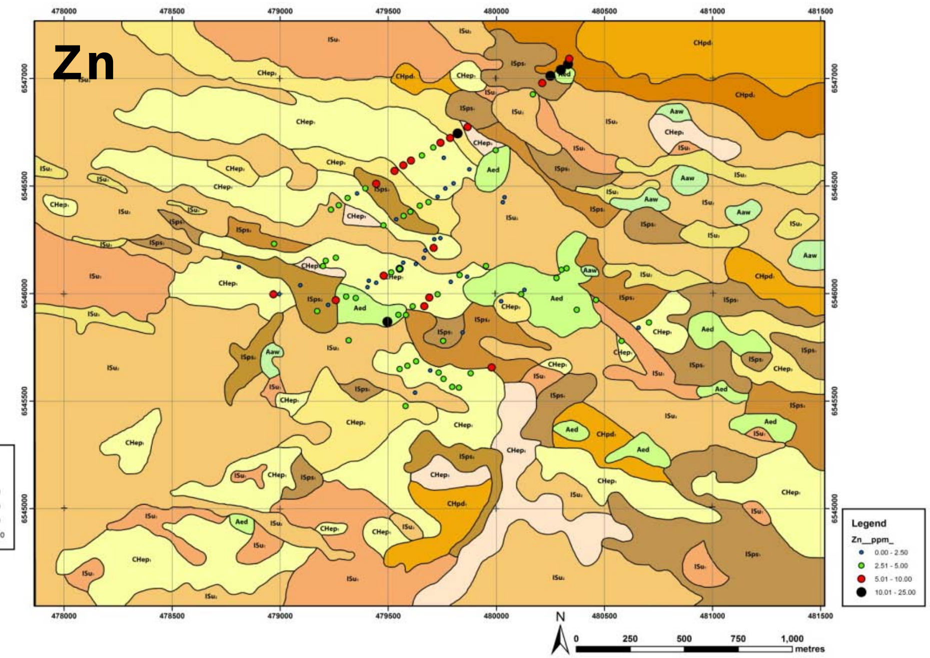
Central region concentrations occur from weathering of parent materials and subsequent movement of clay minerals via palaeochannels

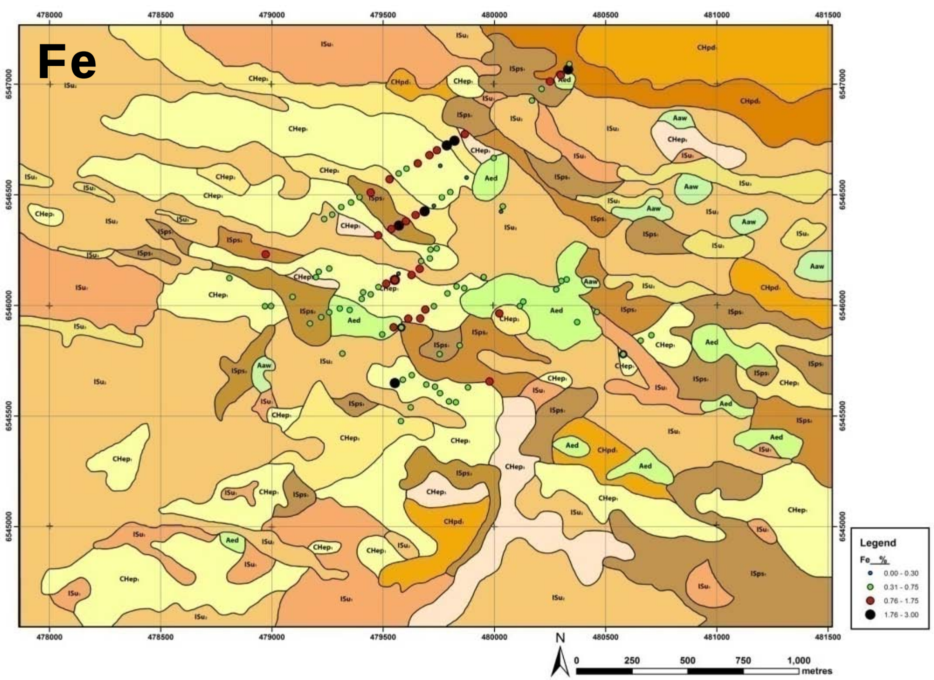
Lead, Zinc and Iron

- Elements associated with mineralisation:
  - Pb (galena PbS),
  - Zn (sphalerite (Zn,Fe)S)
  - Fe (pyrite Fe_2S)

- Poor relationships with the mineralised areas, however individual highs coincide with each other.

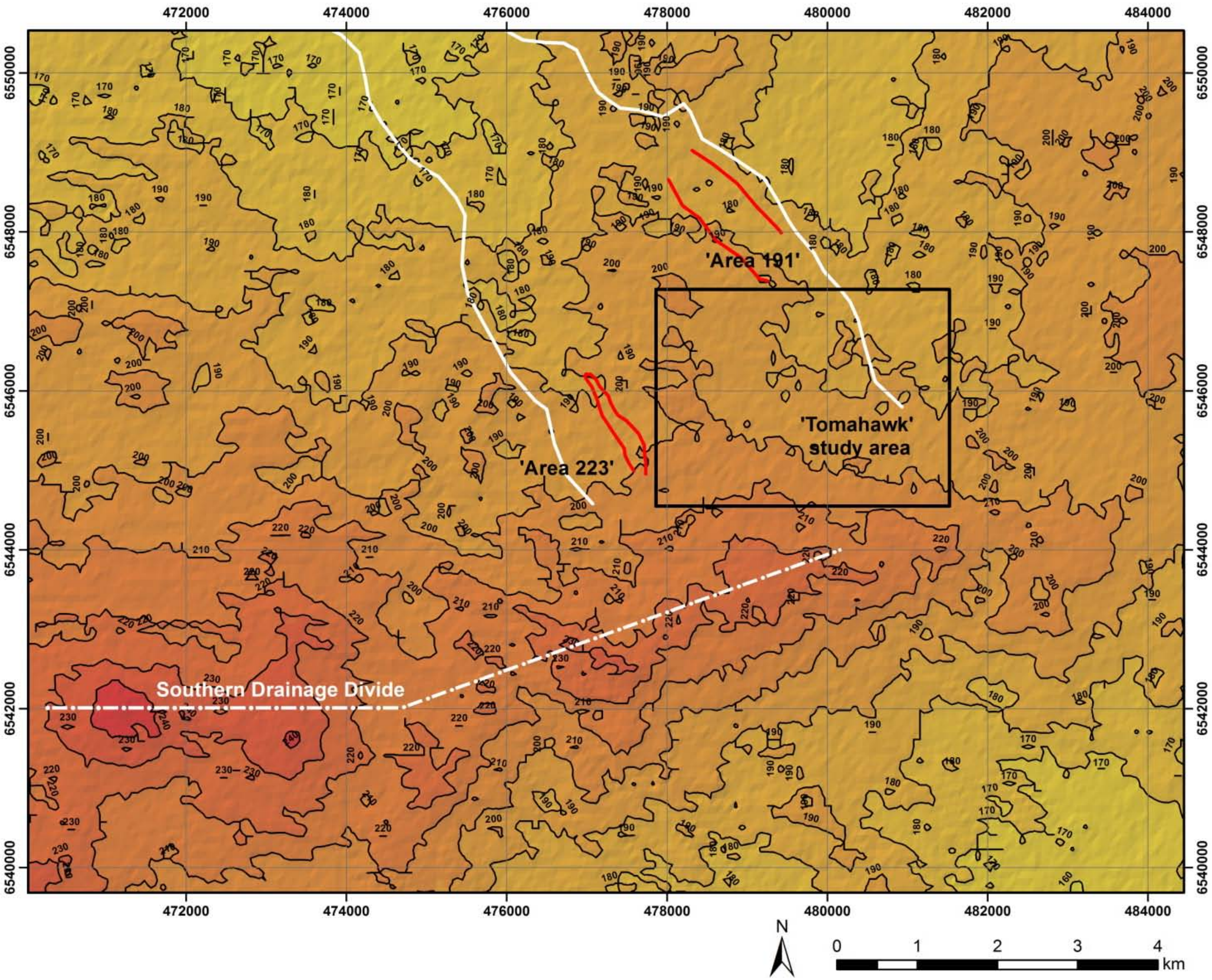






- **Fe-oxide hosted halo to the NE of a possible mineralisation source**
- **Pb is less mobile (more proximal to a sulphide source)**
- **Zn is more mobile (occurs further from source)**
- **All immobile**

Importance of Palaeolandscape:
The Southern Drainage Divide



- Dart, 2009
- Known bedrock-hosted mineralisation at Tunkillia occurs on the N side of a regional drainage divide.
- Elevation change ~220m to 190m.

Continued: Derivative Map

- Dart (2009) produced a symbolic overview of the drainage pathways at Tunkillia
- 'Tunkillia Central' palaeodrainage extended across 'Area 223' and followed the Au-in-calcrete anomaly.

Tunkillia Drainage Map

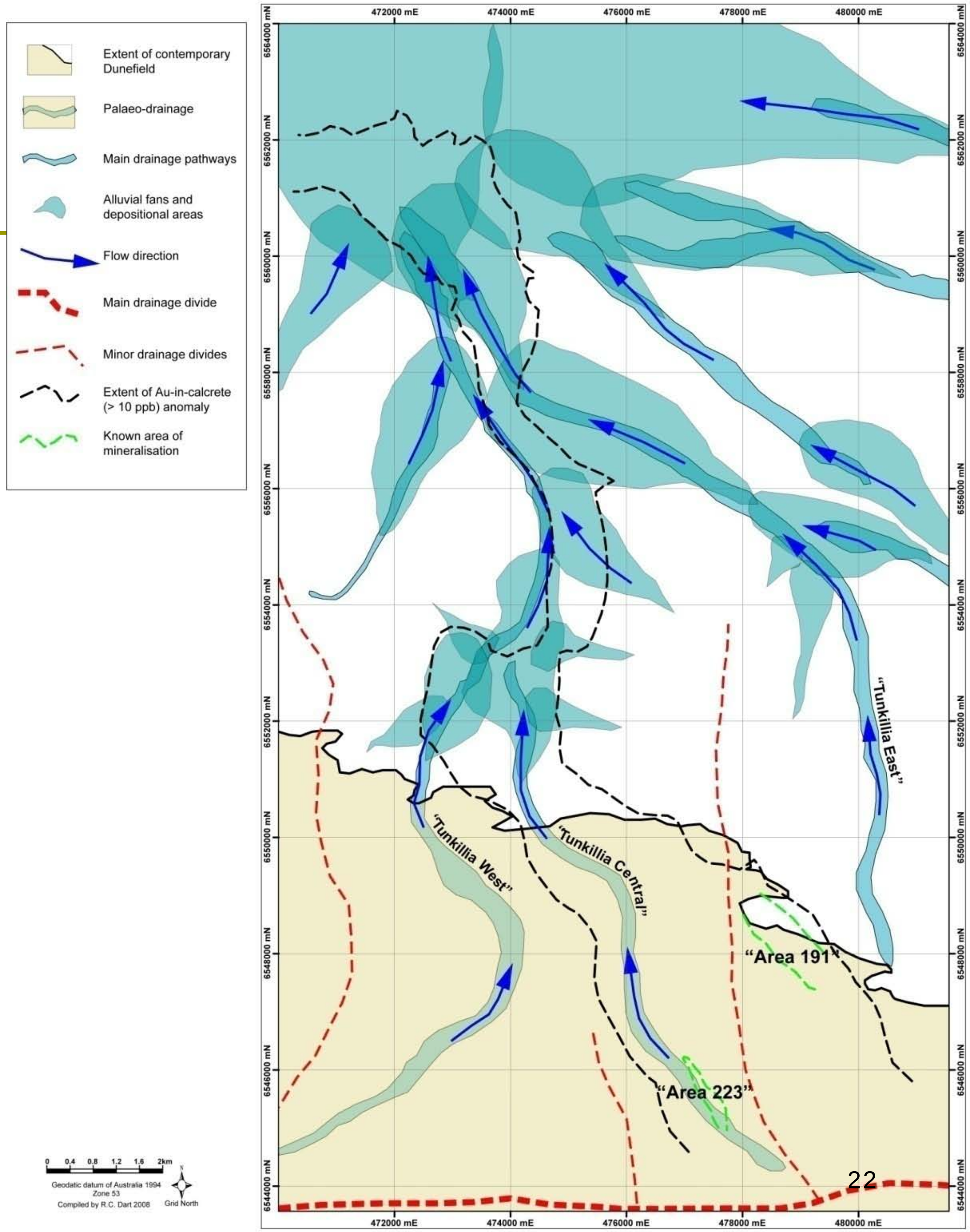
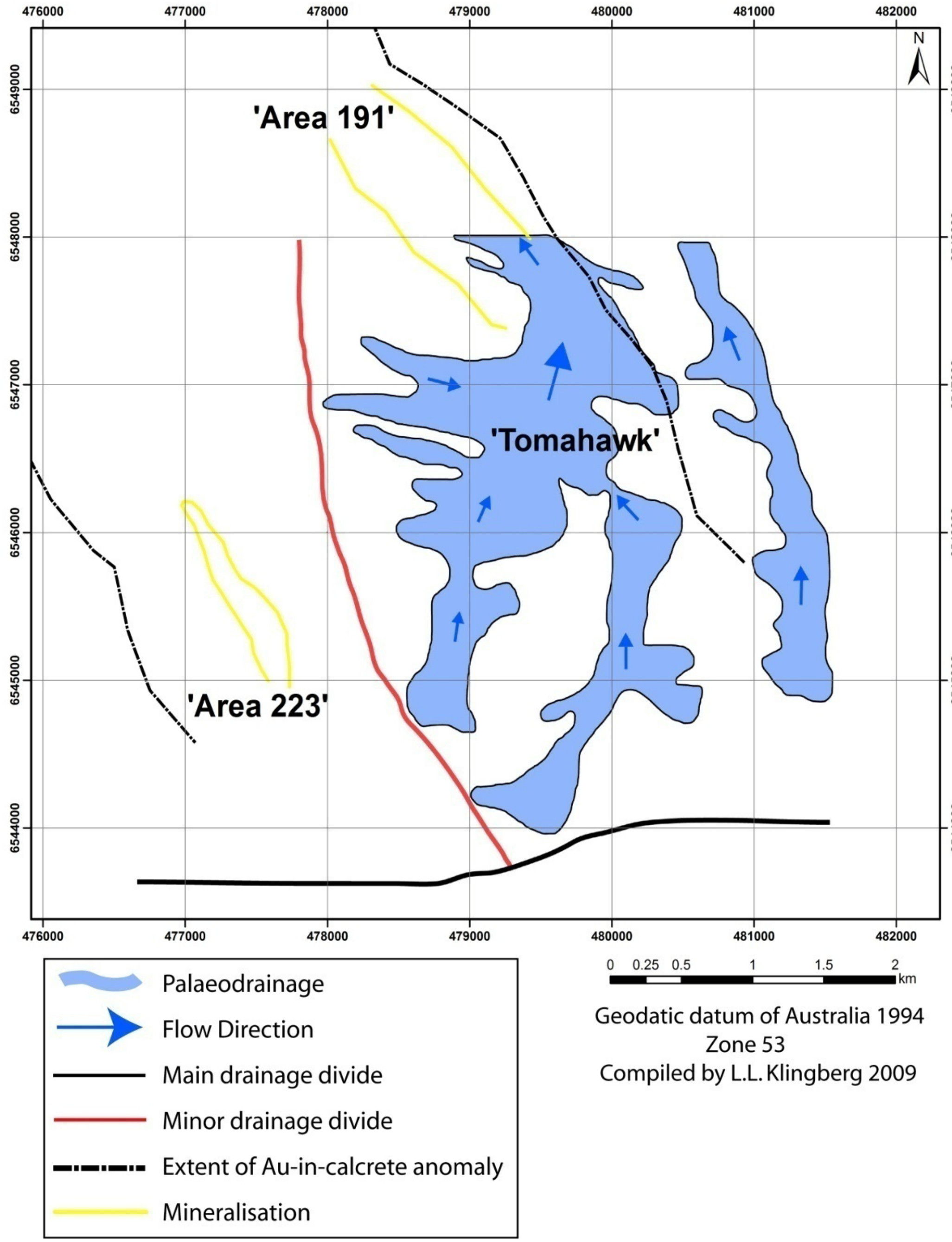
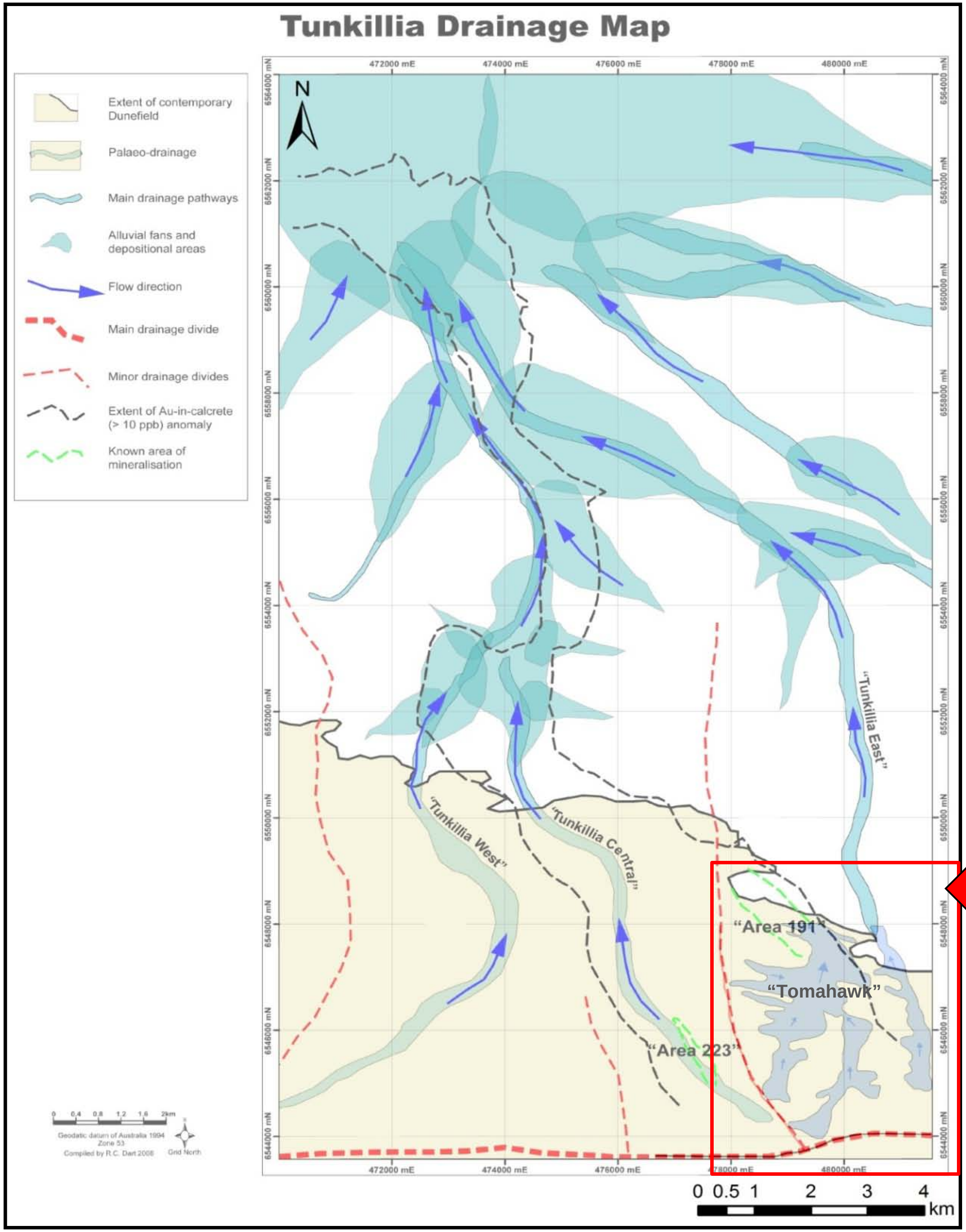


Figure 5.18: Symbolic overview of the drainage pathways at Tunkillia.

(Dart 2009)

TOMAHAWK DRAINAGE MAP

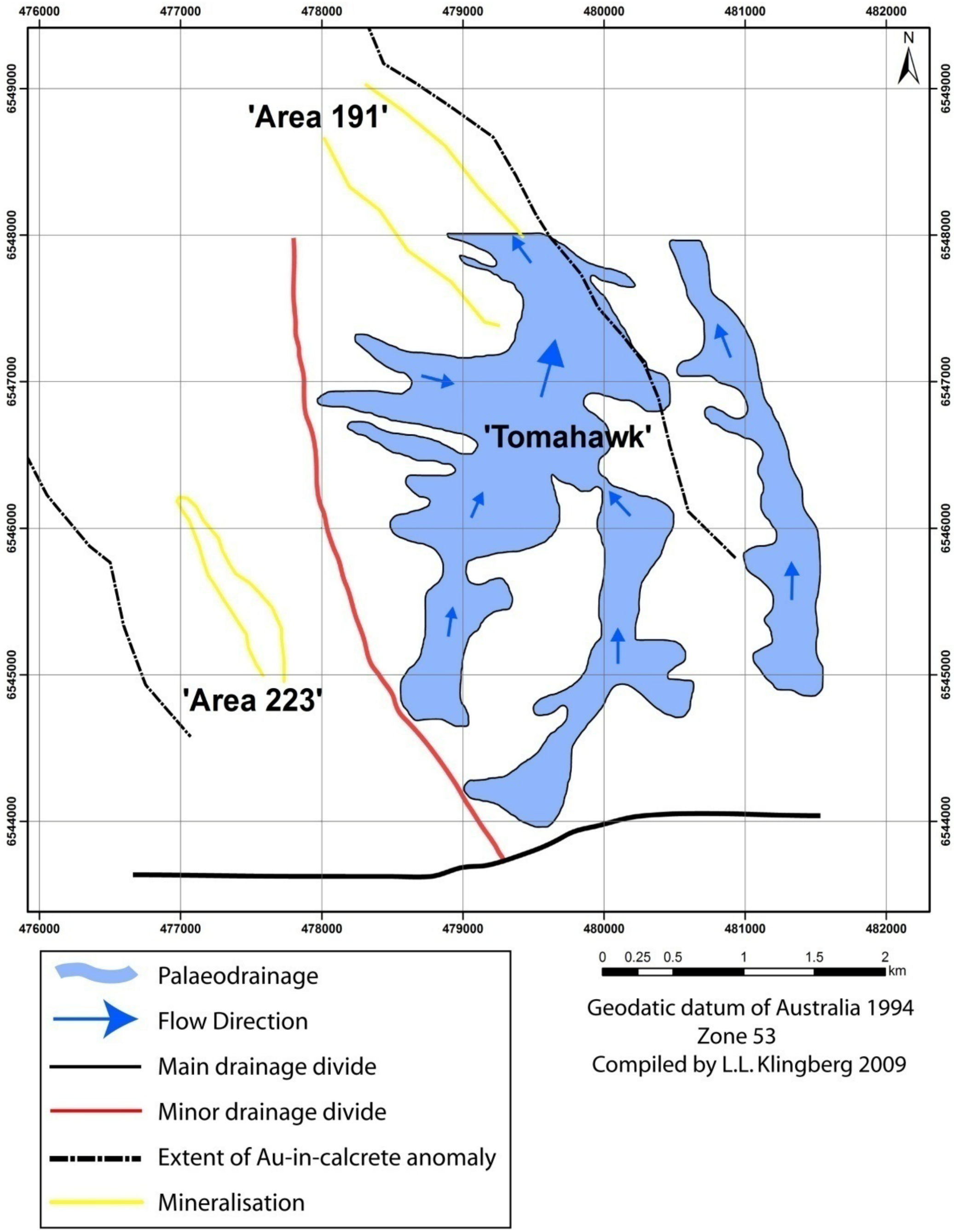




Building on Drainage Map from Dart (2009):

Detail added in this study:

TOMAHAWK DRAINAGE MAP



- ‘Tomahawk’ is associated with a low lying area
- A point of low, broad mixing and confluence of several palaeodrainage channels
- Origin: southern drainage divide
- Provenance: northwards
- Dart (2009), suggested that ‘Tomahawk’, southeast of ‘Area 191’, is potentially **up**-palaeo slope

In Summary:

1. Palaeo- and contemporary landscape setting is CRUCIAL!
   - Regolith-landform mapping
   - Landscape Evolution → has identified weathering and transportation of material to the North along the palaeo- and contemporary drainage

2. Multi-element calcrete analyses “optimises” the technique
   - Rather than the previous Au-only approach
   - Can define secondary Au geochemical signatures
   - Useful elements associated with mineralisation: Au, Pb, Zn, Fe

Continued…

3. The ‘Tomahawk’ study INTEGRATES landscape setting and multi-element calcrete geochemistry to show a large component of ‘Tomahawk’ Au-in-calcrete anomaly is transported

- It provides a means for lateral dispersion of Au from mineralised zones
  - →explains why ‘Tomahawk’ is a ‘spatially large’ Au-in-calcrete anomaly

Further exploration needs to be conducted between the main southern drainage divide and ‘Tomahawk’ study area (i.e. further SE) to fully test the anomaly, and possibly locate a source of mineralisation.

References

- Anand R. R., Phang C., Wildman J. E. & Lintern M. J. 1997. Genesis of some calcretes in the southern Yilgarn Craton, Western Australia: implications for mineral exploration. *Australian Journal of Earth Sciences* **44**, 87-103.
- Belperio A. 2006. Advancing Tunkillia. Paper presented at Paydirt's Gold Conference, Perth, Western Australia (unpubl.).
- Benbow M. C., Alley N. F., Callen R. A. & Greenwood C. R. 1995. Tertiary: Geological History and Palaeoclimate. *In:* Drexel J. F. & Preiss W. V. eds. *The Geology of South Australia. Volume 2, The Phanerozoic*, pp. 208-218. **54** Geological Survey. Bulletin, South Australia.
- Butt C. R. M., Lintern M. J. & Anand R. R. 2000. Evolution of regoliths and landscapes in deeply weathered terrain - implications for geochemical exploration. *Ore Geology Reviews* **16**, 167-183.
- Carver R. N., Chenoweth L. M., Mazzucchelli R. H., Oates C. J. & Robbins T. W. 1987. "Lag" - A Geochemical Sampling Medium for Arid Regions *Journal of Geochemical Exploration* **28**, 183-199.
- Chen X. Y., Lintern M. J. & Roach I. C. 2002. Calcrete: characteristics, Distribution and Use in Mineral Exploration. *Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC LEME), Canberra, Australia*, 170.
- Crocker R. L. 1946. *Post-Miocene climatic and geologic history and its significance in relation to the genesis of the major soil types of South Australia*. CSIRO (Commonwealth Scientific and Industrial Research Organization), Melbourne, Victoria, Australia.
- Dart R. 2009. Gold-in-calcrete: A continental to profile scale study of regolith carbonates and their association with gold mineralisation. PHD Thesis, University of Adelaide (unpublished) South Australia.
- Dart R. C., Barovich K. M. & Chittleborough D. 2005. Pedogenic carbonates, strontium isotopes and their relationship with Australian dust processes. *In:* Roach I. C. ed. *Regolith 2005 - Ten Years of CRC LEME.* CRC LEME, pp. 64-66.
- Dart R. C., Barovich K. M., Chittleborough D. J. & Hill S. M. 2007. Calcium in regolith carbonates of central and southern Australia: Its source and implications for the global carbon cycle. *Palaeogeography, Palaeoclimatology, Palaeoecology* **249**, 322-334.
- Eggleton R. A. ed. 2001. *The Regolith Glossary: surficial geology, soils and landscapes.* CRC LEME, Perth.
- Ferris G. & Wilson M. 2004. Tunkillia Project - Proterozoic shear-zone-hosted gold mineralisation within the Yarlbrinda Shear Zone. *MESA Journal* **35**, 6-12.
- Ferris G. M. & Schwarz M. 2004. Definition of the Tunkillia Suite, western Gawler Craton. *MESA Journal* **34**, 32-41.
- Flint R. B. 2005. Tunkillia joint venture opportunity for Minotaur / Oxiana into tenements ELs 2697 & 2854, ELA 2994/180 held by Helix Resources. Minotaur Exploration Adelaide, SA.
- Gibbons L. 1997. Regolith study of the Old Well gold prospect, Tarcoola District, Gawler Craton. The University of Adelaide, Adelaide (unpubl.).
- Gibbons S. & Hill S. M. 2005. Regolith carbonates of the Tibooburra/Milparinka Inliers, northwest NSW: characteristics, regional geochemistry and minerals exploration implications. *In:* Roach I. C. ed. *Regolith 2005 - Ten years of CRC LEME* CRC LEME, pp.107-111.
- Goudie A. S. 1983. Calcrete. *In:* Goudie A. S. & Pye K. eds. *Chemical sediments and geomorphology; precipitates and residua in the near-surface environment*, pp. 93-131. Academic Press, London.
- Gray D. & Pirlo M. 2004. Geochemistry of Groundwaters at Tunkillia: Similarities and differences to Yilgarn Craton Groundwaters. *In:* Roach I. C. ed. *Regolith 2004.* CRC LEME, pp. 103-106.
- Gray D. & Pirlo M. 2005. Hydrogeochemistry of the Tunkillia Gold Prospect, South Australia. CRC LEME open file report 194, CRC LEME, Bentley.
- Gray D. J. & Lintern M. J. 1998. Chemistry of gold in soils from the Yilgarn Craton, Western Australia, pp 209-221. *In:* Eggleton R. A. ed. *The state of the regolith. Proceedings of the second Australian conference on landscape evolution and mineral exploration* Geological Society of Australia Special Publication, Brisbane.
- Hand M., Reid A. & Jagodziniski L. 2007. Tectonic Framework and Evolution of the Gawler Craton, Southern Australia. *Economic Geology* **102**, 1377-1395.
- Hesse P. P. & McTainsh G. H. 2003. Australian dust deposits: modern processes and the Quaternary record. *Quaternary Science Reviews* **118-119**, 87-102.
- Hill S. M., Greenfield J. E., Gilmore P. G. & Reid W. J. 2008. Guide for mineral exploration through and within the regolith in the southwestern Thomson Orogen, New South Wales.
- Hill S. M., McQueen K. G. & Foster K. A. 1999. Regolith carbonate accumulations in Western and Central NSW: characteristics and potential as an exploration sampling medium. *In:* Taylor G. M. & Pain C. F. eds. *State of the Regolith. Proc. Regolith 98*, pp. 191-208.
- Hou B., Frakes L. A., Sandiford M., Worrall L., Keeling J. L. & Alley N. F. 2008. Cenozoic Eucla Basin and associated palaeovalleys, southern Australia - Climatic and tectonic influences on landscape evolution, sedimentation and heavy mineral accumulation. *Sedimentary Geology* **203**, 112-130.

- Jarvis A., Reuter H. I., Nelson E. & Guevara E. 2006. Hole-filled seamless SRTM data V3. Online <http://srtm.csi.cgiar.org>
- Lane R. & Worrall L. 2002. Gawler Craton mineral promotion project: Interpretation of Airborne Electromagnetic Data Summary report on The Tunkillia Workshop.
- Levinson A. A. 1974. *Introduction to Exploration Geochemistry*. Applied publishing, Ltd., Calgary, Alberta, Canada.
- Lintern M. J. 1997. Calcrete sampling for gold exploration. *MESA Journal* **5**, 5-8.
- Lintern M. J., Butt C. R. M. & Scott K. M. 1997. Gold in vegetation and soil - three case studies from the goldfields of southern Western Australia. *Journal of Geochemical Exploration* **58**, 1-14.
- Lintern M. J., Sheard M. J. & Chivas A. R. 2006. The source of pedogenic carbonate associated with gold-calcrete anomalies in the western Gawler Craton, South Australia. *Chemical Geology* **235**, 299-324.
- Lowrey J. R. 2007. Plant Biogeochemical expression of Au-Mineralisation buried by an aeolian dunefield: Tunkillia, South Australia. The University of Adelaide, Adelaide (unpubl.).
- Lowrey J. R. & Hill S. M. 2006. Plant biogeochemistry of Au-mineralisation buried by an aeolian dunefield: Tunkillia, SA. *In:* Fitzpatrick R. W. & Shand P. eds. *Regolith 2006 - Consolidation and Dispersion of Ideas* CRC LEME, pp. 217-220.
- Martin A. R. & Wilson M. H. 2005. Project Proposal: Lake Everard collaborative drilling program, drill testing of IP anomalies. Helix Resources Limited, Perth, WA.
- Mayo A. M. & Hill S. M. 2005. Mineral exploration through an aeolian dunefield near Wudinna, Gawler Craton, South Australia: a framework of plant biogeochemistry and geobotany. *In:* Roach I. C. ed. *Regolith 2005 - Ten Years of CRC LEME.* CRC LEME, pp. 223-228.
- McQueen K. G., Hill S. M. & Foster K. A. 1999. The nature and distribution of regolith carbonate accumulations in southeastern Australia and their potential as a sampling medium in geochemical exploration. *Journal of Geochemical Exploration* **67**, 67-82.
- Meteorology B. O. 2009a. Climate statistics for Australian locations: Summary statistics for Tarcoola. Online
- <http://www.bom.gov.au/climate/averages/tables/cw_016044.shtml>
- Meteorology B. O. 2009b. Climate statistics for Australian locations: Summary statistics for Tarcoola Aero. Online
- <http://www.bom.gov.au/climate/averages/tables/cw_016098.shtml>
- Pillans B. 2005. Geochronology of the Australian Regolith. *In:* Anand R. R. & De Broekert P. eds. *Regolith landscape evolution across Australia*, pp. 41-52. CRC LEME, Perth.
- Pillans B. 2007. Pre-Quaternary landscape inheritance in Australia. *Journal of Quaternary Science* **22**, 439-447.
- Reimann C., Ayras M., Chekushin V., Bogatyrev I., Boyd R., Caritat P., de Dutter R., Finne T. E., Halleraker J. H., Jaeger O., Kashulina G., Lehto O., Niskavaara H., Pavlov V., Raisanen M. L., Strand T. & Volden T. 1998. *Environmental Geochemical Atlas of the Central Barents Region*
- Norges Geologiske Undersokelse, Geological Survey of Norway, Trondheim, Norway.
- Reis A. P., Sousa A. J. & Cardoso Fonseca E. 2001. Soil geochemical prospecting for gold at Marrancos (Northern Portugal). *Journal of Geochemical Exploration* **73**, 1-10.
- Rogers P. A. & Zang W. 2006. Guide to the sedimentary cover of the Central Gawler Craton, South Australia (with special emphasis on the Harris Greenstone Belt region). Government of South Australia, Primary Industries and Resources SA, Report Book, 2006/01, South Australia.
- Rose A. W., Hawkes H. E. & Webb J. S. 1979. *Geochemistry in Mineral Exploration* (Second edition). Academic Press Inc, London Ltd.
- Sandiford M., Quigley M., de Broekert P. & Jakica S. 2008. Tectonic framework for the Cainozoic cratonic basins of Australia. Online
- <http://jaeger.earthsci.unimelb.edu.au/msandifo/Publications/Manuscripts/Manuscripts/2008_IASV.pdf>
- Sheard M. J., Keeling J. L., Lintern M. J., Hou B., McQueen K. G. & Hill S. M. 2008. A guide for mineral exploration through the regolith of the Central Gawler Craton, South Australia.
- Smith B. H. & Keele R. A. 1984. Some observations on the geochemistry of gold mineralisation in the weathered zone at Norseman, Western Australia. *Journal of Geochemical Exploration* **22**, 1-20.
- Taylor G. & Eggleton R. A. 2001. *Regolith geology and geomorphology*. John Wiley & Sons Ltd, West Sussex.
- Thomas M. 2004. Biogeochemical data ranges from Tunkillia prospect, central Gawler Craton, South Australia. *In:* Roach I. C. ed. *Regolith 2004* CRC LEME, pp. 362-364.
- Wilson M. & Savcin S. 2004. Lake Everard - South Australia EL 2697 Annual Report, for the period 14/02/2003 to 13/02/2004, Helix Resources Limited (unpublished).