PLANT BIOGEOCHEMISTRY OF AU-MINERALISATION BURRIED BY AN AEOLIAN DUNEFIELD: TUNKILLIA, S.A.

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INTRODUCTION

Plant biogeochemistry can be applied to geochemical surveys ranging from prospect to regional scales, however it has had relatively limited adoption by the mineral exploration industry in Australia. This is due in part to:

1. The availability of other popular surficial sampling techniques (such as calcrete, ferruginous material, and soil sampling) that have had some success in finding mineralisation under cover; and,
2. A limited understanding and recognition of the value of biogeochemistry and its potential applications to mineral exploration, particularly for Australian vegetation.

Plant biogeochemistry is an additional tool for geochemical exploration that can provide surficial chemical expressions derived from sub-surface because plant roots extend vertically and horizontally beneath the surface. In arid environments plant roots can grow to depths of tens of metres (a plant's root production is typically greater than shoot production) and because of this the above ground portion of a plant is often described as "the tip of the iceberg" (Taiz and Zeiger, 2002).

Several Australian studies have already investigated plant biogeochemistry in areas with extensive aeolian dunefields, although many of these studies have had some sort of limitation. Although the detailed studies of Mayo & Hill (2005) and Mayo (2005) showed important plant species, organ and landscape setting controls and variations in plant biogeochemistry from a dunefield in the Wudinna region of SA. Their study site did not host significant mineralisation and therefore specific applications for providing expression of mineralisation could not be fully assessed. A previous plant biogeochemistry study by Thomas (2003) provided some characterisation of plant biogeochemistry at Tunkillia, however this was limited in its chemical assay suite (e.g. it did not include Au) and representative number and distribution of samples from the area. Lintern (2004) conducted preliminary biogeochemical investigations on the Barns Gold Prospect in the northern Eyre Peninsula. Although this site contains mineralisation beneath an aeolian dunefield it is highly cleared and disturbed from agriculture and previous drilling. Lintern's early results also did not provide a strong or convincing biogeochemical expression of underlying mineralisation, and did not clearly differentiate plant species and individual organs (ie. plants were only identified to the genus level, and shoot "terminals" were sampled, which are a random mixture of variable aged leaves, twigs and buds).

This paper outlines the preliminary stages of a study that aims to characterise the plant biogeochemistry within an aeolian dunefield overlying Au-mineralisation and then consider its significance for biogeochemical dispersion pathways within the regolith and the implications for mineral exploration under cover. The Tunkillia site contains relatively well-constrained Au-mineralisation as well as a wide range of plant types that extensively cover the area. Although there have been numerous drilling programs conducted in the area, it was possible to take samples away from obvious remains of drill spoil by selecting a sampling path that did not pass through the areas that have been drilled in the last five years.

SETTING

The Tunkillia Gold Prospect is approximately 70 kilometers south-southeast of Tarcoola within the Lake Everard exploration license (EL 3403), presently held by Helix Resources Ltd and under farm-out to Minotaur Exploration. The study area lies within the N-S trending Yarlbrinda Shear Zone: a major crustal weakness that hosts rich Au anomalies. There is moderate access throughout most of the study area via station tracks and cleared gridlines. The Tunkillia site is dominantly covered by densely vegetated sand dunes and aeolian plains. In most places bedrock is covered by approximately 20-30m of Au-depleted weathered bedrock and overlain by aeolian sands. Until recently the regional geochemical exploration in Tunkillia has been focused on Au-in-calcrete sampling programs. These defined an anomaly of ~ 20km^2 at the 10 ppb level (Ferris & Wilson, 2004), which resulted in drilling programs over three anomalies that were of the >100 ppb level.

METHODS

During January 2006, an orientation study was completed in which 216 vegetation samples of varying species and tissue type (Table 1) were collected for multi-elemental assay. Vegetation samples were collected according to the procedure outlined by Hill (2003), however contrary to this procedure, all samples were collected by hand using powder free latex gloves rather than using teflon coated pruning clippers and samples were not washed as this has been reported to have limited effectiveness and may variably leach the samples of elements that are of interest (Hill *et al*, 2005).

Vegetation sampling was undertaken along a 5 km NE-SW trending transect passing through two zones of known mineralization and adjacent 'background' areas (Figure 1). The transect extended approximately 700 m into 'background' at either end of the transect, thus giving means for comparison and contrast. The sampled area was accessed via a service track that gave a near straight reference point. The orientation program involved six species of plants, with samples taken on each crest and swale along the orientation line. This ensured representation of the two main contrasting landscape setting and the associated vegetation communities representative of these. Samples of leaves or phyllodes were taken from target species at each sampling location and duplicate samples were taken at every fifth sample point. Large gaps between sample locations were filled following a review of the data spread and further sampling was also concentrated around two known Au anomalies to compare the responses and representation of different plant organs such as leaves or phyllodes, twigs and fruit over mineralisation.

A second transect that was also sampled in the southern part of the tenement aimed to compare the accuracy of plant biogeochemistry with that of future rotary air blast drill holes. This second transect covers a line of proposed drill holes and therefore entirely eliminates the potential for contamination from drill spoil.

Table 1. Summary of vegetation samples taken from Tunkillia during January 2006.

SPECIES NAME	NUMBER AND TYPE OF SAMPLES COLLECTED		
	LEAVES	TWIGS	FRUIT
Horse mulga (*Acacia ramulosa*)	44 (phyllodes)	5	2
Black oak (*Casuarina pauper*)	34 (branchlets)	4	2
Narrow-leaved mallee (*Eucalyptus leptophylla*)	38	6	3
Red mallee (*Eucalyptus socialis*)	21	3	3
Pearl bluebush (*Maireana sedifolia*)	33	5	-
Bluebush daisy (*Cratystylis conocephala)*	11	2	-

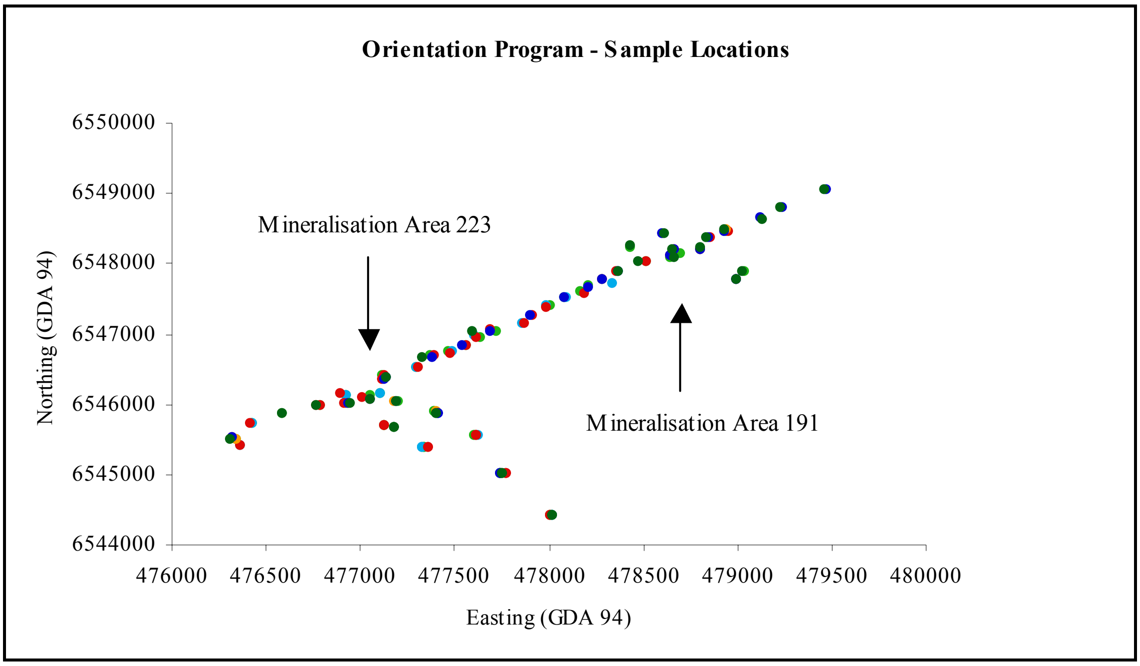

Figure 1. Coordinates of samples taken from the northern part of the study area during January 2006.

Samples were stored in brown paper bags until dry (<60° C) and then refined under clean conditions at the University of Adelaide. Powder-free latex gloves were worn at all times and samples were re-packaged into snap-lock plastic bags prior to analysis. Samples of approximately 20g were sent to ACME Laboratories, Canada, for further sample preparation (VP100) and ICP-MS analysis (Group 1VE-MS) of 53 elements including Au.

RESULTS & DISCUSSION

Regolith-Landforms

The surficial regolith-landforms of the area are dominated by linear dune ridges and swales that trend approximately W-E. Dunes tend to be up to about 10 m high and spaced at about 250 m between dune crests. They are mostly composed of red-brown quartzose sand. Swale areas are flat and surficial regolith is mostly fine sand and silt with abundant regolith-carbonate nodules and hardpans. Kaolinitic clays and silicified quartzose sand and gravel form localised components of surface lags in some swales. The far NE end of the main transect is dominated by an extensive erosional plain that is presently being transgressed by linear dunes migrating to the E-NE. This erosional plain area eventually drains to the north along a drainage depression.

Geobotany

Preliminary geobotanical observations for the study area were made during the sampling process. Some of the associations between target species and regolith-landform setting include:

- *Acacia ramulosa* – widespread across dune crests and swales.
- *Casuarina pauper* – dominate in swales, except in NE of transect where they have been recently buried by transgressing dunes.
- *Eucalyptus leptophylla* – widespread across dune crests and swales, although less abundant in the NE of transect.
- *Eucalyptus socialis* – abundant on dune crests and flanks, particularly in SW.
- *Maireana sedifolia* – widespread in swales and erosional plain in the NE, especially where regolith carbonates are near the landsurface.
- *Cratystylis conocephala* – limited distribution in only some swales.

Ease of Sampling and Preparation for Assay

- *Acacia ramulosa* – readily available species, relatively easy to sample phyllodes but difficult to separate twigs and phyllodes.
- *Casuarina pauper* – distinctive to recognise and locate in the swales. Very easy to sample and prepare branchlets.
- *Eucalyptus leptophylla* – relatively easy to sample and prepare. Disease and malformation common in leaves.
- *Eucalyptus socialis* – relatively easy to sample and prepare. Disease and malformation common in leaves. Widespread on crests but can be confused with other mallee eucalypt species and hybrids.
- *Maireana sedifolia* – requires close inspect to discriminate from *C. conocephala*. Easy to sample, but time consuming to separate leaves from twigs. Hairy leaves can trap detrital dust.
- *Cratystylis conocephala* – requires close inspect to discriminate from *M. sedifolia*. Easy to sample, but very time consuming to separate leaves from twigs. Hairy leaves can trap detrital dust.

FURTHER STUDY

It is proposed that this study will also:

1. Conduct and compile detailed (1:2k scale) regolith-landform mapping of the biogeochemical sampling area;
2. Present and interpret initial biogeochemical assays, for characterising the plant biogeochemistry of the area;
3. Consider processes and mechanism for plant biogeochemistry dispersion and residence, particularly linking plants biogeochemistry with subsurface geochemistry; and,
4. Consider implications for mineral exploration through transported cover, such as recommended sampling media and procedures.

REFERENCES

FERRIS G. & WILSON M. 2004. Tunkillia Project – Proterozoic shear-zone-hosted gold mineralisation within the Yarlbrinda Shear Zone. *MESA Journal* **35**, 6-12.

HILL L.J. 2003. Branching out into biogeochemical surveys: A guide to vegetation sampling. *In:* ROACH I.C. ed. *Regolith and Landscapes of Eastern Australia*. CRC LEME, pp. 50-53.

HILL S.M., BROWN A.D., HULME K.A., PETTS A.E., REID N. & MAYO A.M. 2005. Using biogeochemistry and geoecology to explore through transported cover for mineralisation. *In:* Abstract Volume: Mineral Exploration Through Cover 2005. CRC LEME, 7-10.

LINTERN, M.J. 2004. Preliminary biogeochemical studies at Barns Gold Prospect, Gawler Craton, South Australia. CRC LEME **Open File Report 168**.

MAYO A.M. & HILL, S.M. 2005. Mineral exploration through an aeolian dunefield near Wuddina, 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.

MAYO A.M. 2005. Plant biogeochemistry and geobotany in an aeolian dunefield of the Central Gawler Gold Province, South Australia. BSc Honours Thesis, Department of Geology and Geophysics, University of Adelaide, unpublished.

TAIZ L. & ZEIGER E. 2002. *Plant Physiology* 3rd Edn. Sinauer Associates, Sunderland. pp. 67-86.

THOMAS, M. 2004. Biogeochemical data ranges from Tunkillia Prospect, Central Gawler Craton, South Australia. *In:* ROACH I.C. ed. *Regolith 2004.* CRC LEME, pp. 362-363.

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