Animals and vegetables for minerals: Biogeochemical exploration through sedimentary cover from tropical savannahs to arid shrublands of the Northern Territory

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Introduction

Plants and animals are a prominent part of regolith and landscapes across most terrestrial settings. Their use as mineral exploration and environmental chemistry sampling media has previously gained mixed support in Australia; however, they have numerous advantages for use due to:

- widespread cover across the landscape
- easy access to samples that in many cases are easy to take
- an ability to construct chemical pathways that penetrate regolith (especially sedimentary cover) to the underlying mineral system targets
- an ability to selectively extract and concentrate some elements
- an ability to amalgamate a chemical signature from an enlarged sampling area (potentially achieving greater site representation and reducing potential problems with heterogeneous sample media, leading to 'nugget effects')
- minimal site disturbance and remediation costs associated with sampling
- some proven exploration success for a wide range of flora and fauna species, chemical elements, regolith-landform settings and mineralisation styles.

Further details on biogeochemistry techniques and case studies for mineral exploration can be found in Dunn (2007).

This presentation considers the use of plants and animal samples in mineral exploration programs and in regional pre-competitive geoscience ('base line') surveys, with particular emphasis on settings, and flora and fauna communities and species that are widespread in the Northern Territory.

Studies within regional plant communities

A range of plant communities and target species have been examined in the Northern Territory and equivalent parts of Australia. These include:

- Eucalyptus / Corymbia Open Forest and Woodlands

These communities are widespread in northern regions where mostly a range of *Eucalyptus* and *Corymbia* species have been applied. This includes examples with implications for uranium and gold exploration from the Arnhemland and Pine Creek regions.

A study by Debnam (1955) sampled a very large range of species and their organs from known uranium mineralisation and exploration targets at Rum Jungle, Adelaide River, Brooks Creek, Sleisbeck, The ABC area and Howard Springs. Samples were ashed and analysis was by fluorescence techniques for uranium only. The highlight of that study was the discovery that *Xanthostemon paradoxus* is a uranium accumulator tree. Debnam (1955) also found leaves to be the most useful biogeochemical sampling organ, but concluded that soil sampling was more useful in mineral exploration programs. The improvements in biogeochemical analytical techniques since that study mean that the results from this study warrants further investigation.

In a study at Ranger by Cruickshank and Pyke (1986), *Eucalyptus miniata* and *Melaleuca viridiflora* were included in the sample suite of species. Of these two species, only *E miniata* was considered to provide a suitable distinction between 'background' and mineralisation based on uranium content of plant tissue.

Two further biogeochemical studies from the Pine Creek Orogen included plant biogeochemistry (Reid 2009) and termitaria (Petts 2009) for gold exploration near Adelaide River and Pine Creek.

- Acacia woodlands

Acacia woodlands are widespread in semi-arid regions where mostly mulga (*Acacia aneura*) and other acacia species has been applied due to their widespread distribution. Examples include applications for gold and uranium exploration particularly from the Alice Springs region, and a regional pilot study in the South Australian part of the Musgraves Province testing the chemical fertility of buried mafic dykes.

- Hummock-grasslands (typically with tall open shrubland overstorey)

These are one of the most widespread plant communities of inland Australia. Spinifex (*Triodia spp*) have been widely tested, particularly for gold mineralisation occurrences in the Tanami, as well as in regional sampling in South Australian parts of the Musgraves Province.

- Chenopod shrublands

Areas dominated by bluebush (*Maireana spp*) and saltbush (*Atriplex spp*) are widespread, especially across lowlands with fine grained sediments. They have been widely tested in parts of South Australia and western New South Wales (eg Hill *et al* 2008, Fabris *et al* 2008, Sheard *et al* 2008) for exploration for a wide range of mineralisation styles, and therefore have important implications for parts of the Northern Territory.

Some themes and challenges for further investigation

Some of the themes and challenges for developing the biogeochemical techniques for use in further application include:

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- Accounting for seasonality and how this has an impact on the availability of different plant organs for sampling as well as the biogeochemical characteristics.
- Accounting for longer term climatic cycles, such as El Niño and La Nina, where buried mineralisation may still be expressed but with significant variations in trace element concentrations (eg Mitchell *et al* 2015).
- Normalisation or compatibility of results from different surveys to allow for broad compilation and comparison. This would be essential for developing useful regional data sets. Potential exists here for use of different element ratios and factors rather than single elemental concentrations
- Confidence in representative and optimal sampling.
- Applications across a range of scales from regional scale to prospect scale.
- The important controls on biogeochemical expression from geological variability, such as depth of cover, target mineralogy, and groundwater hydrological and hydrogeochemical (eg salinity) settings (e.g. McLennan *et al* 2013), to name but a few.

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