# FACTORS AFFECTING THE EFFICACY OF BIOGEOCHEMICAL EXPLORATION: THE AUSTRALIAN EXPERIENCE AND THE DEVELOPMENT OF PROTOCOL

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## Introduction

Biogeochemical exploration for concealed mineral deposits is gaining momentum in Australia. In the last year alone, several government-sponsored biogeochemical surveys covering hundreds of square kilometres in area have been undertaken or proposed. In addition, exploration companies have embarked on orientation and first-pass exploration vegetation sampling over tenements. Over the last few years, multi-client sponsored research has been undertaken by CSIRO-AMIRA on a number of prospects to elucidate mechanisms on how metals might be transferred to the surface to create soil anomalies and concluded that plants are contributing in part or whole to these contrast anomalies. We learnt from our experience that this knowledge should be shared amongst those undertaking biogeochemical surveys both in Australia and the rest of the world.

## Methodology

Biogeochemical surveys were undertaken at a number of prospects in Western Australia, South Australia and Northern Territory including Kopai, Kintore, Rose Dam, Degrussa, Garden Well, Bentley, Boddington, Moolart Well, Kintyre, Bentley, North Mittel, Edoldeh Tank and Bibra (Figure 1). Most of these sites were characterised by transported regolith of a variable thickness. Single line, multi-line and/or grid based biogeochemical surveys were undertaken at these sites. Sample media included mulga plant parts, eucalypt plant parts and organic-rich soil. A digestion of dried plant material using nitric acid and aqua regia was followed by an ICP-OES/MS finish. Multi-element analyses (at least 60) were done on these samples including major and selected trace elements such as Au, Ag, Cu, Ni, U, Zn and Pb at the Bureau Veritas (UltraTrace).

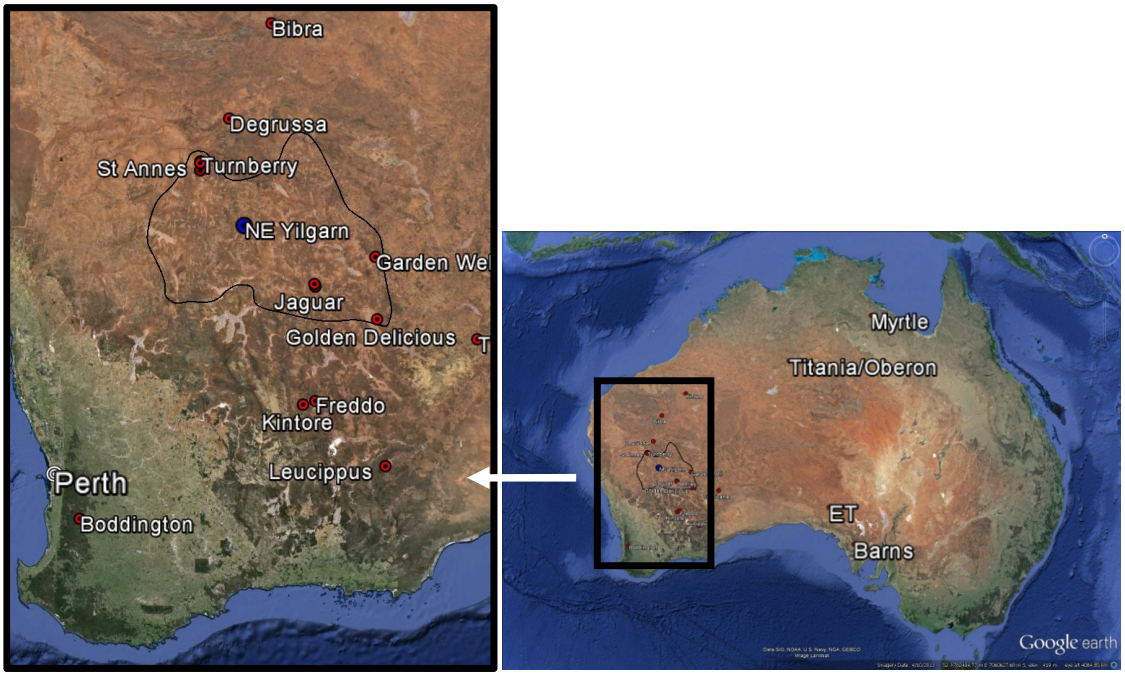


**Figure 1. LHS: Map of Western Australia showing location of selected biogeochemistry study sites. RHS: Map of Australia showing other biogeochemistry sites at Myrtle, Titania, ET and Barns (base map courtesy of Google Earth).**

## Results

The results from selected surveys demonstrate several diverse factors that can affect the efficacy of using vegetation as a sampling medium in mineral exploration. These include:

1) Limitations created by the depth of transported cover
2) The presence of mineralised regolith on metal uptake by plants
3) Overcoming the nugget effect of Au (Figure 2)
4) Seasonal and multi-seasonal effects of sampling
5) What part of a tree should be sampled (Figure 2)
6) The selection of young growth over old
7) The size of the sample to be collected, milled and analysed
8) Whether to wash samples or not prior to milling
9) The need or not to ash samples
10) Similar species but differences in metal contents

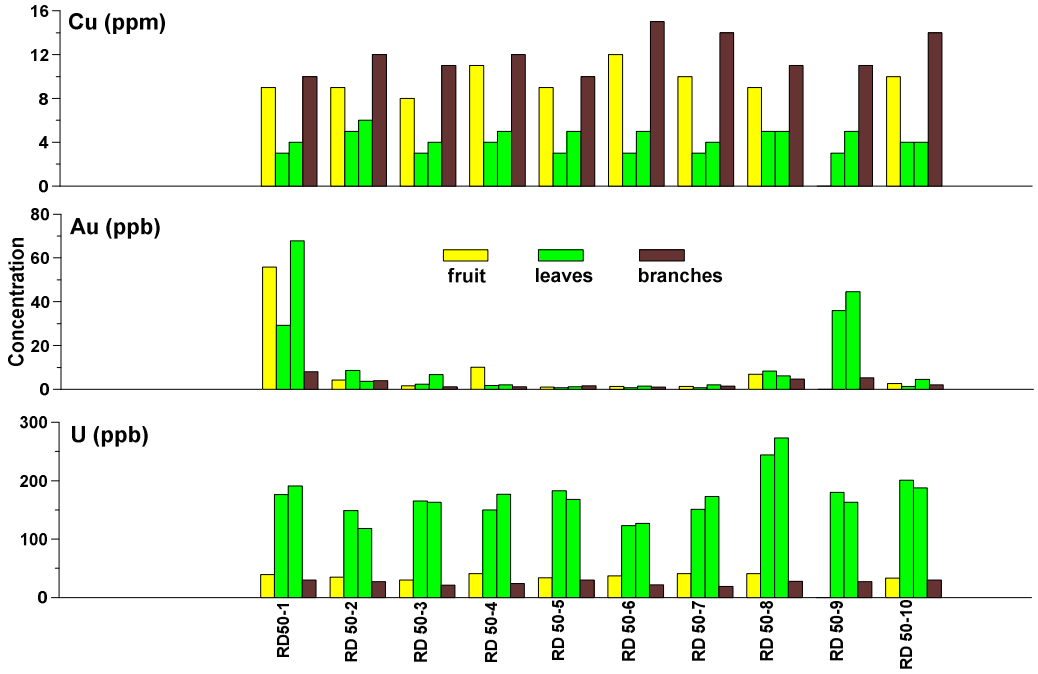


**Figure 2. Variation in Cu, Au and U in different plant parts (fruit, leaves and branches) from 10 positions in the canopy from the same tree. Two duplicates of milled leaves were analysed. Note how U and Au are more concentrated in the leaves whereas Cu has its highest concentrations in branches and fruit. Gold concentrations are highly variable.**

## Discussion

Biogeochemical sampling offers a method by which we can identify mineralisation at the surface even if it is covered by sediments. Plants are able to transport metals to the surface and deposit them at the surface to create anomalies. Many factors can affect the concentration of metals in vegetation (Dunn, 2007) but a systematic study of these has not been undertaken in Australia. Here, we provide a contribution on the effects of some of these factors (e.g. temporal, Au nugget effect, different plant parts) that can affect the creation of metal anomalies at the surface.

Biogeochemical sampling is at a critical juncture in Australia. New surveys are being undertaken and results are highly variable. It is important that the momentum continues so that we have a broad selection of case histories from which to draw upon and compare. Consistence of approach is paramount so that variables in sampling, preparation and analysis are reduced. The reporting of null results are just as important as successful survey results since it is only with understanding and documenting the negatives can we understand the limitations of the technique. Failure to apply the correct protocols will result in inconsistent results which, in turn, will lead to a reduction in confidence by the exploration industry in the adoption of biogeochemistry. We are still near the base of a steep learning curve.

## Conclusions

Biogeochemical sampling may offer great benefits for the mineral explorer. Australia is embracing this new technology but it is important that the momentum is sustained to provide a strong set of case studies and a database. Protocols for the sampling, preparation and analysis are important to this fledgling technique if we are to give it its best chance of success.

## References

DUNN, C. E., 2007. Biogeochemistry in mineral exploration. Handbook of Exploration and Environmental Chemistry, 9. Elsevier, Amsterdam.