Eucalyptus camaldulensis (river red gum) Biogeochemistry: An Innovative Tool for Mineral Exploration in the Curnamona Province and Adjacent Regions

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Abstract

This project is the first major characterisation of *Eucalyptus camaldulensis* biogeochemistry for the purpose of developing its applications for mineral exploration and environmental management. *Eucalyptus camaldulensis* is one of the most widely distributed trees in Australia and is particularly abundant along watercourses in inland Australia, such as in southeastern central Australia, where this study was conducted.

A methodology has been developed and refined for effectively and efficiently sampling *Eucalyptus camaldulensis* plant organs in biogeochemical surveys. Sampling consistency and minimal contamination are the most important considerations for this methodology. If these can be minimised and accounted for the geological and environmental influences on plant biogeochemistry can be more readily isolated.

Leaves were the most conveniently sampled medium and provided the greatest reproducibility and background to anomaly contrast for most trace elements. Leaf biogeochemistry typically showed little relationship with stream sediment substrate, but instead had a closer association with the underlying bedrock substrate and shallow groundwater. The regolith-landform setting of sample trees is also a significant control on plant biogeochemistry, in particular the relationship to channel floodouts, depositional settings and local impediments to channel flow.

In order to account for temporal variations in biogeochemistry, *Eucalyptus camaldulensis* leaves were collected every three months over a two year period between March 2003 and March 2005. There were notable differences in the overall chemical composition between periods of non-growth (autumn and winter) and growth (spring and summer). Most of the elements recorded their highest concentrations during periods of growth, corresponding with an increase in temperature, rainfall and extended periods of daylight, and therefore peak photosynthetic and evapotranspiration activity. These temporal variations are mostly indicative of the availability of water from rainfall and the opportunistic dimorphic root system of the *Eucalyptus camaldulensis* accessing and switching between the shallow soil-alluvium pore water and the deeper groundwater.

Detrital contributions to plant tissue are also need to be recognised when interpreting biogeochemical results. Investigation into the surficial contamination of the *Eucalyptus camaldulensis* through surface secondary electron images and backscattered electron images from a scanning electron microscope (SEM) revealed that the vertically hanging, large, smooth waxy leaves are typically poor repositories for detrital material.

Detailed case studies in the Au-prospective Tibooburra area and the polymetallic Pine Creek (Broken Hill) area demonstrate the variable environmental controls on the biogeochemistry at the catchment scale. In particular, the underlying geological substrate, groundwater at the sediment-bedrock interface and regolith-landform setting were important catchment-scale controls on the biogeochemistry of tree samples.

By accounting for the catchment-scale biogeochemistry of *Eucalyptus camaldulensis* along Pine Creek, this research contributed to the discovery of buried extensions of the Pinnacles mineralisation (the Perseverance Lode) , which is now being evaluated for mining. In this case, leaves from trees over mineralisation contained exceptionally high contents of metals

hosted within mineralisation, including 1.36 ppm Ag, 411 ppm Pb, 338 ppm Zn, 5.2 ppm As and 4.13 ppm Cd. This highlights the potential value and application of this technique for mineral exploration under transported cover.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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Karen A. Hulme

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