Cooperative Research Centre for Landscape Environments and Mineral Exploration

GEOCHEMICAL ANOMALIES IN TRANSPORTED OVERBURDEN

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Background

In mid 2003, LEME and AMIRA developed a proposal, known as P778, called *Predictive Geochemistry in Areas of Transported Overburden*. This project was to research case histories and mechanisms of anomaly formation, so that analytical techniques could be identified and applied for addressing the 'last frontier' in exploration geochemistry. That proposal attracted considerable feedback from industry, but despite several revamps of the scope and costs, it did not attract sufficient support for it to proceed. The proposal of Dec 2003 envisaged a Stage1 involving site selection and mechanism review, and Stage 2 of laboratory and field studies of specific mechanisms identified by Stage1.

The project failed to get up for a number of reasons including uncertainty of the research team, indefinite scope of work, high financial contributions from industry, and disagreement on confidentiality periods. Consequently LEME decided to do Stage 1 as an in-house project, called *Geochemical Dispersion Mechanisms*.

Geochemical Dispersion Mechanisms

LEME's project of this name was undertaken principally by Mehrooz Aspandiar, under direction from Ravi Anand and David Gray. Outputs from that project include presentations (with abstract) at LEME Mineral Exploration seminars, a LEME Open File Report in preparation, and a summary paper in EXPLORE No 125. That review noted metal mobility can be achieved most effectively by **groundwater** related processes, for example lateral advective flow, density or thermal driven advection, capillary rise, dilatancy pumping, and electrochemical transport. **Gas streaming processes** due to atmospheric pumping and metal ions attached to gas bubbles is possible in some environments. Finally there are **biotic** processes such as hydraulic pumping by deep rooted vegetation, bioturbation by ants and termites, and biomethylation of organometallic compounds formed by decay of anaerobic bacteria.

An implied conclusion is that it is difficult to envisage many effective mechanisms to raise metal ions through transported regolith above the watertable. In Australian arid-semiarid environments, where the watertable is relatively deep, this presents a problem. The prime contender is deep-rooted vegetation, with some potential from bioturbation, and gas streaming involving an unknown mechanism. Transformations by microbes may also be important in these processes.

Other LEME Research

Concurrently LEME is undertaking a range of projects within Program2 with the objective of "providing new and improved tools for mineral exploration". These are a suite of integrated multi-party and multi-disciplinary projects, involving both generic process and site studies, under the direction of Program Leader Ravi Anand. They are undertaken with LEME internal funds, but

involve collaboration with exploration companies. These projects address the role of microbes in metal (especially gold) mobility, biogeochemistry of calcrete, laboratory experiments in metal mobility, vectors from hydrogeochemistry of groundwater, kinematics of regolith processes, and 3-D geochemical/mineralogical characterisation of mineral systems in transported regolith in some Australian mineral provinces. These projects clearly show that remobilised gold and pathfinder elements in secondary minerals formed in transported overburden by hydromorphic and vegetation mechanisms.

One project that aims to bring the generic processes together is *Mineral and biological hosts*. In collaboration with the Botany Department (UWA) biota samples have been conducted over several Yilgarn basemetal and gold deposits. A range of standard soil sampling and partial extraction techniques were also employed. Initial results are very encouraging, **for we now see certain biomedia that give reproducible and striking anomalies in transported regolith, where no other sampling techniques work.** Concurrently we have identified a suite of suitable study sites, where undisturbed mineralisation exists below transported regolith. It is this area of biogeochemical research that promises immediate breakthroughs.

New AMIRA proposal for Predictive Geochemistry in Transported Overburden

This background intellectual property (BIP), together with other research advances, could form the platform for a re-branded AMIRA proposal for *Predictive geochemistry in areas of transported cover*. The research strategy would be:

- Detailed low-level geochemical studies of trees of several different species, at all available sites, addressing the full range of organic material available, employing different sample preparation techniques, for different seasons, in order to identify the techniques to fully optimise geochemical signals.
- Detailed study (including DNA/RBA molecular structure) of microbiota in soil, regolith and rootlet tissue, together with microanalysis of geochemical and mineralogical species within and around rootlets, in order to understand process of element uptake.
- Geochemical analysis of soil and regolith material at different levels, using all common leachates (full digestion, partial leach, enzyme and bacterial leaches) to establish the null result.
- Apply soil gas desorption (SDP) and other soil gas techniques to pursue the enigmatic question of labile and mobile metallic elements.
- If geochemical responses are identified in the soils, undertake laboratory experiments using purge-and-trap gas chromatography techniques to detect any organo-metallic volatile components (eg methylated compounds of Hg, As, Sb, Bi, Se, Pb, Ni, Sn)
- Study of hydrogeochemistry, water-rock/regolith interaction, and biota-water interactions

With the BIP now generated by LEME, this project has a much higher level of expected success than any of the previous proposals. The protection and use of LEME BIP means that confidentiality periods could be accommodated.