DEATH BY GOLD

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INTRODUCTION

Vegetation has been used to explore for mineralization in the United States, Canada, and Russia, and less commonly elsewhere. There are only a few reported examples of biogeochemistry that have been used in routine exploration surveys in Australia (e.g., Rattigan *et al*., 1977; Marshall and Lintern, 1995), partially because sampling of soils and other surficial media such as calcrete and lateritic residuum has been very successful (Butt *et al*., 2000). However, as Australian exploration companies move away from traditional areas of outcrop or shallow cover these sample media may not be particularly useful. Biogeochemistry, on the other hand, will gain importance if it can be demonstrated plant roots of certain species penetrate deep cover and reflect buried mineralization in their aerial parts.

One of the reasons for the success of biogeochemistry in the Northern Hemisphere is the presence of vast boreal forests consisting of one or a few species. The most common trees are the black, white and the red spruce (*Picea* spp.), jack pine (*Pinus banksiana*), balsam fir (*Abies balasamea*), tamarack (*Larix laricina*) and paper birch (*Betula papyrifera*). There are very few regions of boreal forest that do not contain one or more of these species. Australia, on the other hand, has an extremely diverse flora dominated in the arid interior by spinifex, acacia and eucalypt trees. There are over 1100 Australian acacia, 40 spinifex (*Triodia* spp.) and 800 eucalyptus species that have been identified. For example, there are more than 50 species of eucalypt around the Kalgoorlie area alone. With so many species occurring in a variety of regolith settings across Australia it may be difficult to find a consistent sample medium.

There are many other factors that need to be considered if biogeochemical sampling is to be effective. These include: the relationship between metal in soil and plant, rooting depth of sampled vegetation, seasonal metal differences, plant status (age, size and health), contamination issues because of low concentrations in vegetation. These factors have enormous practical implications for undertaking exploration surveys using native plants. Unfortunately, there have been few studies on the variation caused by these factors and others in Australian native plants.

Two methods to look at differences associated with metal uptake in plants is to use plant pots containing soil or hydroponic set ups containing nutrient solution. Metal uptake studies may be used to look at, for example, adsorption rates, different metal interactions, salinity effects, micro-organism effects, metal speciation differences, and plant differences. Care, however, must be taken in extrapolating any findings to the natural environment. Plants grown in artificial set ups such as potting mixes or hydroponics may behave entirely differently to those found growing in mineralised soils or other natural settings. A preliminary experiment was set up to look at similarities and differences in metal uptake between two species of plants that appear to adsorb Au in the natural environment.

METHODS

Approximately twenty replicates of two species of plant (*Eucalyptus incrassata* and *Acacia aneura*) were grown in individual small pots containing potting mix and slow release fertilizer over a three month period. Water containing different concentrations of soluble Au was administered to the pots on a daily or twice daily basis. A control set of twenty replicates that was not exposed to Au was also established at the same time. All plants flourished equally although they were exposed to variations in temperature, rainfall events and naturally occurring bacteria during the period of the experiment. For the last two weeks of growth, Au was not added to the daily watering of the plants with the exception of two plants of each species where additional, high concentrations of Au were added.

RESULTS

At the end of the experiment the plants were dissected into individual plant organs (roots, branches, leaves, phyllodes). After drying, plants were analysed for Au content using ICP MS. For each plant part an approximately linear trend over several orders of magnitude was noted between Au concentration in the plant organ and Au concentration in the administered water. Differences were noted between the two species and these will be discussed during the presentation as will the implications for mineral exploration.

When additional soluble Au was added to the two plants from each species the result was death. It appears that large amounts of added Au in solution (1000 ppm) may be toxic (as other salts at these concentrations) to these plant species but concentrations as high as these are unlikely to be encountered in the natural environment. Plant parts from these experiments were examined under the SEM for Au but preliminary investigations have not detected any Au, although several hundred ppm of Au was found by ICP MS.

FUTURE WORK

True hydroponic investigations in relatively controlled environmental conditions have commenced as part of AMIRA Project P778. Thirty common native shrubs and trees occurring in Au mineralized areas have been grown hydroponically from seed (Figure 1). Several plants of each species have been grown. Metals have been added to the hydroponic tanks so that the plants will take up the metals at a constant rate. A variety of experiments involving plant metal uptake are being planned for the future using the hydroponic set up.

Figure 1: Native plants grown in a flood and drain hydroponic set up.

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