THE DISTRIBUTION OF PRECIOUS METALS IN TWO DRY SCLEROPHYLL FOREST TREES: EARLY STEPS IN RESEARCH AT TOMAKIN PARK GOLD MINE, NEW SOUTH WALES

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INTRODUCTION

As mineral exploration companies look into alternate methods for finding precious metals, research is being conducted to increase our understanding of precious metal movement within our environment. CRC LEME is a leader in research regarding the shift of mineral exploration techniques from conventional methods to new ones. Aspandiar (2004) provides an insight into CRC LEME's activities in a discussion of the association of natural processes such as groundwater flow, sub-surface gas migration, vegetation interactions, bioturbation and microbial metabolism as mechanisms useful for identifying metal transfer through regolith.

The focus of the research presented here is the study of natural processes to provide an insight into below soil surface mechanisms of precious metal transfer. This study focuses on the use of vegetation as a mechanism for understanding the transfer of metals within the environment. The biogeochemistry of two dry sclerophyll trees at Tomakin Park Au mine will be used to determine the transportation and distribution of Au throughout each tree. Biogeochemistry is an established method of detecting precious metal resources, although little work has been performed in southeastern Australia (Arne *et al.* 1999). The present study aims to fill the a gap by acknowledging that the unique flora of south-eastern New South Wales may hold one of the keys to understanding below surface processes of metal transfer. Three species are examined in this study: grey ironbark (*Eucalyptus paniculata)*; spotted gum (*Corymbia maculata)*; and, a Cycad, burrawang (*Macrozamia communis*), added as an understorey species. This paper contains detailed site descriptions, field descriptions and sampling techniques used in the field, while the next steps of the biogeochemical study are explained.

PREVIOUS WORK AT TOMAKIN

Frank Reith chose the Tomakin Park Au mine for research on Au mobility and interaction of micro-organisms with the regolith (Reith 2002). The Au deposit has a simple geometry, being a single ore-bearing quartz vein, and the site was reported to be under more or less undisturbed dry sclerophyll forest. Reith's research found that the regolith and vegetation above the underground mine was indeed undisturbed. He determined that *Bacillus cereus* has a strong association with Au in the Ah horizon, where enrichment and mobility increased with proximity to the Au-bearing quartz vein (Reith *et al.* 2005).

Considering the success of Reith’s research and the low level of disturbance above the Au-bearing quartz vein, this site provides an extremely useful location for additional research. A site with native vegetation growing over a Au-bearing quartz vein with little disturbance, sets the ideal scene for biogeochemical research within dry sclerophyll trees.

STUDY AREA LOCATION

The Tomakin Park Au mine is situated on the south coast of New South Wales in the Eurobodalla Shire. The nearest town is Mogo, some 11 km south of Batemans Bay. The mine site is also located 2 kilometres northwest from the coastal village of Tomakin and overlooks the Tomaga River (Figure 1).

CLIMATE

The Eurobodalla region is characterised by a temperate climate, with cool winters and warm summers. The average annual rainfall is 900 mm with an average of 118 rain days per year. Rainfall is variable throughout the year with the wettest month being November (99.4 mm) and the driest being July (32.9 mm), shown in Figure 2. Average daily temperatures are relatively mild due to the maritime influence. February is the hottest month with a mean daily maximum temperature of 25.4°C, while July is the coldest with a mean maximum temperature of 17.1°C. The mean highest daily maximum temperature is 44.8°C in January, while the mean lowest daily minimum temperature is -2.9°C, occurring in July (BOM 2004).

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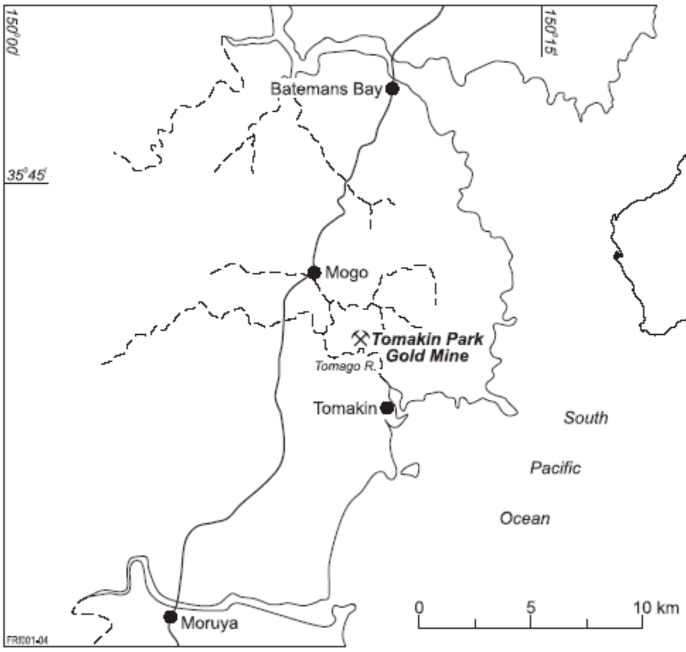

Figure 1: Location map of Tomakin Park Au mine in south-eastern New South Wales (from Reith *et al.* 2005).

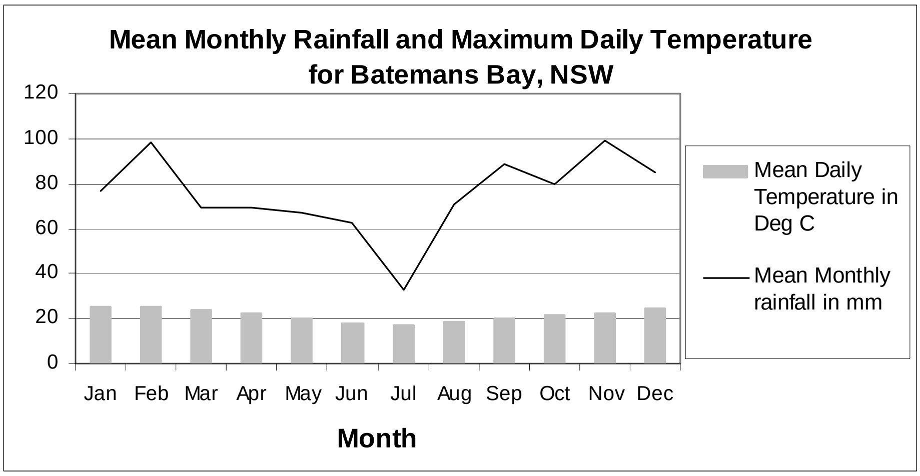

Figure 2: Rainfall and temperature rates for Batemans Bay (BOM 2004).

GEOLOGY

In broad terms the South Coast is located in the most complex geological province of NSW. This is the Lachlan Fold Belt (LFB), extending from the Queensland border through mid-south New South Wales and Victoria to the eastern half of Tasmania. The study area lies in the Molong-South Coast Anticlinorial Zone, which is a structural subdivision of the Lachlan Fold Belt (Ferguson *et al.* 1992).

Much of the detailed geology of the land surrounding the study area is described by McIlveen (1975). Interbedded, metamorphosed greywacke, shale and siltstone of Middle to Late Ordovician age outcrop in the area. The Au-bearing quartz vein outcrops for about 70 meters northward from the mine site and varies in thickness from a few centimetres at the southern end to 0.3 m at the northern end. The quartz vein is vuggy with numerous crystal-lined voids. Pyrite crystal aggregates are present in the unweathered quartz. In the primary ore, the Au occurs within arsenopyrite and pyrite in solid solution or as small inclusions. The quartz vein has weathered over time and contains limonite rather than fresh pyrite. To the east of the major Au-bearing quartz vein, several smaller Au-bearing quartz veins have been located. These strike in the same general direction but appear to be much poorer in Au (Bowman 1979).

GEOMORPHOLOGY

The study area lies approximately 40 meters above sea level, characterised by narrow ridgelines with gentle to very steep side slopes. The site has a southern facing slope located 70 metres from the Tomaga River. An alluvial plain is located on the opposite bank of the river, typified by a marshy drainage system.

VEGETATION

The vegetation of the study area is dry sclerophyll forest, predominantly occupied by spotted gum (*Corymbia maculata)*. Blackbutt (*Eucalyptus pilularis*), grey ironbark (*Eucalyptus paniculata*) and blue-leaved stringybark (*Eucalyptus agglomerata*) are other common eucalypt species of the area. A dense distribution of the Cycad (*Macrozamia communis*) is usually present as an understorey species, under spotted gum. Rainforest patches occupy moist gullies, while swamp she oak (*Casuarina glauca*) occurs on the western slopes and areas surrounding the Tomaga River.

REGOLITH AND SOILS

Few soil surveys have been undertaken in the study area. A field analysis was conducted at the site where soil samples were collected. Soils are colluvial and have been classified as a Yellow Podsolic (Great Soil Group, Stace *et al.* 1968), Dy 4.41 (Australian Principle Profile Form, Northcote 1979) and Yellow Kurosol (Australian Soil Classification, Isbell 1996). It was not classified as Solod/Soloth as the classification of Dy 4.41 would imply, because the exchangeable sodium percentage (ESP) is not more than 6.

The soil profile consists of an Ao horizon to a depth of 3 cm, a sandy loam A1 horizon to a depth of 10 cm, a fine sandy clay loam A2 horizon to a depth of 17 cm and a heavy clay B2 horizon, to a depth of 42 cm. A moderately weathered saprock C horizon occurs at greater depth. This contains an *in situ* quartz vein and metasediments. Quartz gravel, found at the surface, decreased with depth while pH at the surface (5.5) decreased with depth (5.0). The subsoil was yellow-grey clay with minor mottling.

SAMPLING PROCEDURES

A 10 metre long costean was excavated to a depth of 1.4 metres, reaching saprock but limited by the power of the backhoe. This dissected the drip and root zones of a grey ironbark (*Eucalyptus paniculata*), a burrawang (*Macrozamia communis*) and a spotted gum (*Corymbia maculata*). The position of the tree trunks and shape of the costean are illustrated in Figure 3. As the grey ironbark was on the opposite wall of the transect to the spotted gum, samples were collected from both sides of the costean.

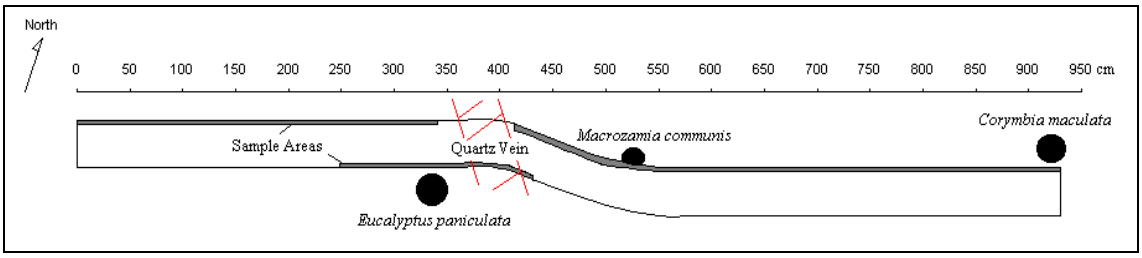

Figure 3: Transect characteristics at Tomakin Park Au mine.

A detailed cross-section of the regolith was drawn using 10 mm grid paper and a 10 cm mesh screen. The screen was placed against the transect wall where the content of one square was drawn into the corresponding square on graph paper. Soil horizons, surface colour and condition, roots, bio-pores and gravel or rock were recorded for the length of the costean. An example of the grey ironbark soil profile is displayed in Figure 4. The mesh screen was also used as a sampling template, where a 10 cm cube or around 500 grams of soil were sampled every 20 cm both vertically and horizontally.

Vegetation was sampled in a variety of forms from different zones of the tree. Leaf litter was collected every 20 cm along the transect surface. Roots were sampled from the costean wall and from the excavated root zone of both trees. Green leaves, flower buds and branches under 10 mm were collected from each main branch. Branches, both dead and living, were collected in diameter classes of 10-50 mm and 50-75 mm, while trunk samples were collected every meter in the form of 20 cm discs (Figure 5A). To record wet vegetation weights all samples were weighed using spring scales in the field, as displayed in Figure 5B.

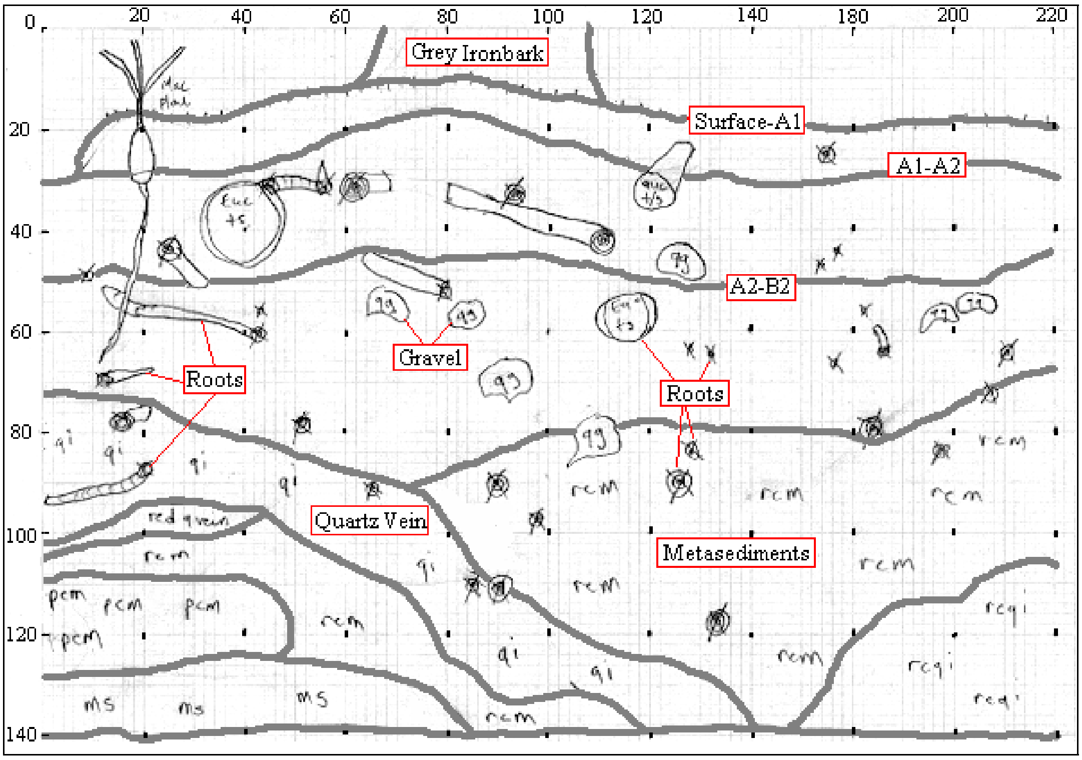

Figure 4: Regolith cross section below the grey ironbark.

Figure 5: Vegetation sampling at 1 m intervals of the grey ironbark trunk (A) and using spring scales for wet vegetation weights in the field (B).

THE NEXT STEP

Soil and vegetation samples will be analysed in the laboratory to determine their chemical contents. Soil samples are to be oven dried and wet digested to clarify the presence of precious metals. They will then be analysed using Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) and X-Ray Diffraction (XRD). Results will be entered into the "SURFER" software package to plot the 3D distribution of elements in the regolith and determine trends relating to vegetation locations. Vegetation samples need to be divided into additional classes. This will involve the separation of young from old leaves and trunk, root and branch sections into heartwood, sapwood, phloem and bark. Samples will be washed, oven dried and analysed using ICP-AES. A biomass assessment will be preformed to determine the concentration of minerals spread throughout both trees using the wet weight of vegetation samples.

CONCLUSION

To increase our understanding of precious metal movement throughout the regolith, it is important to gain an understanding of natural biogeochemical regolith processes and the residence sites of metals in vegetation. The geobotanical study of trees is a technique becoming increasingly popular and useful for this purpose. However more research needs to be done in South-eastern New South Wales to enhance this technique. The Tomakin Park Au mine provides an ideal location for continuing such research with undisturbed dry sclerophyll forest established over a Au-bearing quartz vein. Many more steps than those described here need to be taken for this project to be transformed into a biogeochemical study. Given that it is early days of research for this project, the steps required for completing a biogeochemical study of the Tomakin Park Au mine are well on track to be achieved over time.

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