BIOGEOCHEMICAL STUDIES

OF

NICKEL AND COPPER

IN

NEW ZEALAND

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ABSTRACT

The accumulations of various metals by some indigenous trees growing on the Riwaka Basic Complex, North-west Nelson, New Zealand, were investigated by the application of statistical techniques to biogeochemical data. Particular reference was given to nickel and copper to evaluate the usefulness of plant analysis as a prospecting tool.

Preliminary investigations showed that serious errors could result from the methods of sampling plants and soils and sampling procedures were adopted to minimise these errors. In addition, errors arising from atomic absorption analysis were found to be significant for some metals.

Leaves and twigs from three *Nothofagus* species, *N.racemosa* and *Q.acutifolia* as well as their associated soils, were collected and analysed for nickel, cobalt, copper, zinc, chromium, calcium, magnesium, manganese and potassium. The plants were also analysed for iron. These results showed that each species accumulated different, but related, amounts of various metals and that they distributed these metals in different ways between their leaves and twigs.

N.truncata and *N.fusca* which are closely related genetically, accumulated metals to similar degrees, while *N.menziesii* which is not closely related to the other *Nothofagus* species accumulated metals to differing degrees.

Relationships between the metal concentrations in the plants and in the soils were evaluated by computing correlation coefficients. The best correlations for nickel were obtained for the Nothofagus genus although the other species also showed highly significant correlations. The Nothofagus genus also showed the best correlation for copper.

In view of the above results, a more extensive study of the Nothofagus genus was carried out. A second survey was undertaken in the same area in which leaf samples of this genus as well as their associated soils were collected. While the metal concentrations in the soils collected in this survey compared well to those collected previously, the metal concentrations in the plants, in general, did not show good agreement.

Trend analysis was used to compare in detail the nickel and copper contents in the leaves of the Nothofagus genus with the concentrations of these metals in the soils. It was shown by comparison of the trend surfaces and residuals that the accumulation of nickel was determined primarily by the concentration of nickel in the soil, whereas for copper the accumulation by the plant was a function primarily of the specific requirement of the plant for this metal.

Multiple regression analysis was used to improve the prediction of the copper and nickel concentrations in the soil from the concentrations of these metals in the leaves of the Nothofagus species, by making quantitative allowance for the processes influencing the accumulation of these metals by the plants. Improvements of between 25% and 35% were obtained at the 90% confidence level.

Inter-metal ratios in the leaves were considered as possible indicators of nickel and copper concentrations in the soil but the results were discouraging.

Studies were made of the locations and chemical forms of nickel, copper, zinc and iron in both freeze-dried and fresh leaves from some trees growing on the Complex. Atomic absorption spectrophotometry was used to measure the concentrations of these metals in both plant extracts and on the electrophoresis and chromatography papers used to separate the metal complexes in the extracts. Results indicated that the major part of the nickel present in the leaves was not contained in cell organelles nor was it bound to cell walls, but existed as a positively charged complex in either the cytoplasm and/or the vacuole. Copper, zinc and iron were distributed differently with varying fractions, depending on the metal, existing predominately as anionic complexes.

It was concluded that the research embodied in this thesis had illustrated the application of statistical techniques to biogeochemical studies, showed that biogeochemical prospecting for nickel in New Zealand was feasible and that methods of total analysis for metals could be applied to the study of microgram amounts of metals in biological systems.

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