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ASPECTS OF RADIOBIOGEOCHEMISTRY

A thesis
presented in partial fulfilment of
the requirements for the degree of
Doctor of Philosophy in Chemistry
at
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To my parents,
Dr. and Mrs. V.I.E. Whitehead
with gratitude.

" This I know;

God made man simple,

Man's complex problems

Are of his own devising."

(Ecc. 7.29, Jerusalem Bible)

- SOLOMON (961 - 922 B.C.)

ABSTRACT

Section I: A routine assay for uranium was instituted, and a fluorimeter suitable for the assay designed and constructed. A new method of fusion-pellet manufacture is described. The optimum conditions for the assay were determined. The calibration curve is linear up to about three micrograms of uranium; the lowest limit of detection is about twenty nanograms (about 0.10 microgram/g of sample). Routine alpha and beta counting of samples was developed.

Section II: The forms of naturally occurring data distributions are discussed, and customary methods of examining these noted, together with their defects. A versatile computer programme was developed to determine the form of natural distributions, and to calculate correlation coefficients and their significances.

Section III: An orientation survey of a known mineralised area in the Buller Gorge of New Zealand showed that C.australis, N.fusca, Q.acutifolia, and W.racemosa are suitable for biogeochemical prospecting for uranium. Analysis figures were more nearly log-normally distributed than normally distributed, and multiple distributions were often present. Alpha counts of plant material also proved suitable as indicators of the amount of uranium in the soil, as did the amount of iron in the leaves.

Section IV: Aquatic bryophytes from streams draining mineralised areas were analysed and the results found to be indicative of the presence or otherwise of uranium in the various catchment areas. Even better was the use of specially prepared peat, allowed to soak in the stream water. The accumulation factor for uranium, from stream water, was about ten thousand.

Section V: The gamma-ray spectra of plants and soils were carefully characterised by solvent extraction, and ion-exchange techniques. Plants were found to absorb radium and uranium and lead, but not thorium. B.procerum, and M.berteroana, however absorbed both thorium and actinium. Calculation showed that most of the alpha particles emitted by the samples studied were from ^{238}U .

Section VI: Extraction and characterisation of uranium complexes in C.australis leaves showed the presence of a protein-uranium complex, and an RNA-uranium complex. The latter is at least partially an artefact of the extraction technique, and examination of fresh material showed that more than half the uranium was bound to cell wall proteins. No other types of compound besides protein and nucleic acids possessed measurable binding capacity for uranium.

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