Migration and gamma ray assessment of uranium on a gold tailings disposal facility

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Dissertation submitted in fulfillment of the requirements for the degree *Magister Scientiae* in Environmental Sciences at the Potchefstroom Campus of the North-West University

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May 2014

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Abstract

This project aims to quantify natural gamma radiation in gold tailings disposal facilities (TDFs) relative to uranium concentration data in order to use natural gamma detection methods as alternative methods for uranium resource estimation modelling in gold tailings. Uranium migration within the New Machavie TDF was also investigated as migration affects both the grade of the TDF as a uranium resource and poses a threat to the environment. In order to determine the most appropriate radiometric testing procedure, various methods were employed for natural gamma detection, including surface natural gamma spectrometry, borehole natural gamma spectrometry and scintillometry, as well as incremental sampling. These measurements were then statistically compared to ICP-MS analyses to find the best method, and then modelled to apply volumetric resource estimation procedures. The oxidation reduction potential was also tested as uranium geochemistry is dependent on oxidation for mobilisation. Furthermore, leaching tests were employed to relate specific anions as a mode of transportation in solution. Results indicated that down-hole natural gamma spectrometry performed the best and that 2376.87 kg of uranium is present in the TDF. Migration modelling indicated that uranium is mobilised away from the oxidized top area of the TDF and that accumulation occurs in the saturated zone of the TDF under a reducing environment. Sulphate anions as the result of pyrite oxidation are primarily responsible for the mobilisation as radionuclides in New Machavie. The results of this project can be applied to the resource estimation of all uranium bearing tailings facilities prior to re-mining as a means to decrease exploration costs and to accurately model the distribution of uranium.

Keywords

Gold tailings, Uranium, Resource estimation, Natural gamma spectrometry, Uranium migration, tailings oxidation

Acknowledgements

I would like to express my appreciation to:

- The technology and human resource programme (THRIP) and the industrial partner, Geotron for financial support.
- Mr R.J. van Rensburg from Geotron for technical assistance as well as the use of geophysical equipment.
- Mr P.W. van Deventer for support and guidance.
- The Tlokwe local municipality for allowing access to the New Machavie site.
- Dr R. Dennis for access to three dimensional geological modelling software (Rockworks)
- The various field assistants who helped during the months of fieldwork.

Without their different inputs this project would not have been successful

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List of abbreviations

Ac	Actinium
Ar	Argon
Bi	Bismuth
Ca	Calcium
CPS	Counts per Second
DNA	Deoxyribonucleic acid
EC	Electrical Conductivity
ICP-ES	Inductive Coupled Plasma Emission Spectrometry
ICP-MS	Inductive Coupled Plasma Mass Spectrometry
IDW	Inverse Distance Weighting
K	Potassium
Pb	Lead
pH	Negative logarithm of the hydrogen concentration
ppm	Parts per Million
Ra	Radon
TDF	Tailings Disposal Facility
Th	Thorium
Tl	Thallium
U	Uranium
Wt%	Weight Percentage
XRF	X-ray Fluorescence