

1. Introduction

In recent years the need for greenhouse gas-free energy has stirred up new interest in both uranium (U) and thorium (Th) deposits in South-Africa. As a result, most gold mining houses like Harmony, AngloGold, Goldfields and Durban Roodepoort Deep as well as smaller companies (Mine Waste Solutions, First Uranium and Rand Uranium) have initiated, or are in the process of initiating, U extraction projects from gold TDF (World information service on energy, 2012). Part of the viability study prior to initiating the U extraction project is the exploration and quantification of the U content of TDFs by means of resource estimation.

For this resource estimation, major drilling and bulk sampling projects are conducted, samples are taken and analysed in laboratories using either XRF or ICP mass-or-emission spectroscopy (IAEA, 1992). This project suggests using natural gamma spectrometry instead of the more expensive methods mentioned above, meaning that more detail can be incorporated into the resource estimation at a significantly lower cost to the company.

Quantifying the mobility of U and locating zones with high U content aids the re-mining process as one wants to mine high grade ore when the price is right and production can be maximised. Bulk sampling fails in this regard as little to no detail of the spread of U through the TDF can be determined.

1.1 Research area

The research area is located in the Stilfontein and Potchefstroom area in the North-West province where two TDFs were drilled and sampled. The first TDF is the Harties 1-4 complex just south of the town of Stilfontein and the second is New Machavie, a derelict mine west of Potchefstroom and north-east of Stilfontein.

1.2 Objectives of research

The main objective of this study is to quantify natural gamma radiation on gold TDFs and to relate the measured radiation to U concentration. Secondary objectives include a resource estimation of U in the gold TDFs based on the U concentration data collected, as well as an estimation of U mobility from the same data.

By using natural gamma down-hole probing a three-dimensional (3D) view of the location and concentration of U in the different TDFs investigated in this study will be obtained. Sampling of the down-hole probing sites at certain depth intervals will relate radiation to radionuclide concentration. Both U and Th concentration of samples and boreholes will be measured in order to quantify the U content and leaching of U from the tailings material.

U concentration data was also used to calibrate the natural gamma data in order to establish a data set from which U concentration can be accurately predicted in gold tailings through the use of radiometric methods. This study objectifies the use of radiometrics for the estimation of U resources in gold tailings as a cost effective alternative to conventional methods, in order to decrease resource estimation costs and to benefit the planning process prior to re-mining.

As the mobility of U in the TDF greatly affects the correlation between radiometric measurements and physical concentration of U present, this was investigated as well, especially with regard to the movement between the oxidized and un-oxidized zones in a TDF. To investigate anions responsible for the transportation of radionuclides, column leaching tests were done.

Deliverables of this study include:

- A 3D geostatistical model of the U content in a TDF including cross-sectional profiles to aid in planning for re-mining and;
- A 3D model indicating migration of U through a TDF;
- An oxidation profile of New Machavie;
- Anion transportation dependence of radionuclides;
- Identification of the best radiometric method to measure U content on a gold TDF.

1.3 Layout of dissertation

The layout of this dissertation starts with the traditional Introduction, Literature survey, Description of study area and Materials and methods. These sections are of importance to the whole project and are used in all or most of the sections that follow. After materials and methods, the headings are broken down into different focus areas that were specifically researched as part of this project. Each section has some expanded literature reviews and methodologies. However, the focuses of these headings are the Results, Discussion of results and Conclusions.