

In-Situ Determination of Radioactivity Levels and Radiological Hazards in and around the Gold Mine Tailings of the West Rand Area, South Africa

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Abstract : Mining and processing of naturally occurring radioactive materials could result in elevated levels of natural radionuclides in the environment. The aim of this study was to evaluate the radioactivity levels on a large scale in the West Rand District in South Africa, which is dominated by abandoned gold mine tailings and the consequential radiological exposures to members of the public. The activity concentrations of ^{238}U , ^{232}Th and ^{40}K in mine tailings, soil and rocks were assessed using the BGO Super-Spec (RS-230) gamma spectrometer. The measured activity concentrations for ^{238}U , ^{232}Th and ^{40}K in the studied mine tailings were found to range from 209.95 to 2578.68 Bq/kg, 19.49 to 108.00 Bq/kg and 31.30 to 626.00 Bq/kg, respectively. In surface soils, the overall average activity concentrations were found to be 59.15 Bq/kg, 34.91 and 245.64 Bq/kg for ^{238}U , ^{232}Th and ^{40}K , respectively. For the rock samples analyzed, the mean activity concentrations were 32.97 Bq/kg, 32.26 Bq/kg and 351.52 Bq/kg for ^{238}U , ^{232}Th and ^{40}K , respectively. High radioactivity levels were found in mine tailings, with ^{238}U contributing significantly to the overall activity concentration. The external gamma radiation received from surface soil in the area is generally low, with an average of 0.07 mSv/y. The highest annual effective doses were estimated from the tailings dams and the levels varied between 0.14 mSv/y and 1.09 mSv/y, with an average of 0.51 mSv/y. In certain locations, the recommended dose constraint of 0.25 mSv/y from a single source to the average member of the public within the exposed population was exceeded, indicating the need for further monitoring and regulatory control measures specific to these areas to ensure the protection of resident members of the public.

Keywords : activity concentration, gold mine tailings, in-situ gamma spectrometry, radiological exposures

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