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## Radioactivity assessment of radium and radon concentrations in water sources at and near selected former uranium mines in the West-Rand area of Johannesburg

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The present work aimed at establishing the extent and distribution of the activity concentration levels of  $^{238}\text{U}$  daughter-nuclides;  $^{226}\text{Ra}$  and  $^{222}\text{Rn}$  in the West Rand-area of Johannesburg. The main motive was to ascertain whether the exposure of the nearby residents to ionising radiation due to former mining activities was within the maximum acceptable limit of 1.0 mSv/y for the public. Measurements include the use of Alpha Spectroscopy system (Canberra) with Passivated Implanted Planar Silicon (PIPS) and Solid-state Alpha Detectors for Radon measurements (RAD-7) detectors to identify radionuclides, quantify and analyze isotopes of interest.

A seasonal collection of a total 32 water samples from the mining areas was carried out and analysed for  $^{226}\text{Ra}$  and  $^{222}\text{Rn}$ . The results of radium

( $^{226}\text{Ra}$ ) concentration in water samples obtained by using alpha spectrometry ranged from  $(1.58 \pm 2.74$  to  $164.42 \pm 18.47)$  mBq/l,  $(11.23 \pm 3.89$  to  $136.01 \pm 15.4)$  mBq/l,  $(-3.38 \pm 2.39$  to  $156.15 \pm 18.14)$  mBq/l, and  $(4.25 \pm 1.23$  to  $108 \pm 8)$  for June 2019, September 2019, December 2019 and March 2020 water samples, respectively. The radium values were lower than the suggested maximum contamination levels by US-EPA 555 mBq/L.

The results shows that the range of radon ( $^{222}\text{Rn}$ ) concentration values vary from  $(37.1 \pm 74.1$  to  $269 \pm 79.2)$  mBq/l,  $(57.2 \pm 73.9$  to  $190 \pm 94.9)$  mBq/l,  $(76.6 \pm 63.2$  to  $211 \pm 146)$  mBq/l, and  $(56.3 \pm 71.1$  to  $289 \pm 272)$  mBq/l for June 2019, September 2019, December 2019 and March 2020, respectively. The obtained  $^{222}\text{Rn}$  concentration results in drinking water samples in the current study are low than the approved maximum contamination level (MCL) 11.1 Bq/l as approved by US-EPA.

The observed radon annual ingestion dose from the current study were lower than the European Commission and the World Health Organization proiii posed concentration of  $^{222}\text{Rn}$  in drinking water of 100 Bq/l [1]. The results of this study indicates that the total annual effective doses from possible intake of  $^{226}\text{Ra}$  and  $^{222}\text{Rn}$  radionuclides in sampled water in West-Rand area were found below the World Health Organisation (WHO) recommended limit of 0.1 mSv/y as well as the average radiation dose of 0.29 mSv/y received per head worldwide due to ingestion of natural radionuclides assessed by UNSCEAR 2002

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