

The occurrence of potentially harmful elements in gold mine tailings and their possible impacts on the environment and public health with reference to the Welkom goldfields in South Africa- A review

Rinae Makhadi¹, Hassina Mouri¹, Kim Dowling², Robert Hansen³

^{1,2} *Department of Geology, University of Johannesburg, Johannesburg, South Africa*

² *STEM college, RMIT University, Australia*

³ *Department of Geology, University of the Free State, Bloemfontein, 9301, South Africa*

makhadir@ufs.ac.za

Gold mining activities in the Witwatersrand basin, South Africa, have produced over 270 mine residue deposits, such as tailings facilities and waste rock dumps that have covered a total area of about 400 km². Tailings storage facilities may contain high levels of potentially harmful elements (PHEs) that can be released into the air, soil, and water. Such PHEs can be taken up by humans through drinking water, dermal contact, and ingestion of impacted food crops or geophagia, resulting in serious adverse health effects. Many communities live in the vicinity of the Witwatersrand goldfields and are potentially at risk of being affected by PHEs emanating from the tailing's repositories. Extensive research has been conducted in certain parts of the Witwatersrand goldfields to ascertain the environmental and health impacts associated with the tailings. However very limited studies were conducted in the Welkom goldfields, which forms the focus of this study under the form of a PhD research project. A review of previous studies in the Witwatersrand and Welkom goldfields on the occurrence of PHEs in gold tailings dams, as well as their environmental and public health impacts in comparable parts of the world, was performed. This review provided insight into the environmental effects associated with gold tailings dams on the quality of soil, surface, and groundwater resources, as well as food crops and air quality. For example, previous studies in different regions of the Witwatersrand goldfields showed that U, SO₄²⁻, As, Mn, Cr, Cu, and Pb are amongst some of the most common PHEs emanating from the gold tailings dams. These studies have also highlighted that communities near the tailing dams are prone to adverse health effects possibly linked to the occurrence of PHEs in their environment. A study in Tudor shaft, in the west rand of Johannesburg, South Africa, revealed that children were at cancer-related risk associated with the exposure of metal and metalloids from gold tailings. Given the environmental similarities between parts of the Witwatersrand basin and the Welkom goldfields (the study area), it is, therefore, necessary to conduct a multidisciplinary research investigation in this latter to ascertain and quantify the presence of PHEs in the tailings materials, their mobility to the surrounding environment, pathways, their bioaccessibility and bioavailability, impacts on the quality of air, water, soil and food crops, as well as the health of the communities.