CHARACTERIZATION OF PHYSICOCHEMICAL PROPERTIES AND ENVIRONMENTAL RISK ASSESSMENT OF MINED TAILINGS: A CASE STUDY FOR SUSTAINABLE WASTE MANAGEMENT

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Abstract

Mine tailings constitute the largest waste stream in the mining industry and present significant environmental and public health challenges, particularly in gold-producing regions such as Ghana. This study investigates the physicochemical properties and environmental risk of tailings from Asante Gold Bibiani Limited (AGBL) to support sustainable waste management and valorization strategies. A multi-analytical approach was employed, including X-ray fluorescence (XRF), X-ray diffraction (XRD), inductively coupled plasma mass spectrometry (ICP-MS), and acid-base accounting (ABA) to characterize elemental composition, mineralogy, and acid generation potential. Environmental risk was evaluated using Ecological Risk Assessment (ERA) and Human Health Risk Assessment (HHRA) models based on measured contaminant concentrations in tailings-associated water systems. Results reveal elevated levels of cyanide, arsenic, and iron, with notable temporal and spatial variability. Ecological risk assessment identified cyanide (RQ > 1) and copper (RQ > 1) as major drivers of acute toxicity to aquatic systems. Although non-carcinogenic risks remained within acceptable limits (HI < 1), carcinogenic risk exceeded international thresholds (TCR > 10-6), primarily due to arsenic exposure. The study advocates for risk-based, data-driven management approaches and proposes engineering and nature-based solutions alongside circular economy strategies to transform mine waste into valuable resources.

Keywords: Mined tailing, Human Health Risk Assessment (HHRA), Ecological Risk Assessment (ERA)

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