Predictive Geometallurgy and Mine Waste Valorisation: Circular and Eco-friendly Recovery of Gold in the Witwatersrand Goldfields (South Africa)

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Gold has held a position of immense value throughout human history, and the Witwatersrand Basin in South Africa stands as a testament to this, hosting the largest known gold anomaly on Earth. Despite the extraction of significant portion of gold from this region, mining of primary high-grade ores has plateaued, leaving behind a legacy of large volumes of mine waste. However, historical mine waste dumps, present a unique opportunity for the implementation of circular economy initiatives and sustainable gold recovery practices. In recent years, various studies have explored methods for optimising gold recovery from the abundant waste materials in the Witwatersrand goldfields. However, the study outcomes have not been adopted by the mining industry due to their high energy requirements and challenges in findings integration thus hindering industrial process change. This study introduces a novel hydrometallurgical approach centred on the agglomeration of low-grade ores and tailings. The study areas are located ~ 60 km east and west from Johannesburg which is at the heart of Gauteng and where mine waste reprocessing operations are situated. Our study approach offers a promising avenue for recovering gold from secondary sources in an environmentally friendly and economically viable manner. Preliminary results reveal that the tailings consist mainly of major elements silica, aluminium and iron with trace concentrations of sulphur and uranium which correlates with mineralogical data obtained from the TIMA and QXRD, showing high content of silicates (quartz, muscovite), iron oxides (hematite) and low concentration of sulphides (pyrite) and uranium rich minerals (uraninite), typically associated with gold. With this data and further gold characterization, we intend to design a predictive geometallurgical flowsheet that improves gold recovery efficiency. Efficacy will stem from the use of eco-friendly reagents (i.e. glycine), in the dissolution of gold during the agglomeration process and compared with conventional cyanide-based reagents.