

MINING AFTER MINING: REAL-TIME XRF-CPT FOR STRATEGIC RESOURCE ESTIMATION IN TAILINGS REPROCESSING

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Abstract

"As global demand for critical raw materials intensifies, mine tailings are being re-evaluated as strategic secondary resources. Conventional resource estimation methods, reliant on sparse soil sampling and laboratory analysis, are often costly, time-consuming, and yield high uncertainty due to coarse investigation grids. This fails to capture the significant spatial heterogeneity inherent in tailings deposits, leaving their true potential unexplored.

This paper introduces an innovative, integrated site characterization technology that combines Cone Penetration Testing (CPT) with Energy-Dispersive X-Ray Fluorescence (ED-XRF) to directly address these challenges. The XRF-CPT probe enables simultaneous, real-time, in-situ logging of soil mechanics and quantitative geochemistry, providing high-resolution vertical profiles of heavy metal concentrations (e.g., Cu, Zn, Pb) alongside geotechnical parameters in tailings.

Presenting the results from various field campaigns, we demonstrate how this technology provides a rapid, cost-effective, and minimally invasive method for 3D resource delineation. It successfully identifies deep, high-grade enrichment horizons that conventional near-surface sampling consistently misses. The resulting high-density data set allows for the construction of robust 3D models critical for accurate reserve estimation, economic analysis, and the development of targeted re-mining strategies. We conclude that the XRF-CPT methodology is a transformative tool for the feasibility assessment of tailings reprocessing, turning "mining after mining" into a precise, data-driven, and economically viable operation."

Keywords: tailings reprocessing, XRF-CPT, in-situ resource estimation