Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36292

Microbially Mediated Mobilization of Critical Minerals from Bauxite Residue: Implications for Sustainable Bioleaching

PRIYA SONKER, ANURAG SINGH YADAV, GEORGE MATHEW AND KIRAN KONDABAGIL

Indian Institute of Technology Bombay

Bauxite Residue, a highly alkaline waste produced in the process of Alumina production from bauxite following the Bayer process. Generated in billions of tonnes, it represents both a major environmental liability and an underutilised secondary resource for critical metals encapsulated in Fe-Al-Ti mineral assemblages. However, its extreme alkalinity and high buffering capacity limit the extraction of valuable metals. Consequently, sustainable and environmentally friendly bioleaching strategies for enhanced recovery of valuable metals from bauxite residue remain poorly understood.

Three Indian bauxite residue deposits, namely Utkal, Renukoot and Belagavi, were assessed mineralogically and geochemically using XRD, XRF, SEM, ICP-MS, and TGA-DTA to evaluate their potential for sustainable resource recovery. The general trend shows the dominance of iron and aluminium oxides, followed by titanium and sodium oxides, with minor calcium oxides, and a measurable enrichment of critical minerals (V, Cr, REEs). Hematite, Goethite Gibbsite were the dominant mineral phases.

Bioleaching experiments were performed on Utkal samples in duplicate with two different Glucose supplements (3% and 5%), and the leachate was analysed for pH changes and critical element concentrations using ICP-MS. At 3% glucose, pH reduced significantly, enhancing the leaching of critical minerals. In contrast, 5% Glucose doesn’t affect pH much, and leaching was inhibited, indicating that glucose concentration governs the metabolic regulation of acid production in highly alkaline matrices and, hence, controls bioleaching efficiency.

These findings show how carbon flux regulates metal solubilization in highly alkaline systems by affecting metabolism of microbes, preventing sufficient acid production to overcome the buffering capacity of bauxite residue. This study identifies the metabolic optimisation factor, glucose, not merely microbial presence, as the key control on bioleaching of critical minerals from geochemically reactive bauxite residues.