Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37622

Bioleaching-Driven Metal Recovery Coupled with Bio-Assisted CO_2 Mineralization of Mining Waste

SHARMIN AKTER[1], KAMALPREET KAUR BRAR[2], NANCY N. PERREAULT[2], MAJID SARTAJ[1] AND SARA MAGDOULI[1]

[1]University of Ottawa
[2]National Research Council of Canada

Mining wastes including mafic/ultramafic tailings, smelting slag and bauxite residue are promising sources of untapped economic potential owing to their residual mineral content and higher reactivity towards capture atmospheric carbon. In this study, the potential of integrating the extraction of economically significant critical and base metals from industrial mineral offscourings (i.e., steel slag and bauxite residue) with carbon sequestration by using eco-friendly physicochemical and biological processes is examined. The experimental workflow consisted of three sequential stages: (i) physicochemical pre-treatment of the waste given their basic, silica-enriched and compositionally variable nature to enhance mineral accessibility, (ii) heterotrophic bioleaching to facilitate metal mobilization, and (iii) microbe-assisted and carbonic anhydrase (CA) enzyme-promoted carbonation. *Gluconobacter oxydans,* used as a bioleaching agent, exhibited substantial efficacy for gluconic acid production (30%, w/w), which was used latter to leach critical and base metals. For steel slag, X-ray diffraction (XRD) analysis showed that CaO compounds such as larnite (Ca_2SiO_4) and magnesium iron oxide ($MgFe_2O_4$) are the major mineral phases. Physicochemical treatment with glycine (1M to 4M) and microwave at different time intervals along with indirect bioleaching resulted in a partial dissolution of mineral phases, release of some critical minerals and a decline in crystallinity as confirmed by XRD and scanning electron microscopy (SEM) analyses. Once mineral phases are partially available, bio-assisted process within CA and selected strains was conducted to enhance the mineral carbonatation. Preliminary data showed in the presence of 5% CO_2 and higher CA activity, carbonates formation was observed within 2 days of incubation. This combined approach offers a promising route towards sustainable metal extraction strategy by coupling critical mineral recovery with CO_2 mineralization.