Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.32951

Stabilization of Acid-Generating and Oxidized Mine Wastes in Flooded Pits Using Bauxsol™: A Batch-Scale Study

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Acid mine drainage (AMD) from open-pit mines often contaminates surface and groundwater, causing major environmental damage that requires treatment. Bauxsol™ is an amendment derived from pre-neutralised Australian bauxite residue produced during the alumina refining process. It has been studied in several countries where its effectiveness in stabilizing contaminated water and soil has been demonstrated. This study evaluates the effectiveness of Bauxsol™ produced at the Vaudreuil alumina refinery in Quebec using Virotec technology for stabilizing acid-generating, oxidized mine wastes in flooded pits.

Batch tests carried out on AMD-generating waste rock (100 g of waste rock, 150 mL deionized water, at 150 rpm on a rotary shaker) showed a gradual increase in leachate pH, rising from 2.9 (control) to 6.75 after 24 hours with 15% Bauxsol™ amendment. During the process, Al and Fe were efficiently removed from the solution (> 99%) with only 8% of Bauxsol™ as amendment, likely through hydroxide (co)precipitation and sorption on ferric oxides. Trace metals exhibited distinct removal efficiencies that are positively correlated with amendment dosage. At 15% Bauxsol™, removal was highly effective, where Zn and Cu exceeded 99%, Cd and Cr >were greater than 97%, and Ni and Co reached 95%. However, the chemical composition of Bauxsol™ led to an important release of Na (up to 2895 mg L^{-1} for Na) increasing the electrical conductivity (12.5 mS cm^{-1}) and posing a risk of salinization. This phenomenon, although secondary to neutralization, requires careful dose management to avoid impacts on water quality.

Bauxsol™ may thus serve as an effective alternative to lime for stabilizing AMD-generating, oxidized wastes, thanks to its buffering capacity and its combined mechanisms of sorption and (co)precipitation. However, long-term monitoring of salinity and redox conditions remains essential to ensure the sustainability of Bauxsol™ treatments. In addition, other factors such as contact time, duration of application, amendment configuration, and scale of application could influence treatment efficiency. Ongoing studies are currently tackling some of these issues using laboratory column tests at a larger scale.