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Prospective techno-economic assessment of artificial nickel laterites for CO_2 removal and critical metal recovery

DAN SU[1], JASWANTH YADDALA[1], AMY MCBRIDE[1], SASHA WILSON[2], JESSICA HAMILTON[3], ANDREW J FRIERDICH[4] AND PHIL RENFORTH[1]

[1]Heriot-Watt University
[2]University of Alberta
[3]Australian Synchrotron, ANSTO
[4]Monash University

Presenting Author: d.su@hw.ac.uk

Nickel is typically mined from laterite or sulfide deposits hosted in variably weathered ultramafic rock with concentrations as low as ~1 wt% and most of the processed mine material is 'waste'. Naturally, these mineral waste weathers over millions of years to produce laterites, which involves reaction with CO_2 to store carbon in the form of solid magnesium or calcium carbonate. Coupling mineral carbonation of mine waste with critical metal recovery is an active area of research and explored in this project. A novel acid heap-leaching process is proposed that enhances the ultramafic mine waste weathering and turns them into 'artificial nickel laterites' over shorter timescales and recovers critical metals while producing high magnesium leachate for carbonation.

The heap-leaching process requires a large amount of low-cost, dilute acid, which is likely to dominate the cost of the overall process. This study delivers a prospective techno-economic assessment (TEA) concerning three scenarios of acid supply: through a conceptual integration of a bipolar membrane electrodialysis system using 1) seawater or 2) diluted salt water as brine inputs, and 3) directly purchasing and transporting dilute hydrochloric acid to the processing plant.

This study prospectively evaluates the techno-economic performance of this technology under the above acid supply scenarios over a range of future scenarios, deployment scales and climate scenarios by integrating Shared Socioeconomic Pathways (SSP) along with corresponding Representative Concentration Pathways (RCPs) into the TEA. It is projected that at certain SSP and RCP scenarios, the economic value of recovered nickel could be negligible compared to the value of CO_2 removal credits.

Results of this study will help to inform decision-making around low-carbon mine waste management and optimization priorities for the process to target potential revenue from credible carbon removal and critical metal production.