Bio-enhanced Hydrogen Production and Carbon Mineralisation in Mafic-Ultramafic Rocks

Abdusalam Alasmari[1], Hamid Roshan[1*]

[1]School of Minerals and Energy Resources Engineering, UNSW, Sydney, Australia

Corresponding author: h.roshan@unsw.edu.au

Growing concern over long-term CO_2 mitigation has intensified interest in carbon capture and storage (CCS) approaches. Among these, carbon mineralisation is considered a promising and permanent sequestration strategy because it transforms CO_2 into stable carbonate minerals. However, its widespread application is constrained by inherently slow reaction rates. Although elevated temperatures can accelerate mineralisation kinetics, maintaining such conditions is often economically impractical. To address this limitation, this study explores the use of bio-accelerators to promote faster reaction kinetics under low-temperature conditions. Specifically, the influence of deferoxamine B (DFOB) concentration on CO_2 mineralisation performance and hydrogen production in peridotite-rich systems was examined. Batch experiments were carried out at 60 °C under CO_2 pressures of 1, 5, and 8 MPa, using DFOB concentrations ranging from 0 to 200 µM. Experimental products were characterised through Thermogravimetric Analysis (TGA), Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), and X-ray Fluorescence (XRF). The findings indicate that carbonation efficiency improved steadily with increasing DFOB concentration, achieving a maximum of 3.22% at 200 µM and 8 MPa CO_2 after 48 h, compared with 1.15% under control conditions without DFOB. Hydrogen production reached its highest value of 0.72 µmol H_2/g olivine at approximately 200 µM and 1 MPa, but decreased as CO_2 pressure increased, suggesting competitive interactions between carbonation reactions and Fe(II) oxidation processes. Overall, the results highlight the potential of DFOB-enhanced mineralisation as an effective low-temperature approach for simultaneous CO_2 sequestration and hydrogen generation, providing a feasible pathway for integrated carbon storage and energy production.