Enhancing Passive Atmospheric CO_2 Sequestration and Tailings Stabilization by Ultramafic Mine Waste Aeration

STERLING VANDERZEE[1], GREG DIPPLE[1], K. ULRICH MAYER[1], PETER M.D. BRADSHAW[2]

[1]Bradshaw Research Initiative for Mineral and Mining, University of British Columbia, Vancouver, Canada svander@eoas.ubc.ca
[2]FPX Nickel-Corp., Vancouver, Canada

Rapidly rising atmospheric carbon dioxide (CO_2) levels and the liquefaction of mine tailings pose significant risks to the environment and society. Some ultramafic tailings contain labile magnesium from minerals such as brucite [$Mg(OH)_2$]. These tailings have the ability to quickly chemically react with atmospheric carbon dioxide gas and safely sequester it in the form of cementitious carbonate minerals. This cementitious carbonate material may reduce the risk of liquefaction by creating cohesion and increasing shear strength. However, due to the design of some tailings storage facilities, only the surface (~1-2cm) of brucite-bearing tailings can react with the atmosphere before being buried by fresh tailings. We propose aerating the tailings by puncturing holes (~5-10cm deep) into the surface of brucite-bearing tailings to allow more CO_2 to be sequestered within a larger portion of the tailings. To optimize the aeration design and predict the extent of reaction over time, we study the planar and radial diffusion-controlled reactive transport of atmospheric CO_2 into partially saturated tailings as a function of brucite content. Experimental data (wt.% mineralized carbon profiles) are used to calibrate diffusion models in the reactive transport code MIN3P. We aim to link the reactive transport modelling to the development of liquefaction resistance by delineating a relationship between the unconfined compressive strength (UCS) of CO_2-reacted tailings cores and their bulk wt.% mineralized carbon (wt.% C).