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Nickel recovery from artificial laterites produced during surficial mineralization of mine waste

ANDREW J FRIERDICH[1], DR. ZHEN WANG, PHD[2], MAXIMILIAN MANN[1], JESSICA HAMILTON[3], CONNOR C. TURVEY[4], ARIF HUSSAIN[4], ANNAH MOYO[4], PHIL RENFORTH[5], DAN SU[5], JASWANTH YADDALA[5], LAURA LAMMERS[6] AND SASHA WILSON[4]

[1]Monash University
[2]Nicholas School of the Environment, Duke University
[3]Australian Synchrotron, ANSTO
[4]University of Alberta
[5]Heriot-Watt University
[6]Travertine Technologies, Inc

Presenting Author: andrew.frierdich@monash.edu

An increase in mining is required to meet the materials demand for the expansion of renewable energy infrastructure. Ultrabasic mine tailings resulting from nickel extraction could exceed 1 Gt yr^{-1} and these have the potential, through surficial mineralization, to remove around 300 Mt CO_2 yr^{-1} by 2100. Since these tailings may contain residual nickel, enhanced weathering can be reframed as an ore processing technology if nickel can be concentrated and recovered during carbon mineralization. Here, we discuss the production of artificial laterites during the leaching of ultramafic mine waste by sulfuric acid and their potential as a resource for nickel extraction. Column leaching experiments on serpentine- and forsterite-rich materials produce an iron oxide rich residue (artificial laterite) with Ni contents of 1.5 wt%, an enrichment of over 10x from the initial host rock. X-ray absorption spectroscopy (Fe K-edge) results demonstrate that the Fe mineralogy is dominated by ferrihydrite and schwertmannite. Reaction of these artificial laterites with aqueous Fe(II), which is known to expediate the recrystallization of iron oxides, results in a rapid release of up to 75% of solid-phase Ni to solution. The extent of Ni release from artificial laterites substantially exceeds that from natural nickel laterites reacted under the same conditions. The lower Ni release from natural laterites is likely a result of the higher crystallinity of the iron oxides which host Ni (i.e. goethite). Efforts are currently underway to optimize the enrichment of Ni into the artificial laterite during enhanced weathering of mine waste and to improve yields of Ni recovery during recrystallization. Our results indicate that the leaching of mine waste may produce nickel resources in a carbon neutral way.