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Transition Metal Mobility and Recoverability from Weathered Serpentinite and Serpentinite Skarn Tailings from Lord Brassey Mine, Australia and Record Ridge, British Columbia, Canada

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Ultramafic and mafic mine tailings host transition metal resources, such as nickel (Ni), cobalt (Co), and platinum group elements (PGE), whose high value could serve as a motivator for existing mines to reprocess their tailings. Many of these target metals are initially hosted by olivine, repartitioned during serpentinization to form sulfides, oxides and alloys, and then remobilized during weathering to form authigenic carbonates, sulfates and oxyhydroxides. Reprocessing tailings may further provide environmental benefits, including a reduction in waste output and the ability to offset greenhouse gas emissions by enhanced silicate-weathering and carbonation reactions.

Here we use powder X-ray diffraction (XRD), scanning electron microscopy, electron probe micro-analysis and synchrotron X-ray fluorescence (XRF) mapping to demonstrate how Ni and Co are mobilized to their final sinks. Samples of serpentinite, skarn and weathered tailings from the historical Lord Brassey nickel mine in Tasmania, Australia and weathered outcrops of serpentinite ore from the proposed magnesium mine in Record Ridge, BC, Canada are analyzed and compared.

Our results show that Ni is preferentially sequestered in weathering products, primarily Fe-oxyhydroxides. We demonstrate that it is possible to calculate an accurate elemental bulk composition comparable to that obtained using bulk XRF analysis by integrating electron probe micro-analysis and quantitative XRD results. This approach accounts for the compositions and quantities of the minerals in each sample to provide geometallurgical context that cannot be obtained using bulk XRF alone. An improved understanding of the deportment of Ni and Co in ore and tailings will aid in making an economically viable framework for tailings reprocessing.