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Kinetic testing to evaluate the mineral carbonation and metal leaching potential of ultramafic tailings: case study of the Dumont Nickel Project, Amos, Québec

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Abstract:

Ultramafic mine wastes are known to react passively with CO_2 to form stable hydrated magnesium carbonates. This study uses kinetic tests to evaluate the carbonation potential of ultramafic mine tailings from the Dumont project (RNC Minerals, Québec, Canada) during their weathering, and to determine the impact of carbonation on the long-term quality of drainage waters. The weathering of awaruite [($Ni_{2.5}Fe$)], pentlandite [$(Fe,Ni)_9S_8$], and heazlewoodite [(Ni_3S_2)], which are the main sources of Ni in the studied materials, were also investigated due to their potential to generate contamination. A column test and small-scale weathering cell tests were used to simulate the passive weathering of ultramafic mine wastes, as well as concentrates of awaruite and Ni sulfides. Results from the kinetics tests confirmed that the Dumont tailings have a significant carbon sequestration potential which ranged from 8.5 and 33.6 kgCO_2/t. The surface-normalized carbonation rates varied from 600 to 2200 g of CO_2/m^2/year. Results demonstrated that brucite [$Mg(OH)_2$] content is the main parameter controlling CO_2 uptake by the Dumont wastes. Weathering of brucite and serpentine [$Mg_3Si_2O_5(OH)_4$] are driven by CO_2 dissolution in pore water and by sulfide oxidation. The rapid dissolution of brucite results in leachates with alkaline pH values, thus preventing metal mobility. Metals such as Ni, Zn, Fe, and Cu are suggested to precipitate as hydroxide or carbonate species within the wastes immediately upon being released through sulfide oxidation. The Ni-Fe alloy awaruite is stable and does not release metals in kinetic tests. The Dumont tailings are found to be non-acid generating and CO_2 sequestration is shown to play a significant role in drainage water quality which allow generation of significant alkalinity and the rise of pH.

Keywords: kinetic test; mineral carbonation; ultramafic tailings; brucite; alkaline drainage; mine waste; awaruite.