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A stepwise lab-to-field methodology for carbon mineralisation testing and acid mine drainage mitigation in ultramafic mining wastes at a Ni-Cu-PGE-Au mine in Finland

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Ultramafic rocks are not abundant on Earth's surface, with near-surface resources suitable for carbon mineralisation estimated ~90 tera tonnes [1,2]. Annual alkaline material production is estimated ~7 billion tonnes, including ultramafic waste rocks and mine tailings [3]. Kevitsa is a Ni-Cu-PGE-Au mine located in northern Finland, which has produced >350 million tonnes of waste since 2012. Waste rocks contain ~81% pyroxene and ~11% amphibole, tailings contain ~66% pyroxene, 12% olivine and ~5% amphibole, and both contain 1-2% sulphide and <1% carbonate minerals. High concentrations of ultramafic minerals can potentially capture and sequester atmospheric CO_2, but exposure of this material to atmospheric conditions can also lead to release of potentially toxic elements. Best practices for utilisation and sustainable management of ultramafic mining waste aim to upscale carbon neutral mining and acid mine drainage (AMD) mitigation.

Part of the EU-funded C-SINK project, this study assesses the carbon mineralisation potential of the Kevitsa waste material using a stepwise lab-to-field testing methodology. This includes real-time monitoring of CO_2, O_2 and other parameters in a) sealed barrels filled with waste rocks and b) open barrels filled with tailings under controlled conditions in the lab, and c) a field trial at the mine site (a 2 m deep experimental cell filled with 50^3 of tailings), coupled with bulk chemistry and leachate measurements. Sealed barrel data show relatively rapid O_2 consumption and CO_2 release (1-2 months), but full oxidation and carbonation processes take time to complete (2-3 years). Open barrel and field trial data suggest larger fluctuations in O_2 and CO_2 concentrations over time and against the depth. Overall, this study shows that Kevitsa waste material has a theoretical maximum potential of ~330 kg CO_2 removed per tonne. Continuous monitoring is necessary to assess CO_2 sequestration and AMD potential over time and depth in ultramafic mine wastes and establish best practices for carbon neutral and responsible mining.

References:

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