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Carbon Dioxide Injection into Processed Kimberlite at the Metre Scale and Beyond

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Kimberlite residues mineralize CO_2 from the air into magnesium carbonate minerals [1]. These carbonation rates can be accelerated by increasing the supply of CO_2 into the tailings through injection of concentrated sources, such as diesel flue gas from mine power generation [2]. Successful injection requires careful management of physical properties (moisture content, particle size distribution, degree of compaction, and permeability) to optimize the chemical reactions and make large-scale implementation feasible. These factors and their relationship to successful CO_2 injection were assessed through Proctor compaction and permeability testing and the findings were used to inform an experimental design. This experiment injected simulated flue gas into a 550 kg square meter pad of processed kimberlite from the Gahcho Kué Diamond Mine (NT, Canada), which represented a section of a larger mine-scale design. Injected CO_2 was removed from the gas phase into carbonate minerals in the solid phase as confirmed by increases in total inorganic carbon. The magnitude of carbon captured (1.4 kt CO_2 per Mt processed kimberlite) approached that attained from an idealized centimetre-scale injection experiment on the same material (2.1 kt CO_2 per Mt). This degree of reactivity implies Gahcho Kué could sequester 10 – 15% of their power generation emissions in their mine waste, and the success of the experimental design proposes a manner to do so.

[1] Subarctic weathering of mineral wastes provides a sink for atmospheric CO_2, Wilson et al. (2011), Environmental Science and Technology 45, 7727–7736.

[2] Strategies for enhancing carbon sequestration in Mg-rich mine tailings, Harrison et al. (2013b), Proceedings of International Mine Water Association, 593–598.