

## **Mineral carbonation in smectite-rich kimberlite (diamond) mine tailings**

N. ZEYEN, S. A. WILSON, B. WANG, B. ZHU, K. VON GUNTEN, D. S. ALESSI

Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB, T6G 2E3

Mineral carbonation is one of the promising methods for CO<sub>2</sub> sequestration and is part of a strategy for mining companies to offset their greenhouse gas emissions [1]. In this study, we investigated the reactivity of kimberlite ore and processed kimberlite (tailings) from the Venetia and Voorspoed diamond mines (South Africa). Processed kimberlites from these mines consist of a clay-rich mineral assemblage dominated by serpentine and Mg-rich smectites [2]. Due to the crystallographic properties of smectites (i.e., swelling clays), these phases have a high cation exchange capacity and can act as Mg and Ca sources for carbonation reactions. Combining high concentrations of Mg and Ca in solutions generated by leaching mafic–ultramafic mine tailings with conducive biogeochemical conditions can result in mineral carbonation [3]. However, the most suitable treatments to extract cations from smectite-rich tailings, and determining how microbes in mine tailings provide nucleation sites for carbonate formation, are still not well understood.

Here, we report the results of laboratory-based experiments using sodium, ammonium and proton exchange and inoculation of leachates with cyanobacteria to accelerate carbonation of processed kimberlite from Venetia. Our first results show that hydrochloric acid (0.16 M) has the most efficient cation extraction capacity (30% of Ca and 20% of Mg extracted). Moreover, we show that trisodium-citrate can be used to preferentially select for Ca during leaching, with no extraction of Mg. Finally, analyses of the cation exchange capacity of different facies of kimberlites and tailings allow us to estimate that potential greenhouse gas offsets could be highly significant (around 20%) for the Venetia mine.

[1] Power et al., 2014, *Minerals*, 4, 399-436

[2] Mervine et al., 2018, *Mineralogy and Petrology*, 112 (Suppl 2):S755–S765

[3] McCutcheon et al., 2017, *Minerals*, 7, 191