Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17756

Ex situ carbon mineralisation using scoria

RALF R HAESE[1], ARIHA AGRAWAL[2], LINUS R. OPAT[2] AND AGGELA POLYMENIS[2]

[1]University of Melbourne
[2]The University of Melbourne
Presenting Author: ralf.haese@unimelb.edu.au

Carbon mineralisation is an emerging pathway to capture and permanently store atmospheric CO_2 in carbonate minerals. It may also help to offset hard-to-abate industrial CO_2 emissions. This study investigates the feasibility of using scoria to rapidly mobilise cations of interest (Ca, Mg, Fe) and precipitate them in a second step as carbonate minerals. Scoria is a pyroclastic volcanic rock associated with stratovolcanoes, it is often of basaltic composition (rich in Mg, Ca and Fe), has a very high porosity (30 – 40%) and a very high surface area (typically 1 – 2 m^2/g). A conservative estimate of the abundance of mafic pyroclastic deposits associated with stratovolcanoes worldwide is in the range of 3000 to 8000 km^3, which equates to a carbon mineralisation capacity between approximately 2 to 5 * 10^{12} ton CO_2.

The rate of cation mobilisation through proton-promoted dissolution of minerals in scoria from the Newer Volcanic Province (Victoria, Australia) was determined in flow-through experiments using acids with a pH ranging from 0 to 3. A highly linear correlation ($R^2 = 0.94$) between the H^+ concentration in the inflow and the cation concentrations (∑Ca, Mg, Fe) in the outflow was found. A maximum mobilisation rate for cations of interest was 6.4 * 10^{-4} mmol min^{-1} g_{scoria}^{-1}. If this mobilisation rate is applied to a carbon mineralisation operation with 10 ton of scoria and all of the mobilised cations are precipitated as carbonate minerals, a CO_2 mineralisation rate of over 400 Kg per day can be achieved. 1-dimensional reactive transport models were developed with input from the experiments in order to better understand the relative contribution of different minerals (olivine, pyroxene, plagioclase) to the mobilisation of cations. As expected based on published kinetic data, olivine had the fastest dissolution rate leading to a high rate of magnesium and iron mobilisation.

Ongoing studies focus on additional dissolution mechanisms to further accelerate dissolution rates and on pathways leading to carbonate mineral precipitation and respective carbonate mineral characterisation.