

EGU22-6525

<https://doi.org/10.5194/egusphere-egu22-6525>

EGU General Assembly 2022

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Passive CO₂ mineralisation in slag: evidence from a slag heap in Lanarkshire, Scotland.

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CO₂ mineralization is a natural process that occurs during weathering of silicate materials that are calcium/magnesium-rich and aluminum-poor (Kelemen et al., 2020). During this process, silicates convert to carbonates, making silicate-rich materials such as ultramafic rocks and alkaline wastes suitable for CO₂ removal from air. Using slag to sequester CO₂ is particularly attractive as it is a by-product of a key industry, and it can utilize CO₂ from the emission source, therefore reducing the need for CO₂ and slag transportation, or draw down of CO₂ already in the atmosphere. It is estimated that steel slag has the potential to capture ~150-250 Mt CO₂ yr⁻¹ now, and ~320-870 Mt CO₂ yr⁻¹ by 2100 (Renforth, 2019).

Although the chemical composition of alkaline wastes shows that CO₂ capture can significantly offset emissions from corresponding industries, recent observations reveal that the CO₂ uptake in alkaline wastes is underutilized (Pullin et al., 2019). Here, we use image-based analysis to understand the microstructures of CO₂ mineralization in slag. We use X-ray Computed Tomography (XCT) to visualize slag internal structures and to calculate reactive surface area and pore connectivity. We then use scanning electron microscopy (SEM), coupled with energy dispersive spectroscopy (EDS) to study the distribution of elements within the studied sample.

In our study, we use a slag sample collected from the former Ravenscraig Steelworks in Lanarkshire, Scotland, where steelmaking took place from 1950s until 1992 (Stewart, 2008), leaving behind a slag heap that has been weathering since then. Our analysis demonstrates that calcium carbonate precipitates as pore-lining. Surface passivation and low surface-connected porosity were identified as processes that can cause reduction in CO₂ uptake.

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