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Lithification of slag-dominated artificial ground through atmospheric CO_2 drawdown

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Legacy deposits of by-product slag from iron and steel making create significant volumes of artificial ground around the world. Composed mainly of calcium-silicate mineral phases, experimental studies have shown the potential of slag for capturing atmospheric CO_2 by mineralisation (e.g. Huijgen et al. 2005). Renforth (2019) calculated that steel slag could capture ~370-400 kg CO_2 per tonne of slag, depending on the type of slag. ~0.5 Gt of steelmaking slag is produced every year (USGS 2018) and this could potentially reach ~2 Gt yr^{-1} by the end of the century (Renforth 2019). In addition to new slag, there is an estimated 160 million m^3 of legacy slag in the UK alone (Riley et al. 2020), stockpiled or dumped from historical steelmaking.

Artificial ground poses challenges around ground stability but slag-dominated artificial ground also offers opportunities for atmospheric CO_2 drawdown. In this contribution, we document the lithification of legacy slag deposits – conversion of loose gravelly slag material into a rock-like mass through cementation of calcite via drawdown of atmospheric CO_2.

Parts of slag heaps at our case study sites (Glengarnock and Warton, UK) have a lithified nature: gravel-to-cobble sized lumps of slag are visible but have been cemented together with a mineral cement, with an appearance not unlike a natural breccia rock. We present field, X-Ray Diffraction and $\delta^{13}C$ data from these case study sites to document the lithification of slag-dominated artificial ground through mineralisation of atmospheric CO_2 as a cementing phase; we present scanning electron microscope data to show the microstructural evolution of this lithification. This understanding has implications for artificial ground stabilisation and how atmospheric CO_2 drawdown can be harnessed in this process.

References

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