

Quantifying carbon dioxide removal via enhanced rock weathering in arable croplands within the UK

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Enhanced rock weathering (ERW) has been predicted by modelling studies to have a potential to remove up to 6 to 30 MtCO₂ yr⁻¹ by 2050 when applied to UK arable croplands, contributing to up to 45% of CDR required to meet the UK's net zero target [1]. However, there is a pressing need to verify these model estimates with field trials of ERW conducted under real world conditions before implementing and upscaling this approach.

We present results from a 3-year field trial conducted on typical UK arable croplands in central England. The field site at Harpenden is characterized by a soil pH of ~6.6 and implemented annual crop rotation over the course of the trial. Crushed basalt, consisting principally of fast weathering silicate minerals (e.g. plagioclase and augite) and with an average particle size of <2 mm, was applied each year at a rate of 40 t/ha/yr with shallow tilling prior to crop sowing. Adjacent plots were left untreated to act as controls. Analysis of soil porewaters and the soil exchangeable fraction provided clear evidence for weathering of the applied basalt, with higher alkalinity and concentrations of major cations in soil waters from basalt-treated plots relative to control plots. An average rate of CDR (determined via alkalinity) over the course of the trial was 0.18 tCO₂/ha/yr, though this varied between years as a function of water availability (i.e. the balance between precipitation and evapotranspiration). However, evidence for the significant retention of cations within the soil exchangeable fraction implies a higher net CDR value of 0.6 tCO₂/ha/yr. No evidence was found for basalt treatment causing increased concentrations of heavy metals in the soil waters or the soil exchangeable fraction.

Our results provide strong evidence for the viability of conducting CDR via ERW within UK arable soils and highlight the importance of water availability in controlling the extent of CDR achieved on short (annual) timescales. They also emphasise the need to account for soil-retained cations (and their time-lags for release) when considering the realisation of net CDR potential through ERW.

References:

[1] Kantzas E et al. (2022) Nat. Geosci 15(5): 382-389