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CO_2 removal associated with enhanced rock weathering in arable croplands in Norfolk, UK

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Enhanced rock weathering is a method of atmospheric CO_2 removal where crushed reactive silicate minerals are applied at the Earths' surface thereby enhancing natural weathering rates. Dissolution of silicate minerals leads to atmospheric CO_2 being converted to dissolved inorganic carbon or pedogenic carbonate [e.g. 1]. Croplands are a prime candidate for application of this technique [2] as they have the available infrastructure needed for rock powder application, and nutrients released during rock weathering may provide additional co-benefits [3].

Here we present results from a field trial of enhanced rock weathering conducted with a range of annual crops in Norfolk, UK over a period of 3 years (2019-2021). In this experiment, crushed rock powder was applied to two 0.5 ha plots at a rate of 40 tonnes per hectare per year and two identical plots were left untreated to act as controls. We report geochemical data from soil waters (major cations, anions, total alkalinity and $^{87}Sr/^{86}Sr$) and use these to quantify CO_2removal associated with the generation of dissolved inorganic carbon in soil waters. Additionally, we assess the impact of crushed rock treatment on soil water quality (i.e., trace metal concentrations).

In fields that hosted pea crops, treated plots were associated with increased flux of dissolved inorganic carbon of up to ~40% relative to the control plots. With other crops (e.g., sugar beet, barley) only minimal differences were observed between control and treated sites. We discuss mechanisms that could lead to increased CO_2 removal, including the potential role of nitrogen-fixation (as peas are N_2-fixers).

The multi-year assessment presented in this study provides vital contextual information for assessing the long-term effectiveness of enhanced rock weathering as an atmospheric CO_2 removal strategy. We highlight and discuss the need for further field trials across different climatic and agricultural environments.

[1] Taylor et al. (2016), Nature Climate Change, 6, 402-406
[2] Beerling et al. (2020), Nature, 583, 242-248
[3] Andrews and Taylor, (2019), Elements, 15, 253-258