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Carbon dioxide removal in field trials of enhanced weathering on arable croplands

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Weathering is a natural geological process which converts atmospheric carbon dioxide (CO_2) dissolved in rainwater into dissolved inorganic carbon or pedogenic carbonate that are effectively permanent carbon stores on human-relevant timescales. Enhanced weathering aims to accelerate weathering rates through the application of crushed rocks to areas such as croplands [1] which have the available infrastructure needed for rock application. Additionally, nutrients released during rock weathering may provide co-benefits to the crops themselves [e.g., 2]. Modelling studies show that large-scale deployment of enhanced weathering has the potential to reduce levels of atmospheric CO_2 by ~30 to 300 ppm the end of the century [e.g., 3]. There is, however, a pressing need to verify model predictions through long-term field trials and to incorporate learnings from studies of natural and analogue systems.

Here we present results from large-scale enhanced weathering field trials being carried out through the Leverhulme Centre for Climate Change Mitigation [e.g., 4]. We focus on a trial being conducted with a range of annual crops in Norfolk, UK, over a period of 4 years (2019-2022), where crushed rock powder was applied to two 0.5 ha plots at a rate of 40 tons per hectare per year and two identical plots were left untreated to act as controls. We quantify CO_2 removal associated with both the generation of dissolved inorganic carbon and pedogenic carbonate formation. We report an extensive geochemical data set from both soils and soil waters that we use to assess nutrient availability, soil quality and trace metal mobilisation.

Multi-year assessments of enhanced weathering, such as this study, provide vital contextual information for assessing the long-term effectiveness of enhanced weathering as an atmospheric CO_2 removal strategy. We highlight and discuss the need for further field trials as well natural and analogue studies across a range of environments.

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[2] Andrews and Taylor, (2019), Elements, 15, 253-258
[3] Taylor et al. (2016), Nature Climate Change, 6, 402-406
[4] Larkin et al., (2022), Frontiers in Climate, 4