Direct Field Measurement and Downstream Data Assessment for Enhanced Rock Weathering CDR Estimation in Illinois, USA

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Abstract:
Research collaboration between scientists at University of Illinois, The Leverhulme Centre for Climate Change Mitigation, and Eion Corp provide new insights from two enhanced rock weathering field trials in Illinois, USA. In 2022, Eion initiated a 1-year field trial, whereby soybean fields were amended with 3.71 t/ha olivine application. This olivine study was compared with an ongoing 4-year trial conducted by UIUC, whereby 50 t/ha basalt was applied annually on miscanthus and maize/soybean fields. In both field trials, cations and immobile tracers naturally present in the applied rock were measured in the topsoil along with weathering product fluxes in leachate. In addition, lysimeter-based non-carbonic acid weathering fluxes and plant-tissue based biomass uptake of base cations were directly measured and subtracted from the gross carbon dioxide removal (CDR) budget.

In the Eion trial, approximately half of the fine <100-micron olivine powder dissolved in mildly acidic pH 6-7 agricultural fields within 8-months, yielding a CDR estimate of 1.78 tCO_2/ha/yr. In comparison, 4-year UIUC trial using basalt which yielded a CDR estimate of 8.6 tCO_2/ha/yr for miscanthus and 3.7 tCO_2/ha/yr for maize/soybean. Normalizing by the amount of amendment, the olivine trial yielded a 0.47 tCO2/tFeedstock/yr efficiency, whereas the basalt trial yielded a 0.16 tCO2/tFeedstock/yr (miscanthus) and 0.07 tCO2/tFeedstock/yr (maize/soybean) efficiency. Differences in CDR efficacy are likely due to differences in the natural mineral potential of the feedstocks, the saturation of the UIUC soils with basalt, and plant interactions.

We also quantified precipitation of carbonate minerals in rivers downstream of the specific field sites via the USGS river chemistry network and PHREEQC aqueous speciation program. A small fraction of analyzed aqueous chemistry data points showed positive saturation indices with respect to calcium carbonate phases, indicating the possibility of downstream system loss effects from precipitation and CO_2 degassing. This study demonstrates the need to robustly evaluate CDR processes spanning multiple phases and spatial scales (solid soil, soil pore water and plant tissue measurements, and river chemistry modeling).

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