Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16228

Comparison of Carbon Dioxide Removal estimation methods in Enhanced Rock Weathering

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Enhanced Rock Weathering (ERW), grinding and spreading of silicate rocks, has been proposed as Carbon Dioxide Removal (CDR) technique that can remove between 0.5 to 2 $GtCO_2$ $year^{-1}$ when deployed at scale [1]. Pulverizing the rocks accelerates the natural weathering processes and allows the atmospheric CO_2 dissolved in rainwater to react with silicate rocks, leading to dissolution and release of base cations and bicarbonates.

The main incentive for implementing ERW at scale is the commercial sale of carbon offsets. Therefore, a robust, verifiable method to calculate the amount of CO_2 captured is needed. However, estimates of CDR potential currently reported differ by up to two orders of magnitude [2]. This is due to different experimental settings and conditions in the lab and field as well as different "monitoring, reporting, and verification" (MRV) techniques used to estimate the impact ERW has on carbon mitigation.

Most of the studies estimate the CDR potential based on cation measurements in leachate and soils [2], assuming a complete dissolution of the amendment through chemical reactions and establishing a mass balance of released cations with bicarbonate production. Estimation of CO_2 sequestration from changes in alkalinity or inorganic carbon is often avoided as direct carbon measurements can be difficult to interpret. In this study, we conduct a short-term soil column experiment with ultramafic rock amendment and measure multiple parameters in leachates (cations, anions, pH, alkalinity, DIC & DOC) and in soils (cations, pH, TIC, TOC) to compare CDR estimation methods based on different proxies. Our results show that CDR estimates based on cation proxies results in up to five times higher CDR than direct carbon measurement approaches. Our work aims to benchmark how different MRV approaches of calculating carbon sequestration by ERW influence the final estimation of CO_2 removal. As there is currently no standardized or universally accepted method for verification of the amount of carbon dioxide mitigated, this study aids in the development of a verifiable methodology for carbon accounting.

[1] Beerling et al. (2020), Nature 583, 242–248
[2] Kelland et al. (2020), *Glob. Change Biol*. 26, 3658–3676