Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27669

Strategizing the deployment of enhanced rock weathering for CO_2 removal across the globe.

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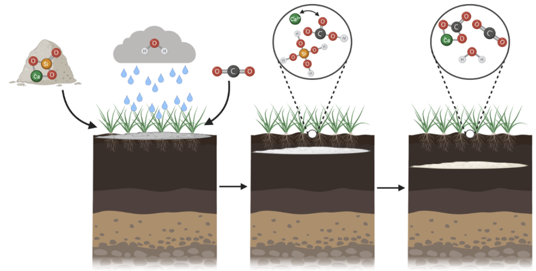
Enhanced rock weathering (ERW) is a promising carbon dioxide removal (CDR) technology that involves the spreading of silicate rock powder in agricultural settings, trapping CO_2 as soil alkalinity and/or pedogenic carbonate minerals, while providing ancillary agricultural benefits. ERW has gained traction largely due to its simplicity and low barrier to entry; however, questions remain regarding the large-scale feasibility of ERW, and whether it can be used to efficiently reach the gigatonnes/year scale CDR rates needed to mitigate climate change.

There are over 1.6 billion hectares of farmland globally. Further, potential ERW feedstocks are widespread, with hundreds of mines and quarries spread across the globe from which suitable rock powder can be produced for ERW. This means ERW has widespread potential to offset CO_2 emissions. However, the geographic separation between mines and agricultural areas introduces logistical questions. One such question is how to develop an optimized deployment strategy through which mines producing suitable feedstocks for ERW can be matched to nearby suitable farmland, such that the costs and emissions from feedstock preparation are minimized. This is a key point that must be addressed, as the net CDR potential of this technique is significantly reduced, and the costs significantly increased, if feedstock distribution is done inefficiently.

We have developed life cycle assessment (LCA) and techno-economic analysis (TEA) models to assess the cradle-to-grave GHG emissions and costs associated with ERW globally. This includes the mining/quarrying, comminution, transportation, and spreading of the ERW feedstock. Here, we integrated standard LCA/TEA models with geographic information systems (GIS) to calculate GHG emissions and costs for feedstock transportation from any global mine to any farmland area. GIS modelling was completed using a multimodal transportation network comprising global roads, railways and shipping routes, and net CDR costs were calculated for four proposed feedstock types, basalt, serpentinite, kimberlite, and wollastonite skarn. Overall, we found that while the net CDR costs for ERW vary greatly depending on the feedstock type and farmland destination, the widespread distribution of rock sources across the globe keeps the CDR costs feasible for large portions of global farmland.



1. $CaSiO_3 + 2CO_2 + 3\ H_2O \rightarrow Ca^{2+} + 2HCO_3^- + H_4SiO_4$
2. $Ca^{2+} + 2HCO_3^- \rightarrow CaCO_3 + CO_2 + H_2O$

Figure 1. Chemical reactions associated with capturing carbon through enhanced rock weathering with wollastonite skarn.