Life Cycle Analysis of Enhanced Rock Weathering

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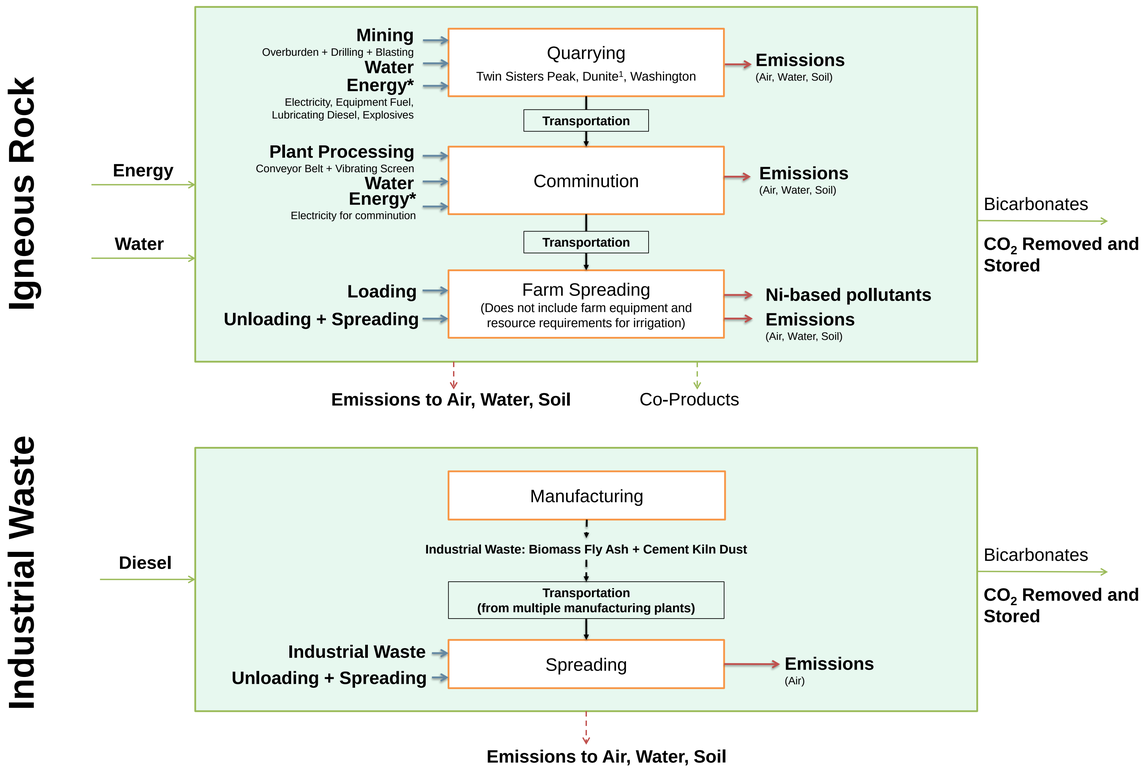
Introduction

- Enhanced Rock Weathering (ERW) is an emerging carbon dioxide removal (CDR) technology that involve reactions between silicate minerals, rock, and water to form stable, environmentally benign, solid carbon materials to achieve net removals of CO_2 from the atmosphere.
- This study aims to evaluate the life cycle impacts of weathering agricultural fields in the U.S. Midwest with igneous rock (dunite/olivine) and industrial waste minerals using literature and estimated data from a techno-economic analysis (TEA) study.

Methods

- Functional unit: 1 tonne (t) of CO_2 removed and stored[a].

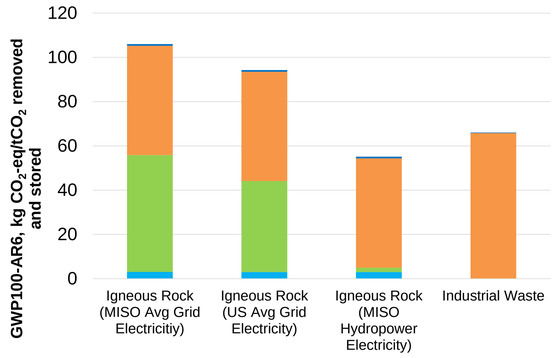


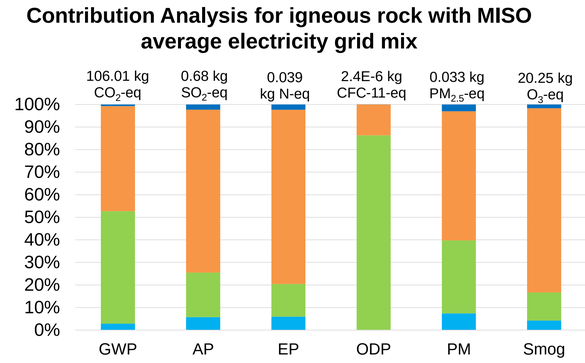
- Environmental impacts are evaluated using TRACI 2.1 factors and 100-year AR6 Global Warming Potential (GWP).

[a] To be consistent with the TEA study, the term *removed and stored* refers to the CO_2 weathered by the ERW technology. The term *net removed* refers to the results after subtracting GWP emissions from the *removed and stored* portion.
* Three electricity grid mixes are considered for igneous rock: MISO Average Electricity Grid, US Average Electricity Grid, and MISO Hydropower Electricity.
Main assumptions (baseline): Transportation distance = 250 miles. Timeframe of study = 1 year. Particle size (rock) = 20 µm. No allocation was considered to Industrial waste materials as it is considered a rejected (waste) co-product.

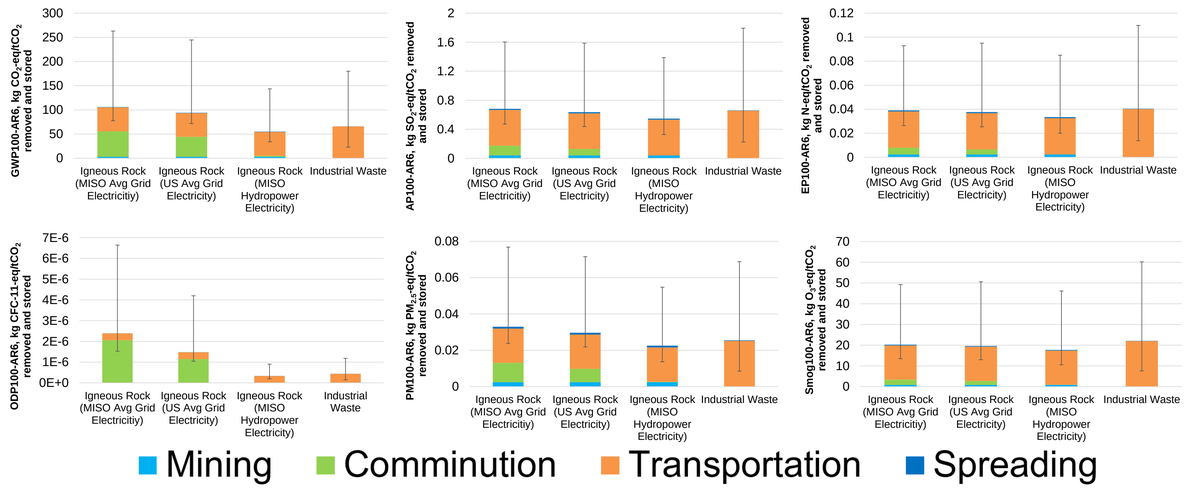
Results

The GWP impact with igneous rock and industrial waste materials ranges 34–263 and 23–180 kg CO_2-eq/tCO_2 removed and stored[a], respectively (overall emissions between –977 and –737 kg CO_2-eq net removed[a]/tCO_2 removed and stored[a]). The main environmental hotspots are comminution and transportation.





Results for main midpoint impact categories



Conclusion

The results from this study indicate that life cycle emissions from ERW are well below the expected CDR potential of the technology and are consistent with values reported in literature. Using low-carbon electricity and transportation technologies can help reduce environmental impacts and achieve more efficient net removal.

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