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Climate mitigation and food production with glacial rock flour - A case for Danish agriculture

One potential climate mitigation solution could be to spread the fine (46 µm) glacial rock flour from Greenland on agricultural fields to enhance its weathering rate with resulting CO2-uptake from the production of alkalinity. The net climate mitigation potential of this process will depend on the weathering rate, but also the embedded greenhouse gas emissions of its lifecycle. This thesis aims to estimate the net greenhouse gas balance of application with glacial rock flour on agricultural fields in Denmark. The CO2-uptake from weathering of glacial rock flour in soil was estimated from the release rates of cations in a pot experiment with perennial ryegrass (Lolium Perenne) in Denmark. There was no significant difference in cation release rates across application rates of 10, 20, 30, 40 and 50 t ha-1 of glacial rock flour, resulting in an uptake of 5.31 kg CO2 t-1 after 8.5 months across all five treatments. The effect on plant growth by the end of the experiment was non-significant but could potentially be due to temperature limitation. The greenhouse gas emissions from the lifecycle of glacial rock flour was estimated for a hypothetical "cradle-to-field" lifecycle using secondary emission data on CO2, and when possible also CH4 and N2O, for activities which are expected to be the closest proxies. It was estimated that the most "climate-optimal" lifecycle emits 26.32 kg CO2e t- 1 or 39.32 kg CO2e t-1 for glacial rock flour extracted on-land or in-water, respectively. The lifecycle greenhouse gas emissions are therefore not balanced by CO2-uptake from weathering after 8.5 months in Denmark, but it is expected that glacial rock flour eventually will lead to a net CO2-uptake of around 215 kg CO2e t-1 and 200 kg CO2e t-1 for land-based and water-based glacial rock flour, respectively, based on its geochemical composition. There is need for more long-term experiments to estimate the continued weathering rate and thereby evaluate the role of glacial rock flour in climate mitigation in this century.

Forfatter: Josefine Lysdal Wulffeld **Type:** Report | Rapport **Årstal:** 2021 **Emner:** Climate; Mitigation; Food; Rock flour **Udgivelsessted:** Copenhagen **Udgivelsesland:** Denmark

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Remineralisation Potential of Glacier Rock Flour – A Comparison of Nutrient Properties of Glacial Rock Flour From Different Proglacial Environments

In a global world where climate change and a growing population increase the requirements for food, the need for fertile soil becomes a problem, especially in the tropics. New research shows that Greenlandic Glacier Rock Flour (GRF) can be used to remineralise nutrient depleted soils and thus, to some extent, alleviate some of these problems.

This project investigates whether GRF ´s fertility potential depends on the size of the glacier thermal regime and locations. Glacier Rock Flour was collected from different sites in Greenland, Svalbard, Alaska and Argentina for comparison. Incubation experiments were carried out by mixing 10% GRF with soil/sand in the ratio 1:1. The level of available potassium and phosphorus was measured after two and four weeks and compared to a control sample only containing the soil/sand.

The analysis shows that there is a difference in the available K depending on location, while the P analysis is more inconsistent.

Based on the results, the main factor for nutrient release is the particle size of the GRF, and this is mainly influenced by the thermal regime of the glacier and the bedrock. The results also show that the physical properties and soil environment affect the release of potassium and phosphorus the most.

Overall, GRF from Greenland seems to be more suitable for remineralisation compared to GRF from other locations, especially when looking at the available potassium.

Forfatter: Lea Maria Frederiksen **Type:** Report | Rapport **Årstal:** 2018 **Emner:** Rock flour; Remineralisation **Udgivelsessted:** Copenhagen **Udgivelsesland:** Denmark

Åben publikation