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Ocean alkalinity enhancement through enhanced silicate weathering in coastal areas: a long-term mesocosm study

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Enhanced silicate weathering (ESW) in coastal environments is a promising method for ocean alkalinity enhancement. The idea behind ESW is to generate alkalinity by application of silicate minerals in coastal areas, where waves, currents and bioturbation can speed up the weathering rate. Due to its potentially large CO_2 sequestration capacity and relatively high technological readiness, allowing rapid upscaling, coastal ESW currently receives substantial interest from researchers and policymakers. However, the vast majority of studies on ESW have been conducted in idealised laboratory conditions, while research on the method in natural environments is lacking. As a result, the CO_2 sequestration efficiency and environmental risks when applying ESW in the field remain largely unknown.

Here we present results from the first and longest-running mesocosm experiment investigating ESW and associated CO_2 uptake in coastal marine sediments. Using tanks containing one square meter of natural seafloor each, we have studied biogeochemical cycling in sediment treated with the fast-weathering silicate mineral olivine. Lugworms (*Arenicola marina*) were added to some tanks to investigate the effect of bioturbation on the olivine dissolution rate, as well as the impact of olivine addition on biota. In the mesocosms, we quantified the sedimentary release of alkalinity and other weathering end-products (trace metals and dissolved silicate). Five years into the experiment, olivine dissolution is obvious from an elevated sedimentary alkalinity release and decreased average olivine grain size. The elevated alkalinity release has further led to higher CO_2 sequestrations in tanks with olivine. Based on the results from this unique mesocosm setup, we will discuss the large-scale effect of ESW on biogeochemical cycling in coastal ecosystems.