Quantifying the CO_2 sequestration potential of enhanced silicate weathering in coastal environments

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Negative emission technologies (NETs) are being actively investigated as a strategy to limit global warming to within the Paris targets. Enhanced silicate weathering (ESW) is a NET approach that aims to stimulate the natural process of silicate weathering. ESW targets to elevate the alkalinity of the surface ocean, thus enabling additional CO_2 uptake from the atmosphere.

Up until now, ESW studies have mainly focused on terrestrial application. Here, we aim to quantify the potential of ESW in the coastal environment, which provides a new and large application domain. One advantage is that ESW can be directly integrated into coastal management programs with existing technology, and there are no competing land claims (as is the case for terrestrial NETs). Moreover, the physical and biological conditions of coastal environments might favour silicate dissolution: (1) currents and waves stimulate abrasion of weathering crusts on particles, and (2) faunal ingestion and microbial metabolism can create favourable acidic environments for weathering.

Although model studies show its feasibility, there has been no rigorous assessment of its CO2-sequestration efficiency and environmental impacts, which are bottlenecks to its implementation. Here, we present the results of experiments in a large-scale mesocosm set-up, which was purposely built to investigate the rate of ESW and associated CO_2 uptake in coastal marine sediments under realistic natural settings (bioturbation, waves, currents). We quantified the sedimentary biogeochemical cycling, the fluxes across the sediment-water interface, and the CO_2 sequestration efficiency following the addition of olivine. We discuss the release of weathering end-products from the sediment (trace metals, alkalinity and dissolved silicate) and the subsequent influence of ESW on the biogeochemical cycling in coastal ecosystems.