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The age of reason for mineral-based ocean alkalinity enhancement?

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To tackle climate change, there is a pressing need for the deployment of carbon dioxide removal (CDR) technologies, which actively remove CO_2 from the atmosphere. One ocean-based CDR technique is ocean alkalinity enhancement (OAE), which aims to increase the alkalinity content of seawater to stimulate the CO_2 uptake of the surface ocean. A particularly prominent implementation of OAE involves the addition of minerals to coastal and shelf sediments, which release alkalinity upon transformation in the seabed - termed “enhanced weathering”. Preliminary model estimates of the CDR potential of enhanced weathering are in the order of several gigatonnes CO_2 per year, yet these estimates do not take into account potential impacts on natural alkalinity generation in coastal systems.

Here, I will discuss the natural alkalinity generation capacity of the global coastal and shelf seafloor and its implications for mineral-based OAE. The long-term carbonate chemistry ‘Munida’ timeseries from New Zealand provides evidence for a natural coastal carbonate buffer mechanism that counteracts ocean acidification. Active alkalinity addition to coastal systems will interfere with this natural buffer mechanism, leading to less CO_2 drawdown than initially assumed (i.e., the recently proposed ‘additionality problem’ [1]). Further practical limitations of mineral additions in the coastal zone make that widespread deployment of mineral-based OAE is unlikely to achieve gigaton-scale CO_2 drawdown. Yet, a well-considered combination of different OAE technologies could buffer ocean acidification and increase oceanic CO_2 uptake on local and regional scales. Optimal deployment of mineral-based OAE technologies will require a good understanding of natural alkalinity generation in the seafloor and sediment transport in the coastal zone.

[1] Bach (2024), *Biogeosciences*, 21, 261–277.