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Sediment Biogeochemical Responses to Ocean Alkalinity Enhancement

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Ocean alkalinity enhancement (OAE) is a marine carbon dioxide removal (mCDR) strategy that accelerates the ocean's natural CO_2 uptake by increasing buffering capacity through the addition of alkaline minerals like magnesium hydroxide. This raises pH, decreases pCO_2, and increases the ocean's CO_2-storage capacity. OAE also has the potential to influence natural biogeochemical processes, including those occurring within marine sediment. Marine sediments generate their own alkalinity through anaerobic respiration and potentially calcium carbonate ($CaCO_3$) dissolution. This natural alkalinity flux may be altered if OAE feedstock settles on the seafloor, where its dissolution could buffer sediment porewater, raise pH, and suppress the natural alkalinity cycling. Such changes may substitute "natural" alkalinity with "artificial" alkalinity or promote secondary $CaCO_3$ precipitation, an issue referred to as the "additionality problem" [1]. Without effective monitoring, reporting, and verification (MRV), it becomes difficult to determine whether OAE is genuinely offsetting anthropogenic CO_2 emissions or simply replacing the ocean's inherent buffering; accounting for this distinction is essential for effective MRV. In this study, *ex situ* microcosm experiments were conducted to evaluate how an alkalinity enhancement feedstock affects sediment geochemistry, with a focus on benthic fluxes of dissolved inorganic carbon (DIC) and total alkalinity (TA). Sediment was collected from the Bedford Basin in Halifax, Nova Scotia, Canada, and divided into three treatments with three replicates each: seawater + feedstock, seawater + sediment, and seawater + sediment + feedstock. It was hypothesized that the treatment containing both sediment and feedstock would produce a greater shift in sediment chemistry than either component alone, enhancing CO_2 storage. Results indicate elevated alkalinity in the seawater + sediment treatment compared to the seawater + feedstock treatment, with the seawater + sediment + feedstock treatment producing the greatest alkalinity overall. There was, however, notable heterogeneity among replicates.

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