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Sediment consumption of added alkalinity reduces the efficacy of ocean alkalinity enhancement

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Ocean alkalinity enhancement (OAE) is a carbon dioxide removal (CDR) strategy with the potential to both remove and store atmospheric CO2 at Gt scales. However, many questions remain about its efficacy and ecological impacts. Focusing on seawater-sediment interaction, for example, recent studies have identified concerns about both a) the stability of added alkalinity (e.g., loss to CaCO3 precipitation); and b) reduction in natural alkalinity generation (i.e., additionality). To assess how seawater with added alkalinity interacts with sand, we conducted lab-based, flow-through sand column experiments. Testing a range of alkalinity additions up to 1200 µM, we show that OAE-treated seawater significantly reduces benthic alkalinity flux. In unequilibrated conditions (i.e., low DIC, prior to seawater equilibration with the atmosphere), added alkalinity is consumed by sediments, resulting in net negative benthic alkalinity flux. In equilibrated conditions (i.e., high DIC, following seawater equilibration with the atmosphere), added alkalinity is also consumed, although to a much lesser degree. In both cases, the net flux of alkalinity to the water column is significantly decreased relative to natural (control) conditions. These results suggest that OAE confronts not only an “additionality problem", but also that a fraction of alkalinity is directly lost during advection through sediments. OAE deployments in coastal areas may need to account for this loss during measurement, reporting, and verification.