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Carbon sequestration in the form of alkalinity via benthic processes in intertidal sediments

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Atmospheric CO_2 is captured by photosynthesis. The organic matter produced in this way represents a storage of atmospheric carbon if it is trapped in sediments over the long term. In coastal environments, this is known as blue carbon. However, sedimentary organic matter is mineralised, meaning that storage is only temporary. Should organic carbon be converted back into CO_2 via aerobic respiration, the net carbon balance will be zero. However, if organic carbon is converted into bicarbonate, the result is carbon that is trapped in the long term. This process occurs as a result of the production of alkalinity during respiration. Alkalinity is chiefly produced during the anaerobic mineralisation of organic matter through denitrification, the reduction of iron and manganese oxides, and sulfate reduction. Alkalinity is produced by the consumption of sulfate and nitrate. It can also be produced by the production of cations, such as Fe^{2+} and Mn^{2+}. However, it is important to note that the alkalinity balance is zero if secondary processes regenerate sulfate (oxidation of sulfides) or reoxidise reduced metals. Precipitation or dissolution of calcium carbonates in sediments also has a significant impact on the alkalinity balance. The study of benthic alkalinity fluxes, vertical profiles of interstitial water, and the solid fraction of intertidal sediments in blue carbon zones along the French coastline shows that denitrification plays a role in the alkalinity balance in eutrophic areas. The reduction of Fe and Mn oxides plays a minor role because the storage of dissolved Fe(II) and Mn(II) represents a low mass balance. Sulfate reduction is the primary source of alkalinity, with the majority of reduced sulfate being stored in the sediment as particulate sulfide. Therefore, in order to accurately quantify blue carbon, it is not sufficient to measure carbon concentrations in the sediment; it is also necessary to measure the authigenic sulfur concentration, which is primarily in the form of iron sulfide. In the salt marsh sediments we studied, where there is no authigenic precipitation of $CaCO_3$, the accumulation of authigenic sulfides increases the estimate of CO_2 sequestered by these environments by up to 50%.