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# The key role of bioturbation in the carbon-sulfur-iron interplay in salt marsh sediments

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Salt marshes are highly productive coastal wetlands that serve a critical role in carbon sequestration and nutrient trapping. In contrast to marine sediments that accumulate slowly over many thousands or millions of years, salt marshes are highly dynamic transitional environments between the terrestrial and the marine realms. Because salt marshes are flushed daily or monthly with seawater (with high concentrations of sulfate), our understanding is that the oxidation of organic carbon in salt marsh sediments is dominated by microbial sulfate reduction, similar to deeper marine sediments. These high sulfate concentrations either inhibit methanogenesis or anaerobically oxidize any methane produced; thus salt marshes are not currently a large source of methane to the atmosphere, unlike terrestrial wetlands.

We present pore fluid geochemicla results taken from salt marsh sediments in eastern England. The subsurface geochemistry can be broadly divided into two types; ferruginous-sediments with very high ferrous iron concentrations (up to 2.5mM) and sulfidic-sediments with high aqueous sulfide concentration (up to 8mM) and methane. These two types of sediment are found as close as a few meters apart and are remarkably different in both geochemistry and sediment type and texture. We suggest that spatial variation in the ferrous iron-rich saline groundwater creates these two distinguishable sediments within the salt marsh. Where this saline water body is close to the surface, the supply of ferrous iron allows bioturbation by scavenging sulfide that would otherwise be toxic. This bioturbation enhances bioirrigation through which oxygen is supplied from the overlying oxygenated pond mixing with iron from the saline water body below. In the aftermath of the bioturbation, the sediment becomes organic-matter poor but sulfate- and iron-oxide rich. In contrast, in locations where the ferrous iron is depleted, the sediment becomes toxic with excess aqueous sulfide and bioturbation is prevented. The end result in this case is sediment that is methane and sulfide rich and iron and sulfate poor.