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Effects of salinity on biogeochemical cycling of phosphorus in coastal soil

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Global warming has led to perceptible sea level rise, with coastal regions suffering from the harmful effects of saltwater intrusion. The influence of increasing salinity on nutrient biogeochemical cycling was studied in coastal soil from Rehoboth Bay, DE, USA using batch incubation methods; changes were measured in phosphate (P) pools and their isotopic composition ($\delta^{18}O_P$), bulk nitrogen isotopes ($\delta^{15}N$), bulk carbon isotopes ($\delta^{13}C$), and microbial parameters, including alkaline phosphatase activity (APA) and dehydrogenase activity (DHA).

Among three salinity treatments [seawater (SW), mesohaline (MS), and freshwater (FW)], biotic treatment showed changes distinct from abiotic (autoclaved) controls. For SW/MS treatments, $\delta^{13}C$ depletion rebounded back to initial levels while FW treatment remained depleted. Within four days, SW controls became enriched in $\delta^{13}C$ where MS/FW controls were depleted. This change was accompanied by the decrease in the NaOH-P pool. Released P may reprecipitate with $CaCO_3$, affecting the $\delta^{13}C$ signal.

There was uniform $\delta^{15}N$ depletion across all treatments; one likely reason was nitrification and nitrite formation in the presence of native microorganisms. The SW treatment had the highest N isotope depletion, suggesting increased NH_4^+ mobilization with salinization.

Comparing P pools among abiotic (control) and biotic incubations, a larger decrease in the NaOH-P and HNO_3-P pools were found in both incubations than in control across all salnity treatments. Increasing salinity results in increased mobilization of Fe-bound P (NaOH) pool, which is consistent with the largest decrease in the NaOH-P pool in SW treatment. A corresponding increase in the more bioavailable $NaHCO_3$-P pool suggests microbial processes likely resulted in the formation of bioavailable P in the all treatments, but in different extent.

Among the three salinity levels tested, the expression of APA was highest in MS and SW and DHA was highest in SW. These results suggest that the salt-tolerant microorganisms are active to convert organic P into inorganic P, which is consistent with a higher increase in P in the $NaHCO_3$-P pool. These results suggest that some of the native microorganisms can tolerate salinity stress to a certain level but increase activity to cycle P pools to meet their metabolic and nutritional demands.