Salinity influences arsenic speciation and mobility in coastal soils impacted by saltwater flooding and intrusion

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Increasing coastal flooding and saltwater intrusion pose serious challenges to the geochemical stability of arsenic (As) in contaminated estuarine soils. Inundation with brackish or marine water alters redox gradients and ion exchange processes, potentially transforming arsenic from relatively immobile soil-bound forms to dissolved, bioavailable species that can leach into nearby aquatic systems. This study investigated the effects of salinity on arsenic mobilization and speciation. Soils collected from a historically contaminated tidal floodplain in Wilmington, Delaware were incubated with three water chemistries: artificial seawater (ASW), artificial rainwater (ARW), and a 1:1 mixture (ASRW), over a 14-day period. Experimental results showed rapid and substantial As release in ASW and ASRW treatments, with aqueous concentrations reaching up to 10 ppm within the first 48 hours and remaining elevated thereafter. In contrast, ARW treatments, especially in soils with lower initial contamination, exhibited minimal and often declining As concentrations over time. Geochemical analysis indicated that higher salinity enhanced As release, likely by disrupting Fe-(oxyhydr)oxide binding through chloride competition and induced reductive dissolution. Synchrotron-based μXRF mapping confirmed As co-localization with Fe and S phases. Arsenic K-edge XANES analysis revealed that both ASW and ARW treatments led to a modest but progressive increase in the proportion of As(V) over the 14-day incubation. Linear combination fitting showed time-dependent oxidation of As, suggesting that even under predominantly anoxic conditions, partial oxidative transformation of As species occurred, possibly influenced by aging or changes in mineral associations. These findings emphasize the central role of salinity in shaping As mobility and speciation in submerged soils and highlight the importance of incorporating salinity-driven geochemical changes into risk assessments for contaminated coastal landscapes.