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Early-Stage Fate and Transport of PFAS and Metals Following a Large-Scale Lithium-Ion Battery Fire in a Coastal Critical Zone

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The rapid global expansion of lithium-ion battery infrastructure has introduced a new class of contaminant sources linked to catastrophic battery-storage fires, yet their environmental fate in natural systems has not been evaluated. In January 2025, a major fire at a large-scale lithium-ion battery storage facility in coastal California released complex mixtures of metal-rich particulates and fluorinated combustion byproducts, including per- and polyfluoroalkyl substances (PFAS), across soils, shallow aquifers, and estuarine environments. Here, we present early field observations from a hydro-biogeochemical investigation designed to capture contaminant deposition, mobilization, and transport in a tidally influenced coastal critical zone. We integrate spatially resolved sampling of domestic wells within situ geochemical measurements (salinity, conductivity, pH) to assess coupled physical, chemical, and hydrologic controls on contaminant behavior across groundwater. PFAS, including both short- and long-chain compounds and selected fluorinated precursors, were quantified using LC-MS/MS. Four distinct PFAS compounds were detected during later field sampling, indicating heterogeneous deposition and early-stage mobilization across environmental compartments. Trace metals, including copper, vanadium, and zinc, were also detected in groundwater; although not uniquely diagnostic of battery materials, their spatial variability provides insight into co-transport processes, geochemical controls, and background metal mobilization in post-fire coastal systems. Our results highlight the sensitivity of PFAS and metal transport to salinity gradients, shallow groundwater conditions, and early recharge dynamics in coastal environments. This study provides the first field-based framework for evaluating contaminant fate following lithium-ion battery fires and underscores the importance of hydro-biogeochemical coupling in assessing groundwater vulnerability and estuarine water quality near rapidly expanding energy-storage infrastructure.

Keywords: PFAS, Lithium Battery Fire, groundwater, geochemistry, contamination.