GEOC: Division of Geochemistry

44 - Hydrologic controls on arsenic cycling due to tidal fluctuation

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Abstract: Historical industrial activities have resulted in soil contamination at sites throughout the United States and worldwide. Many of these sites are located along coastlines, making them vulnerable to hydrologic and biogeochemical alterations due to climate change and sea-level rise. Coastal industrial sites in Wilmington, DE, USA commonly contain elevated concentrations of arsenic (As), lead, chromium, and other inorganic contaminants, which pose potential risks to both human and ecological health. To assess hydrologic impacts on contaminant mobility at one of these former industrial sites along the tidal Christina River, we conducted quantitative comparisons of hydrologic and biogeochemical dynamics across hourly to seasonal time scales. Data were collected from pressure transducers in wells, multi-level redox sensors, and porewater samplers at a location adjacent to a tidal channel. Results indicate that sharp redox gradients exist and that redox conditions vary on tidal to seasonal timescales, likely due to two mechanisms: sub-daily water table fluctuations and seasonal groundwater-surface water interactions. In the tidally impacted variably saturated zone, redox potential varied between oxidizing and reducing conditions as the water table rose and fell. Porewater samples showed an increase in arsenic concentration coinciding with the rising tide. The seasonal hydraulic gradient between the aquifer and the channel also correlated with porewater As concentration. Higher As and Fe^{2+} concentrations were found during summer, when the gradient between average surface water level and groundwater level indicated net flow from the channel to the aquifer. Arsenic and Fe^{2+} concentrations decreased during seasonal periods of discharge to the channel. The seasonal changes were greater than tidal variations in both Eh and As concentration, indicating that the impact of the seasonal mechanism is stronger than that of the sub-daily water table fluctuations. A conceptual model describing tidal and seasonal hydro-biogeochemical coupling is presented. Our study has important implications for understanding impacts of sea-level rise and storm surge events on the mobility of inorganic contaminants.