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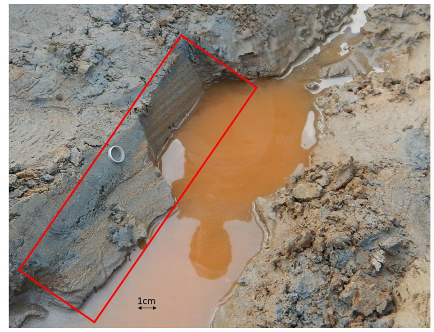
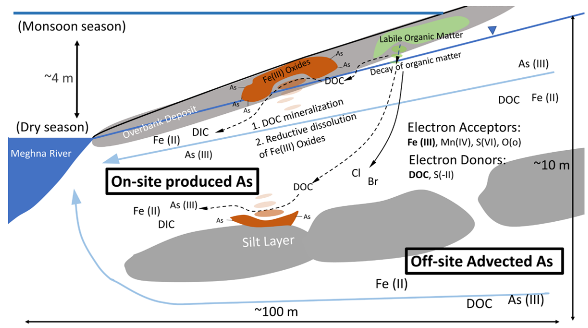
Freshly-deposited overbank sediments create an arsenic release hotspot in riverbanks of a tidally and seasonally fluctuating river

KYUNGWON KWAK[1], TOM S VARNER[2], WILLIAM NGUYEN[3], HARSHAD V KULKARNI[2], PETER S. K. KNAPPETT[1], SAUGATA DATTA[2] AND M. BAYANI CARDENAS[4]

[1]Texas A&M University
[2]University of Texas at San Antonio
[3]University of Texas
[4]The University of Texas at Austin

Presenting Author: kkwak@tamu.edu





Potential sources of arsenic (As) across local and/or regional scales in South and Southeast Asia have been hotly debated. Little attention, however, has been paid to the dynamic cycling of As along terrestrial-aquatic interfaces such as within riverbanks. Along the tidally influenced Meghna River, overbank sediments are deposited over a dynamic mixing zone between reducing groundwater and oxidizing surface water. The surficial sediments of the riverbank are characterized by laminations of 1 cm thick silty sand with alternate grey and orange layers (Figure 1). The tidally fluctuating river stage drives groundwater flow reversals within the bank which potentially regulates the redox condition of the pore waters across the riverbank's shallow hyporheic zone (HZ). We hypothesize that the overbank deposits are concentrated with solid-phase As sorbed onto Fe(III) oxides and labile sedimentary organic carbon (SOC). The reductive dissolution of the Fe(III) oxides releases additional dissolved As into the pore-waters of shallow riverbanks.

To constrain solid-to-aqueous phase mass fluxes, pore water chemistry was observed along a groundwater discharge path towards the river in early dry season (January 2020). Dissolved concentrations of the redox-sensitive elements As (12 to 164 μg/L), Fe (13 to 1865 μg/L), DIC (0.9 to 4.1 mg/L), and NH^{4+} (0.2 to 3.1 mg/L) increased towards the river underlying the intertidal zone, suggesting active reductive dissolution of Fe(III) oxides with OC acting as the electron donor (ED). The available electron acceptors (EA) (0.01 – 0.10 meq/L) and ED (0.07 – 0.28 meq/L) in the dissolved phase were much lower than the total number of electrons transferred during OC oxidation (2.36 – 7.21 meq/L). This implies solid-phase sources of OC and Fe(III)-oxides which are driving the products of reductive dissolution into the groundwater discharge path.

These results suggest that overbank sediments provide labile OC which drives the reductive dissolution of Fe(III) oxides, in turn releasing As to the pore waters in the shallow inter-tidal zone of the riverbank (Figure 2). Understanding the role of fresh overbank deposits in liberating As to the shallow aquifers will help identify and mitigate risks to exposure to high As-laden water along terrestrial-aquatic interfaces in Bangladesh.