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Variation in Sedimentary Organic Matter properties along the Meghna River-Aquifer Interface and its Implications on As Mobility

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Organic matter trapped in sediments, sedimentary organic matter (SOM), is believed to play an important role in mobilizing arsenic (As) from shallow Holocene aquifers in the Ganga-Meghna-Brahmaputra (GMB) delta in south Asia. The SOM regulates the mobility of arsenic (As) in natural environments by facilitating redox reactions and zonation. With abundant labile SOM generally resulting in more reducing conditions. In the hyporheic zone (HZ), the mixing of oxic river water and anoxic groundwater may cause the precipitation of reactive iron (Fe)-oxides which are capable of sequestering (and mobilizing) As depending on dynamic redox conditions. To determine the extent to which SOM may influence As mobility, this study characterizes the reactivity of SOM from HZ sediments along the Meghna River, Bangladesh, and its adjacent aquifer. The SOM in both the riverbank and aquifer is composed of terrestrially-derived organic material containing humic- and fulvic-like signatures. A shallow, buried silt layer (~3 m bgl) within the sandy aquifer contains fresher SOM, potentially of microbial origin, with high proportions of amides and polysaccharide moieties, which are typically labile. The labile SOM from the silt layer contains abundant electron donating moieties that may facilitate As mobilization by supporting the microbially mediated reduction of As-bearing Fe oxides. Within the HZ, the relatively high amounts of labile OM in the aquifer silt and riverbank sand inhibit the accumulation of sedimentary As in the riverbank. Conversely, SOM in a clay aquitard (~37 m bgl) beneath the aquifer contains older and more recalcitrant, terrestrially-derived material, with high proportions of aromatic carboxylate functional groups. The carboxylate-rich aquitard clay helps maintain elevated groundwater As concentrations by favoring the formation of soluble Fe and As organic complexes and ternary OM-Fe-As complexes. These findings suggest that variable SOM characteristics along the Meghna River and its adjacent aquifer contain differing reactive properties that may regulate the mobility and distribution of As and Fe.