

High arsenic groundwater is associated with solid phase arsenate reduction in Bangladesh

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Long-term exposure to trace levels of arsenic (As) in shallow groundwater puts millions of people at risk for chronic diseases in Bangladesh. Though the arsenic is naturally occurring in the shallow aquifers, the mobilization of arsenic from the sediment to the groundwater is predominantly driven by the coupling of microbial metabolism to the reduction of iron (Fe) oxides. In the sediment, As and Fe are sorbed onto minerals, and when Fe is reduced, aqueous As enters the groundwater. However, it is unknown whether the reduction of As(V) to As(III) is a critical part of the mobilization process. The goal of this work was to determine the mineral phase speciation of arsenic in sediment across two arsenic gradients in shallow aquifers. Sediment cores were collected from two well-characterized sites in Araihasar, Bangladesh located about 25km east of the capital, Dhaka. Site B, a high arsenic, slow recharge, shallow aquifer, was located in the village of Baylakandi, and site F, a low arsenic, fast recharge, shallow aquifer, was located in the village of Lashkardi. Samples were collected from drill cuttings and cores taken every five feet from the surface to 60 feet at site B and 80 feet at site F and preserved in glycerol for analysis. The sediment was characterized for arsenic speciation using x-ray absorption near edge structure (XANES) on beamline 11-2 at the Stanford Synchrotron Radiation Lightsource which in bulk mode can determine As speciation on samples with less than 1 mg kg^{-1} As in the solid phase. Arsenic XANES linear combination fits were described by As(V), As(III) and As_2S_3 standards for each depth. At both sites, at depths with low concentrations of aqueous As, the sediment was dominated by As(V). In contrast, at depths with elevated concentrations of aqueous As, the sediment was dominated by As(III). Changes in aqueous As concentrations cannot account for these changes in solid phase As speciation, indicating a bulk change occurs in the As speciation of the sediment in zones of elevated aqueous As concentrations. Therefore, reduction of solid phase As may be a critical step in the release mechanism of As from sediment to water.