Arsenic removal with composite iron matrix filters from Bangladesh

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In Bangladesh, 30–50 million people are exposed to toxic levels of arsenic (As) in drinking water from shallow tube wells. With more than 50% of the affected population still exposed, inexpensive, reliable, and low-maintenance filters to remove As from well water could lead to a significant reduction of As exposure. The SONO water filter, which was developed in Bangladesh and is produced there from local materials, fulfills these criteria as well as the requirements for potable water. It has been used in large numbers in Bangladesh for years and was recently approved by the Bangladesh government.

The removal of As with SONO filters is based on the transformation of zero-valent iron (ZVI) to a porous solid matrix known as composite iron matrix (CIM) and subsequent reactions. Although some of the general pathways for the removal of As with ZVI are known, the complex chemistry within the CIM is not yet fully understood. In particular, a more detailed identification of formed solids and proper mass balances could improve the assessment of the filters' sustainability and environmental impact and would help in the development of a consistent model for As removal with ZVI-based filter systems.

In a combined long-term field and laboratory study, we investigated the chemical reactions involved in As removal with SONO filters. The effect of the water components Ca, P, Fe, and dissolved oxygen (DO) on the As removal efficiency has been investigated for 13 months in the field and was complemented with experiments with small-scale columns in the laboratory. The sampling of the percolating solution and of filter material at different depths enabled the detailed analysis of the chemical gradients within the filter. We identified the main components in the solid samples with X-ray based methods (XRF, XRD) and microscopy (Raman, ESEM) and investigated whether the mode of filtration and the influent DO content had an effect on the solids formed in these filters over time.

The hydrogeochemistry of pond and rice field recharge: Implications for the arsenic contaminated aquifers in Bangladesh

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Researchers have puzzled over the origin of dissolved arsenic in the aquifers of the Ganges Delta since widespread arsenic poisoning from groundwater was publicized two decades ago. Previous work has concluded that biological oxidation of organic carbon drives geochemical transformations that mobilize arsenic from sediments; however, the source of the organic carbon that fuels these processes remains controversial. A combined hydrologic and biogeochemical analysis of a typical site in Bangladesh, where constructed ponds and groundwater-irrigated rice fields are the main sources of recharge, shows that only recharge through pond sediments provides the biologically degradable organic carbon that can drive arsenic mobilization. Chemical and isotopic indicators suggest that contaminated groundwater originates from excavated ponds and that water originating from rice fields is low in arsenic. In fact, rice fields act as an arsenic sink. Irrigation moves arsenic-rich groundwater from the aquifers and deposits it on the rice fields. Most of the deposited arsenic does not return to the aquifers; it is sorbed by the field's surface soil and bunds, and is swept away in the monsoon floods. The findings indicate that patterns of arsenic contamination in the shallow aquifer are due to recharge-source variation and complex three-dimensional flow.