KTH Land and Water Resources Engineering

ARSENIC GEOCHEMISTRY IN THE ALLUVIAL AQUIFERS OF WEST BENGAL, INDIA

Implications for targeting safe aquifers for sustainable drinking water supply

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ABSTRACT

The natural occurrences of high (>10 μg/L) dissolved arsenic (As) in groundwater of Bengal Basin has put millions of people under the threat of chronic As exposure through drinking water. Present study has examined the processes that regulate As mobilization and its distribution in shallow aquifers and the potentiality of finding safe aquifers within shallow depth (<50 m) for drinking water supply. The results indicate that in terms of aquifer sediment colors and water quality two types of aquifer namely brown sand aquifer (BSA) and grey sand aquifer (GSA) can be distinguished within the depth, accessible by low-cost drilling. The redox condition in the BSA is delineated to be Mn oxyhydroxides reducing, not sufficiently lowered for As mobilization resulting in high Mn and low Fe and As in groundwater. While in GSA, currently the reductive dissolution of Fe oxyhydroxides is the prevailing redox process causing As mobilization into groundwater of this aquifer type. It is revealed that the vertical distribution of As and other aqueous redox parameters is related to the redox zonation within aquifer. The decoupling of As and Fe release into groundwater is evident in the shallowest part of aquifer because of Fe enrichment by weathering of silicate minerals especially of biotite, the precipitation of secondary mineral phases like siderite and vivianite and incomplete reduction of Fe oxyhydroxides. It is characterized that the seasonal variations of As and other aqueous solutes are limited within the upper portion of aquifer only (<30 m bgl) and can be related to seasonal cycling of redox status, aggregation and dispersion of As scavenging colloids, local groundwater abstraction and monsoonal recharge. The results of surface complexation modeling indicate that PO_4^{3-} is the major competitor of As(III) and As(V) adsorption onto Fe oxyhydroxides. This study concludes that the reductive dissolution of Fe oxyhydroxides followed by competitive sorption reactions with the aquifer sediment is the processes conducive for As enrichment in groundwater of Bengal Basin. Present study advocates that despite low concentration of As in groundwater, a rigorous assessment of attendant health risk for Mn is necessary prior to considering mass scale exploitation of the BSA for possible sustainable drinking water supply. This study also validates that TW platform colors can be used as a rapid screening tool for As and Mn in drinking water wells to prioritize As mitigation management.

Key words: Bengal Basin; Groundwater; Arsenic; Redox processes; Competing ions; Sustainable drinking water Supply