

Chemical weathering of detrital biotite releasing arsenic in Holocene groundwater aquifer in Bangladesh

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It is well known that groundwater in the sedimentary aquifer of the Bengal Delta Plain (BDP), in large areas of Bangladesh and neighboring West Bengal, India, are enriched with arsenic (As). A large number of studies and numerous publications have been carried out over the past decade to explore the nature of the occurrence, sources and mechanisms of As mobilization in the BDP aquifers. Among the hypotheses regarding the modes of As release, microbially reductive dissolution of arsenic-containing Fe oxyhydroxides coating sand grains and clay minerals is currently the most widely accepted explanation of the As contaminated groundwater formation. In this study, based on the results of integrated geochemical and mineralogical investigations performed on the continuous drilling samples of Quaternary sediments (up to 90.1 m depth) at a transitional area of Holocene and Pleistocene deposits at Sonargaon of Narayanganj district, we propose the different mechanism to form the As contaminated groundwater in the BDP. The subsurface geology of up to 90.1 m depth is classified into three units: Holocene upper sand unit (from surface to 28.6 m), middle mud (28.6 to 38.5 m) and lower sand (38.5 to 90.1 m) units of Pleistocene. The upper and lower sand units correspond to unconfined and confined groundwater aquifers. The middle mud unit acts as an aquitard and separates the two aquifers. The As concentration of the core sediments is between 0.9 and 8.2 mg/kg in the upper sand unit, 1.6 and 11.6 mg/kg in the middle mud unit with the exceptionally highest value of 53.4 mg/kg at the top of this unit, and less than 3.7 mg/kg in the lower sand unit. Sequentially chemical extraction analysis of As in the sediments reveals that more than 80 % of As are fixed in organic and insoluble phases (silicates and sulfides), and that the As adsorbed on or fixed in Fe oxyhydroxides/oxides are minor contribution to the total As in all of the studied sediments. Especially in the lower half (18 to 29 m depth) of the upper sand unit, in which the most of the hand tube wells are installed, As concentration correlates positively to the concentrations of Al, Fe and XRD intensity of mica (muscovite+biotite). As concentration of the separated biotite from the sandy sediments are similar to that of insoluble As. Conclusionally, the primary source of As is detrital bioite in this sediment column. Combining the lithology and structure of the aquifer and groundwater chemistry, we conclude that the As release is caused from the chemical weathering of biotite via vertical infiltration of surface water into the unconfined aquifer.