

Role of microbial activity on the formation of arsenic contaminated groundwater in the Ganges delta plain

Harue Masuda[1]; Ashraf Ali Seddique[2]

[1] Dept. Geosci., Osaka City Univ.; [2] Geosciences, Osaka City Univ.

Microbial reduction-dissolution of Fe-oxyhydroxides/oxides adsorbing arsenic in association with decomposition of detrital organic matters has been the consensus to explain extending arsenic contaminated groundwater in the Ganges delta plain. However, we found that biotite is a primary source of arsenic and hypothesized that chemical weathering, i.e., hydration-decomposition, of this mineral promoted by vertical infiltration of surface water released the arsenic into the groundwater. Fe-oxyhydroxides/oxides accumulate the arsenic in and bottom of the surface water and the reduction must occur in the sediments, where redox condition and microbial activity change drastically following the change of groundwater level. Thus, the shallow sediments below 6m depth, where the redox condition changes with seasonal change of groundwater level, were studied on mineralogy and chemistry to observe the change of arsenic host phase.

The sediment samples were taken using a hand auger at the four sites located in the villages where the level of arsenic in the groundwater was different in Sonargaon, Bangladesh. The sediment columns were taken from the surfaces to about 6 m depth at the maximum in the rainy and dry seasons. The sampled sediments were vacuum packed and carried to the laboratory in Japan.

Major chemistry by XRF, XRD mineralogy and total and chemically extracted arsenic determined by HG-AAS were the same for the sediments taken from the each site at the different seasons, suggesting that the change of redox condition in corresponding to the change of groundwater level does not affect very much for the arsenic behavior. Total arsenic concentration of the sediments well correlates to the concentrations of aluminum, iron, magnesium and XRD mica intensities (muscovite+biotite), indicating the biotite as a primary source of arsenic. Differentially chemical extraction of arsenic showed that the silicate and organic matters were the most abundant phases hosting arsenic more than 80%. Fe-oxyhydroxides/oxides would be a byproduct of weathering biotite but not an abundant host of arsenic. Although total arsenic concentrations are in the same range for the all studied sediments instead of the drilling sites, the rate of arsenic in silicate and organic matter decreases with decreasing level of arsenic in the groundwaters around the sampling site of sediment core. Thus, the arsenic-bearing organic matter must be a secondary phase following the biotite decomposition. Previous researchers supporting microbial Fe-oxyhydroxides/oxides reduction hypothesis have believed that the microbial activity worked as a reducer of the groundwater environment. On the contrast, our result suggests that the microbial activity in the sediment works as fixing arsenic and detoxicating the groundwater.