

Abstract

Contamination of groundwater by As has been reported at the Bengal basin, the world most active delta plain located downstream of Ganges river. Water from two thirds of the wells exceeds national drinking standard of Bangladesh ($50\mu\text{g/L}$), resulting in a serious health hazard. Arsenic appears to originate from natural environment, but detailed formation processes that form the As-contaminated water are still under debate. In order to clarify the processes, we carried out a geochemical study of As-contaminated waters from Sonargaon, central Bangladesh.

About 230 groundwater samples were collected from tube-wells in September 2003 (rainy season) and February 2004 (dry season). 70 % of the waters was contaminated by As with the maximum concentration of $1060\mu\text{g/L}$. Arsenic concentration was high and limited between 15-40 m in the upper aquifer ($<60\text{m}$) hosted by Holocene alluvial sediments, whereas it was not detected in the lower aquifer hosted by Pleistocene sediments. High As groundwaters were characterized by high Fe, NH_4^+ , HCO_3^- , and low SO_4^{2-} , NO_3^- . Dominant As species was As(III), indicating that waters were anoxic.

An impermeable mud layer of 20-40 m thick divides upper (Holocene) and lower (Pleistocene) aquifers. Contents of As in the upper Holocene sediment were $\sim 3\text{ mg/kg}$ and $\sim 9\text{ mg/kg}$ in the impermeable muddy sediments. The As content of interstitial water from the mud layer was found low (maximum $40\mu\text{g/L}$), so the mud layer is not a main source of As. Thus, As was likely derived from the upper, sand rich aquifer. However, the As content of sand layer is low, so that it is essential to know (1) chemical forms of As in the sediment and (2) chemical conditions that lead to As release.

Since As is mainly adsorbed onto the surface of iron hydro-oxide such as FeOOH and its adsorption behavior depends on the oxidation/reduction state (trivalent or penta-valent). We applied the XANES method to evaluate the average oxidation number of As and Fe in the sediments. It was found that As(V) was dominant near the surface and As(III) became dominant toward lower part of the upper aquifer. Similar trend was confirmed for Fe. The above findings suggest the reduction of FeOOH and As(V), the key chemical processes for As release, is taking place near the surface just around water table, and then As is transported downward. We found that the lower Pleistocene aquifer was clearly oxidized, and As is thought adsorbed on the surface of ferric iron oxides. This is a reason why the lower aquifer is not As-contaminated.