Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

AHW27-15 Room:301B Time:May 24 14:15-14:30

Spatial distribution of arsenic in shallow alluvial aquifer in northwestern part of Bangladesh: Implication for arsenic

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Concentrations of As in groundwater sampled from the 38 shallow tube wells at different depths spanned three orders of magnitude, from 0.5 μg/L to 164 μg/L (Mean 20 μg/L$\pm$ Std. 36.46 μg/L). Groundwater As concentration generally increased with depth starting from the shallowest monitoring well, peaked at 15 m and 20 m at different sites, and then declined again towards the deeper part of the shallow aquifer. The dominant groundwater type is Ca-HCO_3 with high concentrations of As and Fe but low levels of NO_3^- and SO_4^{-2}, while As is not correlated with Fe (R2=0.05) and positively correlated with Mn (R2=0.126) in groundwater. The positive correlations along with results of sequential leaching experiments suggest that reductive dissolution of FeOOH and MnOOH mediated by anaerobic bacteria represents mechanism for releasing arsenic into the groundwater. Poor correlation between As and Fe as well as As and Mn concentrations in groundwaters suggest that probably siderite (saturation indices 1.53-4.21) and/or rhodochrosite (saturation indices 1.34-2.97) precipitated as secondary mineral on the surface of the sediment particles. Factor analysis was performed on hydro-chemical data. The results show that a few factors adequately represent the traits that define water chemistry. The first factor of Ca, Mg and Na reflects the hardness of groundwater, which is confirmed by the hydrochemical facies analysis. Cl and SO_4 are grouped under the second factor representing the groundwater contamination due to anthropogenic activities. The third factor, represented by As, Mn and K is related to As mobilization processes. K may be derived from anthropogenic activities which may be responsible for the mobilization of arsenic mobilization. The fourth factor of Fe and HCO_3 is strongly influenced by bacterial Fe(III) reduction which would raise both Fe and HCO_3 concentrations in water. Groundwaters in Barogoria village contain low concentration of As below the WHO standard ($<$10 μg/L), and this type of water is generally suitable for extraction for domestic uses though this is Holocene aquifer. Spatial evolutions help in better understanding mechanisms of As mobilization and in developing effective strategies for ensuring drinking water safety. Possible solutions are to install tube wells in the deeper Pleistocene aquifers or use clean surface water sources such as reservoirs or rain water. The investigation suggested that monitoring of groundwater As should be routinely carried out to ensure the drinking water safety in the As-affected areas.

Keywords: Northwestern Bangladesh, arsenic mobilization, siderite / rhodochrositeprecipitation.

Keywords: Fe-oxyhydroxides, Mn-oxides, Bacterial reduction