

A comparison of geochemical features of arsenic contaminated groundwater between rainy and dry seasons, in Sonargaon, Bangladesh.

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Aims of research:

Groundwater in Bangladesh and West Bengal of India, have been known to exhibit the most serious arsenic pollution in the world. Many investigations have been done regarding the formation mechanisms of arsenic contaminated groundwater. However, the detailed mechanisms are still under debate. Except the cases where there is a clear anthropogenic source, As appears to originate from natural environments. Thus, geochemistry can play a key role in identifying the source of the element and solving this problem.

We have collected groundwater from Sonargaon, Bangladesh, three times so far, i.e., September 2003 and February 2004. In December 2004, we also drilled a core to collect sediments. This study aims to know 1) distribution of groundwater arsenic speciation, 2) the local hydrology, i.e., recharge rate, and flow path of the water, 3) seasonal changes of groundwater chemistry, and 4) geomorphology and geology of the study area. In this report emphasis was put on the changes in groundwater chemistry during dry and rainy seasons in relation to the above mentioned aims 1), 2), and 3).

In September 2003 (late rainy season) and in February 2004 (late dry season), altogether 230 groundwater samples were collected from tube-wells in Sonargaon, Bangladesh. Samples include duplicate collection from the same wells. We analyzed them for the total arsenic, arsenite (As(III)), major element concentrations, and hydrogen and oxygen isotope ratios.

Distribution of arsenic:

Most of groundwater samples contained the total As less than 50 ppb in the Pleistocene aquifers. In contrast, a large numbers of samples in Holocene aquifers have more than 100 ppb As. The arsenic concentration depends on the well depth collected. The most highly As concentrated groundwaters were found at depths about 25m. They sometimes exceeded 1000 ppb. Groundwater samples taken from wells deeper than 200m rarely contained arsenic.

Dominant arsenic species is arsenite in the study area. Samples collected during rainy seasons often contained more than 1ppm arsenite. Arsenite concentration decreased in dry season probably reflecting prevailing oxidizing conditions of groundwater.

Relationships between arsenic and major components:

High As groundwater samples are characterized by high alkalinity, NH_4^+ , DOC and low SO_4^{2-} , NO_3^- . These relationships, however, are not linear. Increase of SO_4^{2-} and NO_3^- during dry season is in harmony with decrease in arsenite that is probably derived from oxidation of groundwater. High NH_4^+ and DOC values suggest that arsenic dissolution occurred in association with organic matter decomposition. High arsenic samples often contained high PO_4^{3-} .

Isotopic signatures:

$\delta^{18}\text{O}$ values showed large variations regardless of the narrow study area of 4km². The $\delta^{18}\text{O}$ values varied from -7.1 to -2.2 permillage in groundwater shallower than 40m. Deep groundwater samples (below 40m) had relatively constant $\delta^{18}\text{O}$, around -5.5 permillage. These features suggest that the deep groundwater does not mix with the shallower groundwater. No change was observed in $\delta^{18}\text{O}$ between rainy and dry season. This suggests that movement of the groundwater in this period was limited. Relationships between arsenic and $\delta^{18}\text{O}$ showed that high arsenic groundwaters have relatively high $\delta^{18}\text{O}$ value (-3~-2 permillage).