Arsenic mobilization in shallow aquifer of Bengal Delta Plain: role of microbial community and pathogenic bacteria

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ABSTRACT: In West Bengal, India, arsenic, iron and microbial contamination has been reported from shallow aquifers (<50 m) of the Bengal Delta Plain (BDP). Six groundwater affected side at Chakdaha Block of Nadia District in West Bengal was selected to study groundwater quality parameter notably arsenic and microbial contamination. The study revealed that arsenic contamination is the highest in site B (up to 0.171 mg L⁻¹), whereas site E has been identified as the lowest (0.089 mg L⁻¹) and rest are in between. Similarly microbial contamination has been the highest in site D and the lowest in site A. Further, high concentrations of arsenic along with microbial contamination have also been found in several sites A, C, D and F. The field scale study indicated simultaneously occurrences of arsenic and microbial contamination, suggesting role of microbial pollution in arsenic mobilization.

1 INTRODUCTION

Arsenic (As) is one of the numerous toxicants that is naturally/anthropogenically introduced into the aquatic ecosystem impairing the water quality and also impairing life of different aquatic species (Biswas *et al.*, 2012). Microorganism has developed several mechanisms that can transform arsenic by extracellular precipitation, intracellular accumulation or oxidation and reduction reaction (Oremland & Stolz, 2003). Interestingly, different arsenic resistant bacteria belonging to enteric group has been isolated from the arsenic prone zone. Some common bacteria *Pseudomonas*, *Geobacter grbicium*, *Clostridium* are isolated from BDP (Islam *et al.*, 2004; Chatterjee *et al.*, 2010, van Geen *et al.*, 2011).

2 METHODS/EXPERIMENTAL

2.1 Study area

Ground water samples were collected from six sides (Site- A, B, C, D, E, F) of Bengal Delta Plain (BDP) in Chakdaha Block, West Bengal, India.

2.2 Sample analysis

Total arsenic (As) concentration in the samples was measured by hydride generation atomic absorption spectrophotometer (HG.AAS VARIAN-240, detection limit <1 µg L⁻¹). Membrane filtration method was used to determine total coliforms and Thermo tolerant fecal coliforms present in the ground water

Table 1. Variation in the abundance of arsenic and microbial population in groundwater at the study sites.

Site	[As] %	[MO] %	[As & MO] %
A	81.66	38.75	32.87
B	26.97	34.21	15.13
C	60.37	36.22	27.16
D	23.82	54.04	24.68
E	31.42	32.14	18.21
F	44.55	68.31	34.65

samples. This microbial population was enumerated on Chromocult Agar and differentiated by standard methods as per US-EPA.

3 RESULTS AND DISCUSSION

3.1 Results

Considerable variation in concentration of arsenic in groundwater between the collection sites as well as between different depths were observed. Based on the arsenic content, the total study samples could be set high arsenic content (0.103–0.171 mg L⁻¹).

3.2 Discussion

We have observed that in all the six sites under study, high amount arsenic and microbial contamination is present (Fig. 1). Similarly Figure 1c shows that at A, C, D & F sites both arsenic and microbes are present.

Figure 1. Distribution of a) total arsenic, b) total microbial population, and c) arsenic & microbial population in groundwaters at the study sites A to F.

Another proposed hypothesis is due to the release of arsenic sorbed to aquifer minerals by competitive exchange with microbial phosphate ions that migrates into aquifers due to application of fertilizer to surface soil. In all the situations, the released iron (II) is also oxidized to iron (III) in the presence of oxygen.

4 CONCLUSIONS

Our study indicates that As and microbial activities, specifically fecal coliforms which gains entry into water by fecal contamination. However, too much availability of As into water affects microbial activity and hence shows negative correlation with As-Fe coimmobilization.

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