Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia Earth and Planetary Science 7 (2013) 143 – 146

Procedia
Earth and Planetary Science

Water Rock Interaction [WRI 14]

Groundwater arsenic in the fluvial Bengal plains: geochemistry and mitigation

D. Chatterjee[a]*, B. Nath [a,b], S. Chakraborty[a,c], S. Majumder[a,d], A. Biswas[a,e], S. Bhomick[a,d], D. Halder[a,e], P. Mondal[a,f] , A. Kundu[a], D. Saha[a], S. Barman[a], U. Biswas[a], I. Saha[a], A. Das[a] , S. Sarkar[a], D. Chatterjee[g]

[a]*Department of Chemistry, University of Kalyani , Nadia , Pin-741235 , India*
[b]*School of Geosciences, University of Sydney, Sydney, NSW 2006, Australia*
[c]*Department of Chemistry, Kanchrapara College, Kanchrapara 743145, 24 Pgs (N), India*
[d]*Department of Chemistry, Campus Montilivi, University of Girona, Girona 17071, Spain*
[e]*Department of Land and Water Resources Engineering, Royal Institute of Technology (KTH), Teknikringen 76, SE-100 44 Stockholm, Sweden*
[f]*Department of Chemical Engineering, KU Leuven, B-3001 Leuven, Belgium*
[g]*Department of Chemical Technology, Heritage Institute of Technology, Kolkata 700107, India*

Abstract

The water quality and chemistry of the groundwater of the fluvial Bengal plains have been investigated. It has been found that shallow aquifers (< 50 m bgl) are contaminated in a few pockets, surrounded by areas with low arsenic (As)/As-free groundwater, while the deeper aquifer (> 100 m bgl) is generally free from As (< 10 µg/L). It also reveals that multiple As mobilization processes are occurring simultaneously, rather than any single geochemical process. An attempt has been made to demonstrate the degree of As heterogeneity with groundwater quality, and this has been followed by a few local conditions. The study further suggests that the As distribution (spatio-vertical) helps to identify safe shallow aquifers, and several signatures (colour of the sediments /land use pattern/ geomorphological features /local recharge events) are apparent that can be useful for formulating long-term mitigation options.

Selection and/or peer-review under responsibility of the Organizing and Scientific Committee of WRI 14 – 2013

1. Introduction

Drinking water has always been considered as the major ingestion route of As to the human system and recently, exposure from the food chain has also been reported. The occurrence of As in groundwater

* Corresponding author. Tel.: +91 33 2582 3883; fax: +91 33 2582 8282.
E-mail address: debashis.chatterjee.ku@gmail.com.

Selection and/or peer-review under responsibility of the Organizing and Scientific Committee of WRI 14 – 2013
doi:10.1016/j.proeps.2013.03.014

(>50 µg/L) is observed in several pockets surrounded by large areas with low As/As-free water (1). The As distribution pattern is heterogeneous in nature and often shows severe anomalies with respect to spatial and vertical distribution. The influence of local conditions on As release/mobilization both spatially and vertically is reported (2). In this study we would like to document the spatial scale of As heterogeneity in a deltaic region of West Bengal. The inter-relationship between the prevailing local conditions and surveyed wells is studied carefully that often regulates the (hydro)chemical environment, notably the concentrations of redox elements. Ultimately, this helps to formulate the planning of water supply structures and better management of the affected aquifers.

The study area (~ 400 km^2, 23.02- 23.14^o N; 88.49- 88.62^0 E) encompasses part of the world's largest delta. The aquifers consist of thick (~ up to 250 m) sands overlain by a surface silty clay aquitard (~ 20 - 40 m). The upper aquifer material consists of silica sand (86 %) with minor biotite, muscovite, illite and iron oxyhydroxide, while the lower aquifer passes downward into silty sand. The area lies within the active flood plain of the Hooghly-Bhagirathi River (3).

2. Methods and materials

Groundwater samples were collected in acid-washed bottles. The sampling procedures have been described previously (1,3). Samples were filtered (0.45µm membrane filter) and collected in three separate bottles: (i) As_T by AAS in HG mode (Varian 440 A), (ii) cations and trace elements (acidified with suprapure HNO_3), and (iii) major anions. Analysis of As(III) and As(V) was made through a disposable cartridge (Metal Soft Centre, USA). Anion analyses were determined by ICP and cations by IC. Fe_T and Fe(II) concentrations were measured spectrophotometrically using 1, 10 phenanthroline (510 nm). DOC samples were measured by a Shimadzu 5000 TOC analyzer.

Undisturbed core samples were collected in HDPE bags purged with nitrogen on-site (wash sediment colours were observed soon after their recovery from the borehole, prior to atmospheric oxidation). Sediments were analyzed by several techniques. C_{org} was analyzed with the help of a CNS analyzer (Leco) after initial dissolution in 10% HCl to remove inorganic carbon. Commercially available reference materials (NIST-STM-1643e/STM-2583) were used for quality control.

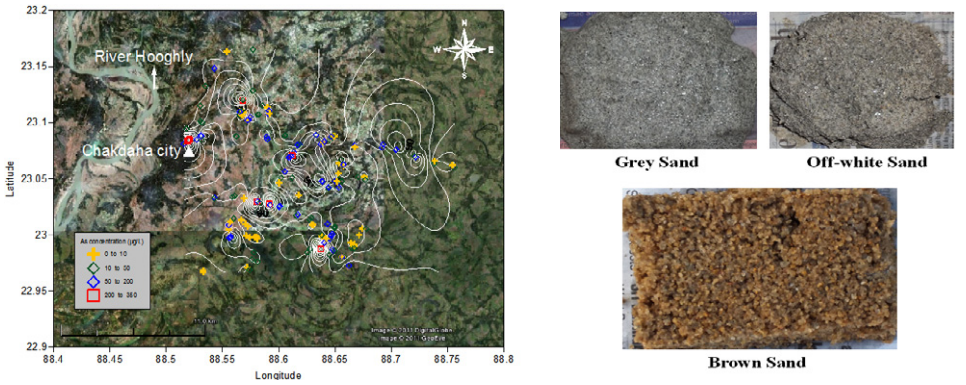

Fig. 1. (a) Contour maps of groundwater As in the study area (Chakdaha block, West Bengal); (b) colour of washed sands.