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Hydrogeochemical controls on mobilization of arsenic in groundwater of a part of Brahmaputra river floodplain, India

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ABSTRACT

Study region: Arsenic enriched groundwater regime within low-industrialized Brahmaputra floodplains in Assam, NE India.
Study focus: We examined the origin, distribution and processes of As release by investigating the salient groundwater chemistry and subsurface sedimentological characteristics. Besides collection of

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groundwater samples from domestic and public water supply wells, sediment samples from boreholes were investigated for textural and colour linkages.

New hydrological insights for the region: Arsenic concentrations above the WHO guideline value of 10 μg/L were present in 33 wells and above the previous Indian national drinking standard of 50 μg/L were present in 15 wells. The green-olive colour sediments were more likely to yield As-enriched groundwater. The supersaturation of groundwater with respect to Fe(II) minerals, such as siderite and vivianite, explained the poor correlation between dissolved As and Fe. The result reinforced the phenomenon of reductive dissolution of Fe(III) oxyhydroxides releasing As to groundwater. This study throws light on the processes and mechanisms involved with As release in groundwater. The homogenous floodplain terrain makes the hydrological As imprint unambiguous and the hydrogeological signatures untarnished. Considering the absence of anthropogenic sources in the study area, the conclusions on the nature and causes for As release to groundwater looked dependable although the final contamination at specific subsurface sites would be influenced by advection–dispersion of groundwater flow accompanied by retardation, ion exchange, surface complexation and possible biodegradation.

1. Introduction

The grim problem of arsenic (As) enrichment of groundwater has received global attention over the past three decades. Groundwater of several river basins of South Asia has been found to be contaminated by As above the WHO drinking water guideline of 10 μg/L (Ahmed et al., 2004; Bhattacharya et al., 1997, 2002a,b, 2011, 2014; Nickson et al., 1998; Smedley and Kinniburgh, 2002; Chatterjee et al., 2003; Hasan et al., 2007, 2009a,b; McArthur et al., 2001; Ahamed et al., 2006; Nath et al., 2008a, 2009; Mukherjee et al., 2008; Kumar et al., 2010; Naidu and Bhattacharya, 2009). Although the source of As is mostly geogenic and its release in groundwater is a result of natural processes, several studies in recent years have shown that As release has been accentuated by human activities. Besides being toxic, the consumption of As-laced water over extended periods renders individuals consuming groundwater vulnerable to chronic As poisoning (Chakraborti et al., 2004; Kapaj et al., 2006). By now, there have been many instances when prolonged ingestion of As-contaminated water over the years has resulted in skin, lung or liver cancer as well as cardiovascular diseases and damage to internal organs (Kapaj et al., 2006).

The presence of groundwater As in the state of Assam in northeastern India, was first recognized in 2004 following the studies of Singh (2004), Chakraborti et al. (2004), and later by Nickson et al. (2007). The study conducted by Singh (2004) at the North Eastern Regional Institute of Water and Land Management (NERIWALM) reported drinking water sources in 20 of the 30 districts of Assam having As concentrations exceeding 50 μg/L. Chakraborti et al. (2004) based on their work in two districts, Karimganj and Dhemaji, reported, 19% of the groundwater samples contained As concentrations >50 μg/L, while 2% contained >300 μg/L. Based on these studies, the Public Health Engineering Department (PHED) of Assam carried out a state-wide blanket survey in 2005 (JOPA, 2005). In total 5,729 water samples collected from 22 of the 30 districts in Assam were analysed for As. The JOPA results revealed that the water samples collected from 18 districts had As concentrations >50 μg/L. Chetia et al. (2011) reported As concentration ranged between BDL (below detection limit) and 128 μg/L in six blocks of the Golaghat district located on the southern bank of the Brahmaputra River in Assam. However, none of these studies attempted detailed hydrogeochemical investigations to understand