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Geochemical comparison of high and low arsenic groundwater in the Hetao Basin, Inner Mongolia

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Abstract

Four multilevel samplers were installed in both As-affected areas and low-As areas for long-term monitoring of chemical variations of shallow groundwater (< 30 m in depth). Results showed slight increasing trends in As concentrations in groundwaters with high As concentration (> 50 μg/L), and in groundwaters at 15 m depth in low-As areas. Variations in As concentrations were in line with those of Fe(II) in low-As areas (< 50 μg/L), while incompatible variations were generally observed in groundwaters from As-affected areas. This indicated that authigenic siderite and pyrite immobilized As in groundwaters with high As concentration (>200 μg/L), being released from aquifer sediments via reductive dissolution of Fe oxides.

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1. Introduction

High As groundwater has received serious concern from scientific community and water management agencies [1-3]. Reducing aquifers have been found to host high As groundwaters in major river deltas of SE Asia such as Red River delta, Mekong delta, Ganges delta, Yellow river delta, Pearl River delta [1-3] and inland basins for example the Hetao basin, the Datong basin, the Yinchuan basin, the west Jilin basin, and Zhunger basin [4-7]. Unpredicted patterns of spatial and temporal variations are the universal characteristics of groundwater As in those aquifers of river deltas and inland basins [1-5].

The Hetao basin is a typical inland basin hosting high As groundwater in shallow aquifers (0.6-572 μg/L) [4]. Spatial distribution of groundwater As has been well documented [4-7], showing the patchy

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distribution of As concentration at both local (~100 m) and regional scales (~10 km) [4]. However, few data are available on temporal variation in groundwater As concentration. Limited data showed that groundwater As concentration is mostly higher at the time of high groundwater level (< 1.0 m below land surface) [7]. Comparison of hydrogeochemical temporal variations between high As groundwater (> 50 μg/L As) and low As groundwater would help in effectively managing groundwater resources for ensuring drinking water safety and in better understanding mechanisms of As mobilization in the shallow aquifers.

The major objectives are to (1) characterize geochemistry of high and low As groundwater, (2) to investigate temporal variations in groundwater chemistry in high and low As aquifers, and (3) to evaluate hydrogeochemical processes controlling groundwater As concentrations.

2. Materials and Methods

Four multilevel samplers were installed in the Shahai town, two of which are located in the regions with high As groundwater (BH01 and BH04), and two in the regions with low As groundwater (BH02 and BH03) (Fig.1). Depths of samplers and lithologic settings were provided in Guo et al. [6]. Groundwater was sampled from each sampler after pumping (usually 20 min). All of samples were filtered through 0.45 μm membrane filters in the field for analysis in the laboratory [5].

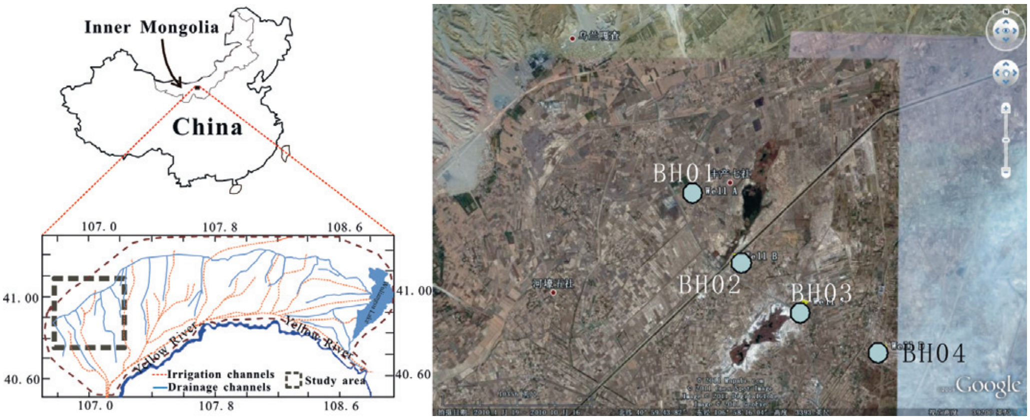

Fig. 1. Location of multilevel samplers in the study area

3. Results and Discussion

3.1. Chemical characteristics of high and low As groundwaters

Groundwater had neutral-weak alkaline pH, with the range between 7.25 and 8.54. Eh values lay between 28.5 and 246 mV. Total dissolved solids (TDS) ranged between 745 and 5280 mg/L, showing increasing trends with depth. The highest TDS value was found at BH03, which is the discharge area of local groundwater flow system. Evaporation is the major process controlling groundwater chemistry at BH02 and BH03, evidenced by the enrichment in ^{18}O and D.

High As concentration was found in BH01 and BH04, with the levels between 220 and 625 μg/L (median 331 μg/L), while low As concentration in BH02 and BH03 with As concentrations between 0.4 and 113 μg/L (20.3 μg/L). Arsenic (III) accounted for 60 % - 99 % of total As in water samples with total As > 20 μg/L. For both low and high As groundwater, water type is mainly Na-HCO_3-Cl/Na-Cl-HCO_3.

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