

Contamination status by arsenic and other metals in groundwater from Myanmar

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Abstract

Concentrations of arsenic and other metals were examined in groundwater collected in the middle and southern parts of Myanmar in 2015 and 2016. As the reference, tap water, river water, and bottle water samples were also analyzed. Arsenic concentration in water samples ranged from <0.01 to 209 µg/L. About 28% of water samples collected in our sampling exceeded World Health Organization (WHO) drinking water guideline value (10 µg/l) for arsenic. Interestingly, some tap water samples also had over the guideline value, suggesting that those public waters are not suitable for drinking. Geographical distribution of arsenic in groundwater revealed that hot spots of arsenic contamination were widely dispersed, not concentrated in a certain area. On the other hand, relatively high concentrations of arsenic were detected in groundwater from 15 – 60 m depth, indicating that there is significant arsenic rich aquifer in this layer. For other metals, concentrations of manganese and uranium in some groundwater contaminated by arsenic were also higher than the WHO guideline values. Therefore, human health risks by multiple elements including arsenic, manganese, and uranium through the drinking of groundwater are of great concern in Myanmar.

Keywords: arsenic (As), manganese (Mn), uranium (U), groundwater, Myanmar

1. Introduction and Objective

Arsenic (As) is one of the most toxic chemicals on public health. Contamination by As in groundwater is emergency problem in the world, especially in developing countries where it is not always obtain clean water for drinking. World Health Organization (WHO) expected that more than 200 million people expose to As exceeding guideline value (10 µg/L) for drinking established by WHO [1] through the consumption of groundwater. Indeed, some people chronically exposed to As have suffered from several arseniasis such as skin disease and cancers. Therefore, it is

necessary to understand As contamination in groundwater in the world in detail and develop As free alternative water resource or As removal system.

Myanmar is one of the poorest countries in Asia, while the economic growth rate is high. Water system is available in only urban areas and groundwater has been used in almost all areas. However, the groundwater may be naturally contaminated by As. It has been considered that Holocene alluvial sediment derived from Himalayas is significant As source in groundwater and heavy contamination by As was detected in the sediment-deposited areas like the Ganges

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River and the Mekong River Basins. By using geologically based data, Winkel et al. [2] estimated As contamination in groundwater around the Ayeyarwady River, where the water source is from the Himalayas, in Myanmar. Indeed, recent studies revealed the relatively high concentration of As in groundwater samples from Myanmar [3, 4]. However, because the information is still limited, further detail investigation is required. Furthermore, other metals as well as As in groundwater were exceeded WHO guideline values for drinking in some As contaminated-groundwater areas [5], suggesting the necessity for research on contamination by multiple elements in groundwater and their mixture toxicity.

Hence, concentrations of As and other metals in groundwater from the Ayeyarwady River Basin were determined to understand the contamination status of multielements in the present study.

2. Materials and Methods

2.1 Sampling

In December 2015 and December 2016, we collected groundwater ($n = 49$) from the middle and southern parts along the Ayeyarwady River Basin. Information on well depth, history, and usage was obtained *in situ*. In addition, river water ($n = 1$), tap water ($n = 9$), and tap water ($n = 1$) were sampled to compare with groundwater.

2.2 Chemical Analysis

Filtered and non-filtered water samples were used for chemical analysis. Filtration was performed using 0.20 μm filter unit. 27 elements (Li, Be, Na, Mg, Al, K, V, Cr, Mn, Fe, Co, Cu, Zn, Ga, As, Se, Rb, Sr, Ag, Cd, In, Cs, Ba, Tl, Pb, Bi, and U) were measured with inactively coupled plasma mass spectrometer (ICP-MS).

3. Results and Discussion

Concentration of As in water samples were in the range of $<0.01 - 209 \mu\text{g/L}$ (Fig. 1) and the most of samples existed as dissolved form (About 88% on average). About 28% of all water samples were over WHO drinking water guideline value of As [1] (Fig. 1). Interestingly, even tap water sample had above the guideline value (Fig. 1). These results indicate health risk of As poisoning in local people through the drinking As-contaminated water.

Hotspots of As contamination in groundwater were not concentrated in a certain area but widely distributed in several areas. Furthermore, high concentrations of As were detected in groundwater from 15 - 60 m depth, suggesting existence of As rich aquifer in this depth range.

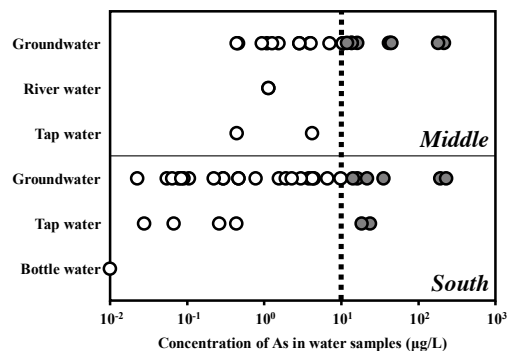


Fig. 1 Concentration of As in water samples collected from middle and south parts of Myanmar. Vertical bold line means a WHO drinking water guideline of As [1].

Analytical results of other elements except for As revealed high concentrations exceeding WHO guideline values for manganese (Mn) and uranium (U) [1] in several groundwater samples. Remarkably, multiple contaminations by As and Mn, and As and U were observed. From these results, human health risks by multiple elements through the drinking of groundwater are of great concern in Myanmar.

4. References

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