

# Arsenic Speciation in Bangladesh Groundwater Tank Precipitates

Derek Peak, Maria Martin, P.M. Huang

Department of Soil Science, College of Agriculture and Bioresources, University of Saskatchewan.

# 40

## PRINCIPAL CONTACT:

### Derek Peak

Assistant Professor, Dept.  
Soil Science, University of  
Saskatchewan  
derek.peak@usask.ca  
(306) 966-6806

## Introduction

The mass arsenic (As) poisoning of the people of Bangladesh and West Bengal is one of the most important environmental stories of the last decade. As such, a large amount of research on the geochemistry of arsenic and on the toxicological effects of arsenic in the region has been performed. However, one aspect of arsenic chemistry in the region that is very poorly understood is the geochemical transformations that arsenic undergoes upon precipitation and aging in water storage tanks. It is known that allowing groundwater to

settle in tanks results in precipitate formation and lowers water soluble As levels. However, little is known about As speciation of groundwater precipitates that form in storage tanks in especially under the influence of aging. This is of concern because the precipitate phases are eventually applied with the stored water during irrigation on agricultural lands. Therefore, the objective of the proposed research is to investigate the chemical speciation of As in the groundwater precipitates from the Ganges-Brahmaputra-Meghna (GBM) plain in Bangladesh as influenced by aging.

## Science

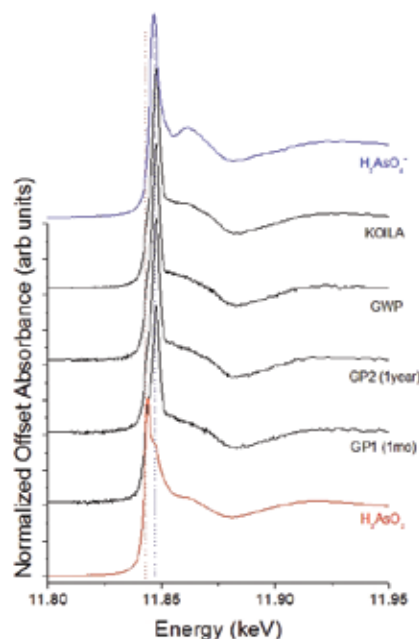
Samples of groundwater precipitates were obtained from groundwater storage tanks in Bangladesh. Both a freshly precipitated sample (less than 6-month aging period) and an aged sample (3 to 4-year aging period) collected from the bottom layers of the same tank were obtained for comparison. These preliminary samples were freeze-dried and subjected to a wide variety of chemical analyses. The groundwater precipitates were analyzed by a variety of analytical techniques, and were found to contain (on average): 0.2% As, 31.7% Fe, 6.4% Ca, 6.1% Si, 3.6% P, 1.3% Al, 0.1% Mg, 1.6% inorganic C and 2.7% organic C. These precipitates are quite porous (59% porosity) and have a specific surface of 262 m<sup>2</sup>g<sup>-1</sup>. In the aged precipitated sample, calcite, vivianite, and poorly ordered ferrihydrite are present. Based on the chemistry of As and associated minerals and our preliminary data, it may be hypothesized that the As may be adsorbed on poorly ordered metal oxides or co-precipitated with Fe, Ca, Mn, Al, Si and other associated elements in the groundwater precipitates. However, these potential phases encompass several degrees of magnitude in As solubility.

To more accurately assess the solubility and bioaccessibility of the precipitated As, As *K*-edge X-ray Absorption Spectroscopy (XAS) was performed at the HXMA beamline 06ID-1 of the

Canadian Light Source. The preliminary data shown in this report was collected at room temperature on freeze-dried samples in fluorescence mode using a Lytle detector.

## Discussion

Results from As *K*-edge XANES experiments at HXMA are shown below in Figure 1.



**Figure 1** As *K*-Edge XANES of several Bangladesh groundwater precipitate samples taken from reservoir tanks. For comparison, an As(V) and As(III) aqueous standard is shown.

In general, the samples show a mixture of As(V) and As(III), with the former being dominant. The spectra shown in Figure 1 are single scans of the samples. Subsequent scans showed a decreased amount of As(III) and an increase in As(V) due to beam damage and/or exposure to the atmosphere. However, it is clear that in samples with increased tank residence time (1 year vs. 1 month) there is an increased presence of the more reduced As (III) oxidation state. Attempts to characterize the bonding mechanisms of As in the samples via XAFS analysis were not attempted due to the stated issues with sample damage.

## Conclusion

It is possible to determine the relative amounts of As(III) and As(V) in these natural groundwater precipitate samples using HXMA. However, the use of freeze-dried samples at room temperature greatly limits the quality of the results. Experiments are planned to study samples preserved in a hydrated and reduced state and scanned at low temperature to preserve their natural oxidation states and mineralogy.