Berkeley Arsenic Alleviation Group
2007 Summer Fieldwork Trip Report
Funded by the UC Berkeley Blum Center for Developing Economies and the National Collegiate Inventors and Innovators Alliance (NCIIA)

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Background

Johanna Mathieu and Tasnuva Khan, two members of the Berkeley Arsenic Alleviation Group (BAAG), traveled to Bangladesh this summer to conduct fieldwork in a village in Sonargaon District. We arrived in Dhaka on July 1, 2007 and visited Neel Kanda, a small village of about 110 families, from July 2 to July 5, 2007. In addition, we spent several days visiting professors at two Bangladeshi universities in order to develop in-country research collaborations. We returned to the U.S. on July 16, 2007.

The goal of the trip was to better understand the chemical properties of ARUBA (Arsenic Removal Using Bottom Ash), developed by Dr. Ashok Gadgil at Lawrence Berkeley National Laboratory. ARUBA is a low-cost and easily scalable technology which removes arsenic from drinking water. It was developed specifically for use in Bangladesh where much of the groundwater is contaminated with high levels of arsenic.

Though ARUBA has been extensively studied in the laboratory, its effective performance in Bangladeshi water was first verified on BAAG's first trip to Bangladesh in March 2007. At that time ARUBA's arsenic removal efficiency (measured in grams of ARUBA per milligrams arsenic removed) was shown to be about ten times less than that in the lab. Though ARUBA is still cost-competitive (raw material cost of about 8 cents per person per year), water treatment requires a lot of material (about 45 grams per person per day). Therefore, we applied for a Blum Center SWS Initiative summer travel grant to return to Bangladesh in order to conduct experiments in an effort to discover ways to improve ARUBA's arsenic removal efficiency.

Figure 1. Children helping us carry water samples, at our fieldsite in Neel Kanda, Sonargaon, Bangladesh.

Several alternative treatment protocols were developed and tested in the lab before arrival in Bangladesh. It was found that adding ARUBA in consecutive partial doses rather than adding a full dose all at once improved ARUBA's arsenic removal capacity. In addition, it was suspected that collecting water, letting it sit for some time before treatment, and keeping it well oxygenated could increase total arsenic removal, as arsenic precipitates with naturally occurring iron in the groundwater and as As III turns into As V (which ARUBA is better able to remove). Each new treatment protocol was tested in the field. We also performed a number of other experiments to

quantify ARUBA's basic chemical interactions with real Bangladeshi groundwater containing high arsenic concentrations (greater than 150ppb). The interactions we tested include ARUBA's arsenic removal kinetics, treatment scalability, and treatment repeatability.

Trip Logistics

During our trip we were aided by BRAC (Bangladeshi Rural Advancement Committee), Bangladesh's largest NGO. BRAC helped us identify Neel Kanda as an appropriate field site and introduced us to village leaders during our first site visit. Though we returned to Dhaka every evening, we drove to the village for four consecutive days to collect water samples, and perform basic repeatability experiments at the Sonargaon District BRAC office. Most of our more complicated experiments were completed in our make-shift laboratory in Dhaka on water samples we had taken earlier in the day.

Though we did measure arsenic levels at the field site and in Dhaka with a field kit- Arsenic QuickTest (by Industrial Test Systems), the bulk of our arsenic samples were brought back to the U.S. for high accuracy Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) analysis at a Berkeley lab.

Results

Our results are very promising. ARUBA treatment proved to be repeatable and more or less scalable (more laboratory experiments are necessary). We demonstrated that ARUBA removes more than half of the arsenic from water within five minutes of treatment! Treatment is approximately completed after 1 hour.

Illustrative results are shown in this report – full results will be reported in a manuscript under preparation.

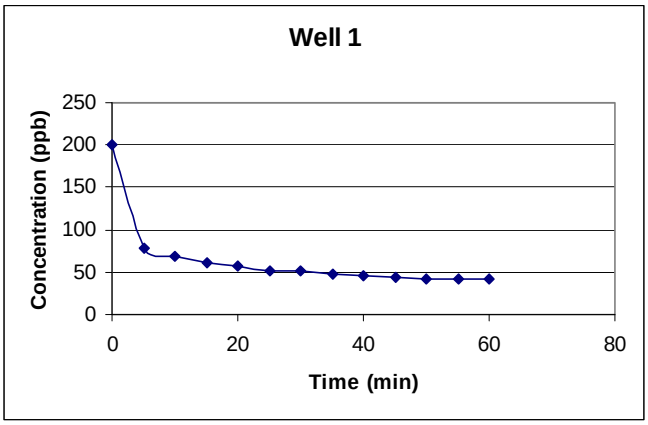

Figure 1. *A graph of arsenic removal over time during treatment with ARUBA. After 5 minutes more than half of the arsenic has been removed by ARUBA. The arsenic concentration comes below the Bangladeshi standard of 50ppb at the 40 minute mark. All data are from ICP-MS measurements.*

Moreover, we learned that it is possible to improve ARUBA's arsenic removal efficiency through consecutive partial dosing (the more doses the better). Also, allowing water to stand for three days and then treating with ARUBA produced final arsenic levels ten times lower than treating water directly out of the well. Aeration of the water sample reduced the standing time required.

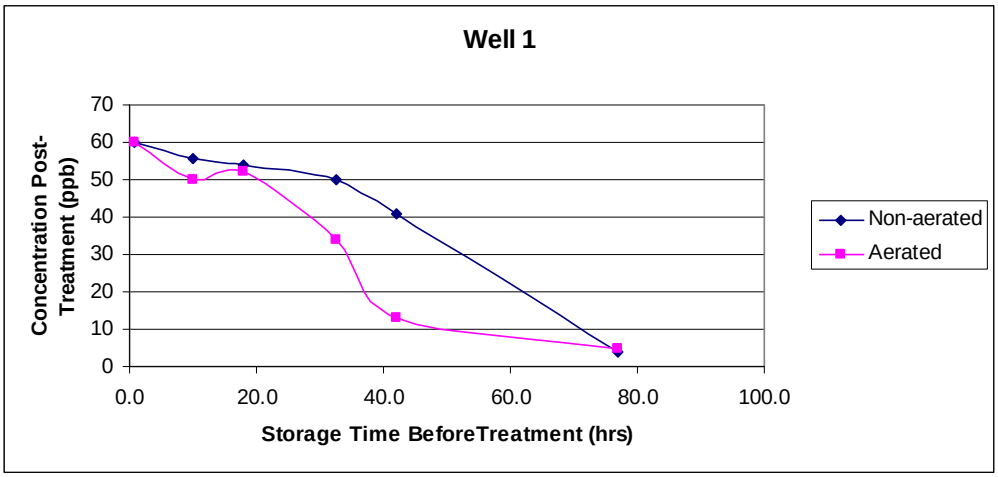

Figure 2. *A graph of arsenic concentrations of water treated with ARUBA. The water has been stored after collection from the tubewell. After three days, sooner with aeration, ARUBA can remove nearly all the arsenic present. All data are from ICP-MS measurements.*

In addition to our technical objectives, we established contacts with professors at BRAC University and the Bangladesh University of Engineering and Technology (BUET). Our BUET contacts proved to be particularly helpful, offering us use of their laboratory facilities and equipment, and performing arsenic analysis of some of our water samples. We are now in the process of establishing a formal collaboration with BUET and hope to start working with a Bangladeshi Environmental Engineering Master's student who is interested in helping us with ARUBA fieldwork in the future.

All told our trip was incredibly productive. We gathered a significant amount of data which corresponds well to laboratory experiments, showing the ARUBA remains a promising arsenic removal technology. Importantly, we have begun to develop strong in-country contacts which will ensure the long term sustainability of this project.

Acknowledgements
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