

## **Report for 2003GU26B: Speciation Studies of Arsenic in Guam Waters.**

- Water Resources Research Institute Reports:
  - Maika Vuki, 2004, Arsenic Speciation Study in Guam Waters, Water and Environmental Research Institute of the Western Pacific, University of Guam, Mangilao, Guam 96923, (in preparation)
- Conference Proceedings:
  - Maika Vuki, 2004, Arsenic Speciation Study in Guam Waters, in College of Liberal Arts and Social Science 25th Annual Research Conference Abstracts, University of Guam, p7.

Report Follows

# PROJECT SYNOPSIS REPORT

## Project Title: Speciation Studies of Arsenic in Guam Waters

### Problem and Research Objectives

The toxicity of arsenic has received both national and international significance over the past 10 years because of its proven carcinogenic properties. High levels of arsenic are often closely associated with areas having high arsenic content in soils and rocks. However, more concern is now centered on manmade impact on arsenic levels in the environment. Some of the common uses of arsenic are wood preservatives, pesticide, metal extraction in mining. The most vulnerable systems to be affected are water and air where humans are susceptible to contamination. In the U.S. more than 700 sites for drinking water out of the 1300 National Priority sites has been reported to have high arsenic levels. The growing concern of high arsenic levels in ground water in the U.S. has led to the reduction of the maximum safety limit to 10 part per billion (ppb) in drinking water in 2001.

Arsenic occurs in several forms in the environment. Inorganic species, namely arsenite As(III) and arsenate As(V) usually predominate in ground waters and acid mine drains. However, organoarsenicals can often be significant in surface waters, especially when they have been impacted by human activities. The two common organic forms of arsenic are monomethyl arsenate and dimethyl arsenate. Two main sources of organic arsenic are animal feed supplement and herbicide. As(III) is the most toxic of all the species of arsenic and the conversion between the different forms is possible given the right conditions. Very little is known on the fate of these compounds once distributed in the environment.

For the island of Guam, the levels of arsenic in ground water wells are generally low. However, some recent data show significant levels of arsenic in spring waters along Tumon Bay on the northern part of the island. From the nine stations that were studied in Tumon Bay in 2001, arsenic levels ranged from 16 ppb to 100 ppb with the average of 37 ppb. These levels are clearly high and warrant further investigation. Guam's major industry is tourism and Tumon Bay is the main tourist hub where most hotels are located. The high level of arsenic in the spring water poses a serious threat to holiday makers that rely heavily on its beach and water for recreation. All the springs on Tumon Bay discharge directly into the bay.

The objectives are

- i. To investigate the levels of Arsenic in Tumon Bay, the connecting freshwater wells on Guam and other potential sites during the wet and dry season.
- ii. To conduct speciation studies of arsenic to ascertain the levels of the different forms of As both organic and inorganic.
- iii. To conduct speciation study on the sediments and biota samples
- iv. To conduct an interlaboratory validation exercise laboratory
- v. To correlate the levels of arsenic to the likely sources and sinks.

## **Methodology**

The first part of the project was to verify the levels previously reported from the two studies along the established sites. The hydride generation method with atomic absorption spectroscopy was used and this method has a detection limit of 1ppb. The method has four pretreatment regimes for the water sample to differentiate the four arsenic species; As(III), As(V), MMA, and DMA. Two pretreatment methods were considered first in this study to determine the levels of inorganic arsenic species, As(III) and As(V). These two forms of arsenic are known to be the major source of toxicity.

Water samples from the 10 sites along Tumon Bay were collected during the dry and wet season. Sampling protocol followed standard method. Samples were acidified with concentrated hydrochloric acid. Replicate samples together with field blanks were collected at the 10 stations for quality assurance. Measurement for pH, dissolved oxygen, salinity, and temperature were conducted at each site.

Water samples were filtered in the laboratory stored under 4<sup>0</sup>C in the laboratory before analysis.

The arsenic levels were measured using atomic absorption spectrometry coupled with the hydride generation technique. Three Research Assistants were employed to assist in the laboratory and field activities.

## **Principal Findings and Significance**

Result obtained in this study is shown in Table 1.0. Almost all the values were below 1ppb level. Arsenic levels reported by Guam EPA in 2001 ranges from 16ppb to 100ppb with 37ppb as the average. It is clear that Guam EPA values in 2001 were significantly high. However, a follow up study by Guam EPA in 2002 along the same sites reported on much lower values. The levels of arsenic reported in 2001 along the same locations were much lower and appears to be in agreement with data from this study. The arsenic levels in the Guam spring water are low but further analysis needs to be conducted to confirm the results from this study.

**Table 1.0. Levels of inorganic arsenic in Tumon Bay Springs.**

<b>Tumon Bay Samples</b>			
<b>Sample</b>	<b>Spring Location</b>	<b>Concentration ug/L</b>	
		<b>July 7, 2003</b>	<b>July 29, 2003</b>
TB1	Hilton On-Site Spring	0.6	0.2
TB2	Hilton On-Shore Spring (Dup.)	0.4	0.2
TB3	Marriott On-Shore Spring	0.4	0.2
TB4	Reef On-Shore Spring	0.4	0.3
TB5	Westin On-Shore Spring	0.6	0.3
TB6	Outrigger Off-Shore Spring	0.6	0.3
TB7	Hyatt Off-Shore Spring	0.4	0.3
TB8	Wet Willie's On-Shore Spring	0.4	0.2
TB9	Gun Beach On-Shore Spring (Background)	0.4	0.4
TB10	Gun Beach Rock Ledge On- Shore Spring	0.4	0.4
TB11 (Exp. Blank)	Blank	0.4	0.2
TB2SP(10)	Hilton On-Shore Spring (Spiked)	9.8	NA
TB9SP(5)	Gunbeach On-Shore Spring (Spiked)	5.8	NA
Std. 5	Calibration standard	Na	4.9
Std. 10	Calibration standard	NA	9.1