Identifying Predictors for Bioavailability of Arsenic in Soil at Mining Sites

V.L. Mitchell; C.N. Alpers; N.T. Basta; D.L. Berry; J.P. Christopher; D.D. Eberl; C.S. Kim; R.L. Fears; A.L. Foster; P.A. Myers; and B.M. Parsons

(1) Department of Toxic Substances Control, Cal EPA, (2) U.S. Geological Survey, (3) Ohio State University, (4) Chapman University.

ABSTRACT

Accidental or toxic releases due to arsenic (As) in soils cause toxicity problems based on exposures to soils. Arsenic’s toxicity and bioaccessibility, the ability of As to be released from soils, to water, and to be bioavailable to humans and animals, is a major concern in the environment. Arsenic bioaccessibility in soils can be quantified by various in vitro methods, and also by in vivo techniques which measure bioavailability in the body. However, it is not clear how in vitro methods measure bioaccessibility in soils, nor are the methods predictive of in vivo bioavailability. This study is focused on the development of in vitro methods to measure bioaccessibility of As in soils, and the ability of the methods to predict in vivo bioaccessibility. This study will identify the soil properties which control the bioaccessibility of As, and to develop in vitro methods that can be used to assess the bioavailability of As in the environment. The development of accurate in vitro methods to measure bioaccessibility of As in soils will provide a better understanding of the bioavailability of As in the environment, and will result in better soil sample analysis methods.

METHODS

Arsenic in vitro bioaccessibility

In vitro Gastrointestinal Test Method:

Gastric Phase

• 1.0 M NaCl, pH 1.5
• 1.0 g soil solution ratio
• Manual adjustment to pH 1.5 with constant stirring for 1 h

Intestinal Phase

• 0.63 M Bicarbonate added
• Manual adjustment with HCl to pH 7.0 with constant stirring for 2 h

Figure 1: Bioaccessible As using an in vitro gastrointestinal (IVG) method. The IVG method measured the As bioaccessibility from 1.4% of the total As. Plotting Log [Total As] vs. Log bioaccessible As indicated four populations. Inorganic As (As0) is primarily associated with iron (hydr)oxide (ferrihydrite). Arsenic associated with organic matter and other phases was more variable and difficult to identify.

High energy synchrotron-based X-ray Analysis

Arsenic X-ray Absorption Fine Structure (XAFS)

Arsenic X-ray Absorption Fine Structure (XAFS) was used to determine the chemical state of As in the soil samples. The XAFS spectra were collected using the high-energy synchrotron X-ray facility at the Stanford Synchrotron Radiation Laboratory. The XAFS spectra were analyzed using the EXAFSPak software, which is available online at http://ssrl01.slac.stanford.edu/exafspak.html. The analysis was performed using the K-edge absorption spectra, and the spectra were fit with a model compound to determine the chemical state of As in the soil samples.

REFERENCES:


