

Extraction of arsenate and arsenite species from soils and sediments

Myron Georgiadis^a, Yong Cai^{a,*}, Helena M. Solo-Gabriele^b

^a Florida International University, Department of Chemistry and Biochemistry and Southeast Environmental Research Center, University Park, Miami, FL 33199, USA

^b University of Miami, Department of Civil, Architectural, and Environmental Engineering, P.O. Box, 248294, Coral Gables, FL 33124-0630, USA

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NaDDC preserves arsenite during soil and sediment extraction.

Abstract

The primary objective of this study was to develop a simple method that can be used to extract the more readily mobilizable and bioavailable arsenic species from soil and sediment while at the same time minimizing the transformation between (As^{III}) and (As^{V}), the two most commonly found arsenic species in the environment. Several extraction strategies were evaluated using phosphate as extractant in combination with either ethylenediaminetetraacetic acid (EDTA), hydroxylamine hydrochloride ($\text{NH}_2\text{OH}\cdot\text{HCl}$), or sodium diethyldithiocarbamate trihydrate (NaDDC). The addition of EDTA in the phosphate solution did not prevent As^{III} from oxidation. While promising results were shown when 1% $\text{NH}_2\text{OH}\cdot\text{HCl}$ was added, conversion of As^{III} began to occur with extended extraction time (> 12 h). Good results were achieved using 10 mM phosphate and 0.5% NaDDC where As^{III} oxidation was clearly minimized. The combined phosphate and NaDDC solution was applied to several soil and sediment samples. As^{III} spiked was quantitatively recovered in all soil types tested.

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1. Introduction

Research on arsenic biogeochemical cycling and its health effects has spanned the spectrum from occurrence and exposure to intervention and medical treatment. Arsenic study is complicated by the fact that both organic and inorganic arsenic forms can exist in environmental and biological systems (Cullen and Reimer, 1989; Frankenberger Jr., 2002). Arsenic is also a redox sensitive element which can exist in multiple oxidation states (5, 3, 0, and -3). Conversion between different oxidation states occurs readily in environmental and biological systems (Frankenberger Jr., 2002; Meng et al., 2003; Watt and Le, 2003). The environmental fate, bioavailability and toxicity of arsenic vary dramatically with its chemical forms. Therefore, assessment of arsenic fate and transport, environmental impact

and human health risk based only on measurement of total arsenic concentration is not reliable. Frequently, the lack of the speciation information is the major limitation to our understanding of the biogeochemical cycling of arsenic and its health effects to human beings.

The identification of different arsenic forms in environmental and biological systems has become an important and challenging research area in environmental and biomedical studies. The separation steps should be considered closely in order to maintain the integrity of arsenic species. As with many other metals, speciation analysis of arsenic involves a complex scheme of operation (Templeton et al., 2000). One of the approaches to study the solid-phase association of elements that has been extensively applied to metals and metalloids is the sequential partial dissolution technique proposed by Tessier et al. (1979). This analytical procedure involves sequential chemical extractions separating trace metals into five fractions: exchangeable, bound to carbonates, bound to Fe-Mn oxides, bound to organic matter, and residual.

* Corresponding author. Tel.: +1 305 348 6210; fax: +1 305 348 3772.
E-mail address: cai@fiu.edu (Y. Cai).