Arsenic biovolatilization from soil – A global phenomenon?

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Arsenic biovolatilization in the environment is a scarcely studied phenomenon which seems to be an important pathway to the atmosphere [1]. Using a recently validated chemotrapping technique involving silver nitrate impregnated silica-gel tubes [2], we propose here to unravel what appears to be a ubiquitous mechanism.

A whole range of soils from Europe and Asia, such as mine tailings, rice paddies, estuary sediment or upland peat ranging from 1.2 ± 0.1 to 15200 ± 117 mg. kg^{-1} As were investigated for volatile arsenic species concentration using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for total analysis and High Performance Liquid Chromatography (HPLC) with ICP-MS for speciation analysis. The absolute limit of detection of 5.3 ng As on the traps (0.5 μg. kg^{-1}. yr^{-1} under normal trapping conditions) allows to detect low-level volatilization. The rates of volatilization measured ranged from 0.53 ± 0.23 to 69.20 ± 33.09 μg. kg^{-1}. yr^{-1} with an As removal rate of up to 0.17% for the upland peat. All soils were found to volatilize arsenic, trimethylarsine TMAs being the most volatilised species, before dimethylarsine, Me_2AsH and arsine, AsH_3.

The method was deployed in the field in Spain and in Bangladesh on 4 different sites: two rice paddies, a mine tailing and a mangrove forest. Pumps and flow boxes were used to trap volatile arsenic species. Rates were found to be ranging from 0 to 237 ± 90 mg. ha^{-1}. yr^{-1} and speciation results confirmed mesocosm findings with in order of importance TMAs > Me_2AsH > AsH_3.

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Elemental cycling in shallow-sea hydrothermal sediments

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Shallow-sea hydrothermal systems are the often overlooked intermediate between deep-sea hydrothermal systems [e.g. MOR and arc systems] and terrestrial hot springs. Geochemical characteristics of hydrothermal fluids at shallow-sea systems are a result of mixing heated marine and meteroric water with cold seawater in permeable sediments. The limited number of investigations concerning these heated sediments suggest that microbial communities share characteristics with both deep-marine and terrestrial counterparts [1-4]. Further, the relative ease of sampling at shallow-sea systems makes them an attractive alternative for viewing microbial community dynamics in hydrothermal marine sediments, and provides a unique glimpse into element cycling relevant to the deep and 'dark' biosphere.

Bioavailable nitrogen, essential to any microbial community, is often limited in natural systems. Organisms capable of nitrogen fixation may be critical to the development and maintenance of a succesful microbial ecosystem, yet identifying the members of the community that are capable of this key function can be difficult [5]. In nutrient limited environments, such as deep-sea hydrothermal systems, the capacity for nitrogen fixation has been explored [6], as have other portions of the nitrogen cycle such as ammonia oxidation. This study is the first to investigate multiple steps of the nitrogen cycle within shallow-sea hydrothermal sediments. Here, we explore the presence of functional genes that are key in steps of the nitrogen cycle, such as nitrogen fixation [NifH], denitrification [nirKS], and ammonia oxidation [AmoA]. Of further interest is the portion of the community which may be active in the cycling of sulfur, though sulfide oxidation [Sox] and sulfate reduction [Dsr] [7]. Results indicate the capacity of these sediments for supporting active elemental cycling, and lead naturally to investigations of gene activity and expression.

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