Biovolatilisation of arsenic: Validation of a low level, field deployable, chemo-trapping technique

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Biological volatilisation through methylation is potentially an important pathway of arsenic release from terrestrial pools into the atmosphere. However, it is a scarcely studied phenomenon due to inherent sampling issues associated with cryo-trapping technologies, and poor validation and speciation of chemo-trapping approaches. To quantify arsenic volatile species (arsines) in the environment, we developed a field-based sampling method, using a flux chamber and silver nitrate impregnated silica gel tubes.

Validation of the method was achieved by trapping known amounts of the four different arsines (arsine, mono-, di- and tri- methylarsine) on the silver nitrate impregnated silica gel tubes and by measuring the recovery after elution with diluted hot boiling nitric acid. Both UV-HG-AFS and ICP-MS were used to analyse the samples. Results from three separate experiments show that the method is reproducible and allows for quantitative trapping and eluting of arsines with recoveries ranging from 80.1 to 95.6%. HPLC-ICP-MS analysis confirmed that when hot boiling water was used to elute the traps, the As-C bound of the three methylated species remained intact, which allows for speciation analysis. Finally, we tested this method to measure natural arsenic volatilisation from two non-spiked soils that naturally contain arsenic, a paddy soil from Pearl River Delta (China) and mud from the Don estuary (Scotland).

This technique will enable one to know to what extent and under which forms arsenic is released from reduced environment, such as rice cultivated paddy fields, wetlands or flooded soils.

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Evaluating the oxidation state of antibacterial minerals

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Understanding the action of antibacterial clays is desirable because few new antibiotics have been developed recently, despite the emergence of antibiotic-resistant bacterial strains. Our past research on French green clays used in the treatment of Buruli ulcer (a mycobacterial skin infection), showed that one of the green clays killed a broad spectrum of human pathogens including antibiotic resistant strains. Recently we identified two more clay deposits that are antibacterial. There is no physical interaction between the clay and the bacterial surfaces; therefore our investigation focuses on chemical interactions.

A comparison among the mineralogical and chemical properties of these clays shows that: (1) each is dominated by expandable clay minerals, but in detail are mineralogically different; (2) each sample contains minerals with reduced Fe and other transition metals that may produce reactive oxygen or nitrogen radicals capable of degrading DNA; (3) the antibacterial agent(s) are water soluble, and leachates display extreme (<4 or >10) pH and low oxidation state and; (4) the minerals and leachates lose their bactericidal capacity when oxidized.

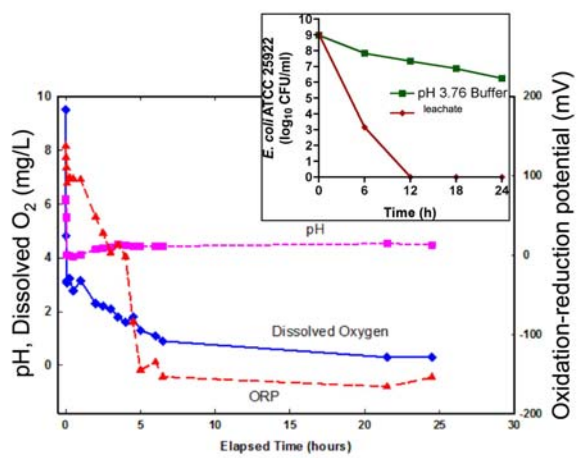

Figure 1. Changes in oxidation state and pH of aqueous leachate over 24 h. The killing curve for *E. coli* (upper right) compared to a buffer (pH 3.8) suggests a minimal role for pH and points to the more important role of oxidation state in the bactericidal process.