Adsorption of As(III) and As(V) onto vivianite – Evaluation as a sink for arsenic in Bengali aquifers

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Although microbially mediated reduction of Fe(III) oxy-hydroxide phases is thought to be critically implicated in the mobilisation of arsenic in shallow aquifers in Bengal (Islam *et al.*, 2004), Cambodia (Rowland *et al*., 2004) and other parts of world, there is substantial evidence that mobility of arsenic in such aquifers is also controlled by the nature and distribution of secondary Fe-bearing phases. Secondary Fe-sulfides, magnetite, siderite and vivianite have all been suggested as potential arsenic sinks. Whilst there are considerable data on the adsorption and/or incorporation of arsenic into Fe-sulfides (Farquhar *et al*., 2002; Wolthers *et al*., 2005) and magnetite (Dixit and Hering, 2003; Coker *et al*., 2006) there is a dearth of such data for vivianite. In this study, we report the sorption behaviors of both arsenite and arsenate on vivianite under anaerobic conditions as a function of solution pH and dissolved arsenic oxidation state and concentration

Natural well crystallised vivianite was characterised by ESEM/EDS, XRD, EPMA and BET and then mixed (1:8 wt/wt) with 1, 10 and 100 µM of As(III) or As(V) in a background electrolyte of 0.1 M $NaNO_3$ with pH adjusted from 3 to 11 with HNO_3 or NaOH. Solutions were purged with nitrogen and the studies were conducted under a modified atmosphere of 5% H_2 + 95% N_2 in an anaerobic cabinet at ambient temperature (T = 23 +/- 3°C) and pressure. Fe, P and As in the aqueous phase after 40 hours were measured by ICP-AES.

The adsorption of As(III) was found to be pH dependent, increasing from 10% of a 100 µM solution at pH 3 to 33 % at pH 10 and 75% at pH 11. Implications for the scavenging capacity of vivianite for As(III) in shallow reducing groundwaters in Bengal are discussed.

References

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Fossilized microorganisms from Emperor Seamounts: Evidence for a deep sub-seafloor biosphere

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Fossilized microorganisms have been observed in drilled samples of seafloor basalts collected during ocean Drilling Program (ODP) Leg 197. During that leg three different seamounts belonging to the Emperor Seamounts in the Pacific Ocean were drilled: Detroit (81 Ma), Nintoku (56 Ma) and Koko (48 Ma) Seamounts respectively. A wide variety of microbial-like structures were found in veins, attached to mineral surfaces and embedded in minerals like calcite, aragonite and gypsum. Morphologically, the microfossils vary a lot. Globular cell-like coccoids, sheaths, segmented filaments, twisted filaments and branched filaments were found. With ToF-SIMS (Time of Flight Secondary Ion Mass Spectrometry) fatty acids and lipids were detected in the microfossils. This is, to our knowledge, the first time such compounds have been found in association with microbial remnants from sub-seafloor environments. ToF-SIMS further showed concentrations of C_2H_4 and PO_3 in the microfossils. The biogenicity was also supported by dying the microfossils with the pigment PI (propidium iodide) that binds to dead bacteria cells and remnants of DNA. EDS-analyses showed that they contain slight amounts of elements like Si, Al, Mg, K and Na but very high amounts of carbon (~10-50 wt % C) and iron (~10-50 wt % Fe). The high iron content as well as a close association with iron oxides and deposition of iron oxides onto the filaments indicate that the microorganisms were involved in iron oxidizing reactions and that iron probably served as an energy source for the metabolism of the microorganisms.

Our observations show that all three seamounts drilled during ODP Leg 197 have been supporting a deep sub-seafloor biosphere during their volcanically active period of time when hydrothermal activity was present and fluids circulated the rocks.