Microbially-mediated arsenic release from Mekong Delta sediments

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The release of arsenic (As) from deltaic sediments into groundwater is an issue that exposes millions of people in South-East Asia to toxic levels of As via drinking water. While reductive dissolution of iron oxyhydroxides and the associated As is a known mechanism of release, there are areas in which the sediments do not harbor iron oxyhydroxides. For instance, in the Vietnamese Mekong Delta, in a reduced, As-rich, peat layer harboring a brackish porewater and interpreted as a relic from a mangrove depositional environment [1], As is found associated with arsenian pyrite and natural organic matter (NOM).

Flow-through experiments show that this peat layer releases a large amount of As and characterization of the solid phase reveals that both arsenian pyrite and NOM contribute approximately equally to the release. Furthermore, poisoning of the sediment decreased the amount of As released, suggesting a microbially-mediated process. However, the mechanism of As release from arsenian pyrite remained unclear. Further batch experiments revealed that pyrite was oxidized, releasing sulfate and As. The electron acceptor for the process is likely to be nitrate as it is the only detectable electron acceptor in the porewater of the peat layer (other than sulfate). Furthermore, amending peat with increasing concentrations of nitrate resulted in a linear and positive correlation with As released, supporting the role of nitrate. Similarly, it was suggested that heterotrophic denitrification could release As from NOM through oxidation of thiol groups. This work shows that a peat layer formed from a paleo-mangrove can serve as a source rather than a sink for As *in situ* through a microbial mechanism, provided that an appropriate electron acceptor is available. The implication is that the mobility of As in deltaic sediments is not solely dependent on reductive dissolution of iron oxyhydroxides but also on oxidative dissolution of arsenian pyrite and degradation of NOM.

[1] Wang et al. *Environ. Sci. Technol.* 2018 52, 3431-3439.