Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29092

Arsenic Mobilization into Groundwater Caused by Microbial Fe(III) Mineral Reduction Coupled to Methane Oxidation in Vietnam

JUNJIE ZHU[1], MARIE MERGENTHALER[1], SIGRID VAN GRINSVEN[1], SARA KLEINDIENST[2] AND ANDREAS KAPPLER[1]

[1]University of Tuebingen
[2]University of Stuttgart

Geogenic arsenic (As) contamination affects ~140 million people [1], and Vietnam is severely affected as groundwater is its main domestic water source [2]. Microbial reductive dissolution of As-bearing Fe(III) (oxyhydr)oxide minerals is widely recognized as a key mechanism driving As mobilization in groundwater. In a previous study from our lab using sediments from the Hanoi area in Vietnam, in-situ natural organic matter (NOM) has been identified as an electron donor for Fe(III) reduction. This process has been shown to mobilize even higher amounts of As compared to simple organic compounds such as acetate or lactate [3]. Additionally, recent studies at the same field site in Vietnam have suggested that methane (CH_4) can serve as an alternative electron donor for anaerobic methane oxidation (AOM) coupled to the reduction of As-bearing Fe(III) minerals [4]. However, the broader influence of CH_4-mediated Fe(III) reduction on As mobilization in the Red River Delta in Vietnam is currently unknown.

This study investigates two field sites in Hanoi, Van Phuc and Dan Phuong, where elevated CH_4 concentrations were detected and found to correlate with groundwater As(III) and Fe(II) concentrations[4,5], suggesting that Fe(III)-dependent AOM may play a significant role in As mobilization in these environments. We conducted drilling campaigns in the redox transition zones at both sites and performed mineralogical and geochemical characterization of sediment and groundwater samples. To better understand the microbial mechanisms of As mobilization, we conducted laboratory microcosm experiments using sediment samples amended with CH_4 and NOM to compare the role of Fe(III)-dependent AOM with NOM-driven Fe(III) reduction. Additionally, in-situ microcosms using groundwater and sediments were set up to enrich microbial communities capable of Fe(III)-dependent AOM, aiming to establish new enrichment cultures and identify key microorganisms involved in this process. This study aims to enhance our understanding of CH_4-driven Fe(III) reduction and its impact on As mobilization in contaminated groundwater in the Red River Delta.

[1] UNICEF (2018) *Arsenic Primer.* [2] Shaji et al. (2021) *Geosci. Front.* 12, 101079. [3] Glodowska et al. (2020a) *EST* 54, 4149. [4] Glodowska et al. (2020b) *Commun. Earth Environ.* 1, 37. [5] Postma et al. (2007) *GCA* 71, 5054.