Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37579

Monsoon-triggered microbial blooms drive arsenic mobilization in a shallow Holocene aquifer

JUAN PABLO MARIN JARAMILLO[1], KHAI QUANG HA[2,3], VO DAN THANH[2], MANON FRUTSCHI[1], PHU LE VO[2,3] AND RIZLAN BERNIER-LATMANI[1]

[1]École Polytechnique Fédérale de Lausanne (EPFL)
[2]Vietnam National University Ho Chi Minh City
[3]Ho Chi Minh University of Technology (HCMUT)

Deltaic aquifers provide essential sources for drinking water purpose to hundreds of millions of people, particularly across South and South-East Asia, yet the mechanisms by which monsoon-driven hydrological pulses reshape subsurface microbial communities and influence trace metal(loid) transformations remain poorly constrained. This gap is especially relevant in arsenic-affected deltas, where microbially mediated redox shifts can promote Fe(III) oxide dissolution and arsenic mobilization. Here, we integrate biological and geochemical observations from a shallow Holocene aquifer transect in the Vietnamese Mekong Delta monitored continuously through a full monsoon cycle. We combined high-frequency hydrological measurements with monthly groundwater geochemistry and quarterly microbial community characterization using quantitative PCR (qPCR) and 16S rRNA gene sequencing.

At the onset of monsoon recharge, quantitative PCR and sequencing revealed a pronounced microbial bloom, characterized by increased bacterial abundance and a community shift dominated by heterotrophic taxa. Following bloom initiation, we observed coherent increases in Fe(II), As(III), and pH across the transect, indicating a transition toward more reducing conditions consistent with enhanced oxygen consumption and subsequent reductive processes. To quantify coupling between hydrologic forcing, bloom dynamics, and trace metal(loid) response, we applied regression models that relate post-bloom geochemical changes to bloom magnitude while accounting for hydrologic state using window-mean water level. These analyses show that As(III) enrichment increases with bloom intensity, supporting a mechanism in which bloom-driven oxygen depletion lowers redox potential and promotes reductive dissolution of As-bearing Fe(III) oxides, thereby triggering arsenic mobilization.

Beyond arsenic release, event-study regressions with hydrologic controls revealed a delayed (~3 month) positive association between bloom magnitude and DIC accumulation, consistent with progressive in situ CO_2 production from organic matter respiration as the aquifer responds to recharge. Altogether, these results demonstrate that monsoon-triggered microbial blooms can couple hydrologic perturbations to biogeochemical outcomes, simultaneously enhancing subsurface CO_2 generation and promoting trace metal(loid) mobilization.