Microbial arsenic mobilization in groundwater aquifers of the Red River Delta, Vietnam

M. PATZNER[1], M. GLODOWSKA[1], E. STOPELLI[2], A. LIGHTFOOT[2], M. SCHNEIDER[3], R. KIPFER[2], L. WINKEL[2,5], O. CIRPKA[1], E. EICHE[3], A. KONTNY[3], T. NEUMANN[3], B. RATHI[1,4], H. PROMMER[4], D. VU[6], M. TRAN[6], N. VIET[6], V. M. LAN[6], P. K. TRANG[6], P. H. VIET[6], M. BERG[2], S. KLEINDIENST[1], A. KAPPLER[1]

[1]Center for Applied Geoscience, University of Tuebingen, Germany (monique-sezanne.patzner@student.uni-tuebingen.de)
[2]Eawag, Swiss Federal Institute of Aquatic Science and Technology, Dübendorf, Switzerland
[3]Institute of Applied Geosciences, KIT, Germany
[4]University of Western Australia, Perth, Australia
[5]Pollutant Dynamics, ETH Zurich, Switzerland
[6]CETASD, Vietnam National University, Hanoi, Vietnam

Arsenic contamination of groundwater leads to serious health risks for millions of people, especially in densely populated river deltas in Southeast-Asia. The mobilization of As has generally been attributed to microbial reduction of As-bearing Fe(III) (oxyhydr)oxides coupled to organic carbon oxidation. Yet, little is known about microbial reduction of As-loaded Fe-minerals from threatened aquifers using in-situ organic carbon or ammonium as potential electron donors. In groundwater at Van Phuc village (Hanoi area), organic carbon and ammonium are present as potential electron donors for microbial reduction of Fe(III) minerals. This site is characterized by a juxtaposition of a high-As aquifer upstream of a so far low-As aquifer in an area where increasing water extraction of Hanoi dominates lateral groundwater flow. We used microcosms with aquifer material from this redox transition to quantify the rates and extent of Fe(III) reduction and As mobilization, as well as to identify the involved microorganisms and the used electron donors. Freshly collected, oxidized aquifer sediments were suspended in original or artificial groundwater, either un-amended or amended with acetate/lactate, in-situ organic carbon or ammonium to determine their effect as potential electron donors for microbial Fe(III) mineral reduction under anoxic conditions (N_2/CO_2 headspace). Over time (up to 100 days), we quantified dissolved As, Fe, DOC, NH_4^+, P, S, Mn and analyzed the microbial community composition in the beginning and at the end as well as the Fe mineralogy using Mössbauer spectroscopy. Our findings will help to evaluate how fast the redox front progresses and when the so far safe water will potentially be contaminated.