

Predicting spatial and temporal concentrations of arsenic within the Mekong Delta

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It is generally accepted that arsenic release from sediments within the vast deltaic plains of South and Southeast Asia transpires under reducing conditions, and microbially-mediated reductive dissolution of arsenic-bearing iron (hydr)oxides is the dominant reaction liberating arsenic to the aqueous phase. Further, strong links have been established between groundwater contamination and arsenic release within near and sub-surface environments, and it has become clear that hydrogeologic conditions impart a domineering effect on As distribution during and following liberation. The hydrologic systems of the deltaic aquifers throughout South and Southeast Asia, however, have drastically changed due to extensive groundwater extraction, and from massive anthropogenic alteration of the soil-sediment profile for numerous small and large-scale (excavation) projects. We here present a unifying biogeochemical-hydrogeologic analysis of processes governing arsenic using field-calibrated one- and two-dimensional reactive transport simulations, and utilize three-dimensional simulations to examine the possible effects of excavation and irrigation pumping—processes prevalent in other countries in South and Southeast Asia. The ability to project arsenic levels in space provides the critical capacity to assess optimal locations and depths for groundwater extraction—provided they exist—while projecting temporal changes allows us to determine long- and short-term threats to low-arsenic wells, particularly those arising from land use changes.

Arsenic mobility in a waste rock pile at Dlouhá Ves, Czech Republic

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Products of fifty-years long alteration of a waste rock pile from a Pb, Zn-deposit at Dlouhá Ves, Vysočina region, Czech Republic, were studied in the pile centre (profile I) and on its slope (profile II). The pile material had initially high sulphide (10-20 wt. %) and very low carbonate content (1-2 wt. %); the only primary mineral of As was arsenopyrite.

Significant oxidation of sulphides (pyrite, pyrrhotite, arsenopyrite, sphalerite, galenite) took place in both profiles. The principal As-bearing phase at the top of the profile I is goethite, while down to its base most of As is present in the jarosite group minerals. Melanterite and anglesite were found in a sulfide-rich, lower part of the profile I. At the profile II, minerals of the jarosite-beudantite group, scorodite and kaňkite prevail and no Fe (II)-minerals were found. The paste pH was lower at the profile I (≥ 1.9) than at the profile II (≥ 2.8). Processes in the pile are affected by the ratio pyrite to arsenopyrite, where high pyrite content decreases the As/S ratio and results in the formation of jarosite group minerals and low pH conditions. Where arsenopyrite predominates, sulphides are coated by scorodite and other Fe-As phases like schwertmannite, which limit their further oxidation.

Arsenic concentrations released during the leaching experiments were generally low; maximum amounts (up to 0.56 ppm) were released from horizons with jarosite and arsenopyrite. In contrast, minimum amounts of arsenic were released from horizons with beudantite and scorodite. Differences between both profiles are caused mainly by limited water flow through the pile material and also limited penetration of oxygen into the deep parts of the excavation profile. It seems that beudantite and scorodite could represent a long-term option for immobilization of arsenic, but arsenic stored in jarosite can be mobilized relatively easily [1, 2]. However, potential mineralogical transformations and stability of arsenic in beudantite group minerals have yet to be evaluated, because the long-term stability of secondary arsenic minerals remains a serious problem [3].

[1] Kocourková *et al.* (2011) *J Geochem Expl*, in press.

[2] Gieré *et al.* (2003) *Appl Geoch* **18**, 1347–1359.

[3] Majzlan *et al.* (2007) *Geochim Cosmochim Acta* **71**, 4206–4220.