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# A $ZnHAsO_4$ phase controls As(V) and Zn(II) solubility in a multi-contaminated soil- a study combining µ-XRF, µ-EXAFS and geochemical equilibrium modeling

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Multi-contaminated soils are challenging when assessing element speciation and solubility control mechanisms. In this study, the solubility and speciation of As and Zn were studied in detail in a soil contaminated with As (2,000 mg/kg), Cu (500 mg/kg), Cr (1,200 mg/kg), and Zn (2,200 mg/kg) salts for wood impregnation. The leaching behavior of particles, colloids, and dissolved species was studied in intact column experiments with artificial rain water applied at three intensities. Furthermore, batch studies over a wide pH-range (2-8) were performed to study the solubility of the elements. Microscale X-ray fluorescence (µ-XRF) was performed on the bulk soil and the leached particles, and it indicated that As and Zn were highly correlated in space in the bulk soil ($R^2$>0.69) and in the particles ($R^2$=0.40). Interestingly, As was not correlated with Fe in the bulk soil ($R^2$<0.15), whereas it was in the particles ($R^2$=0.48). Geochemical equilibrium modeling of the batch experiments and the dissolved fraction leached from the column experiment, indicated that a $ZnHAsO_4$ phase controlled the dissolved fraction of As(V) and Zn(II) (log $K_{sp}$=-21.8). µ-EXAFS (extended X-ray absorption fine structure) spectroscopy of As and Zn on selected hotspots in the soil and in the particles, indicated the presence of an amorphous variant of the rare mineral koritnigite ($ZnHAsO_4 \cdot H_2O$). Since this phase lowered the solubility of As by almost two orders of magnitude in soil at pH above 5, it could be of great importance at other similar sites.

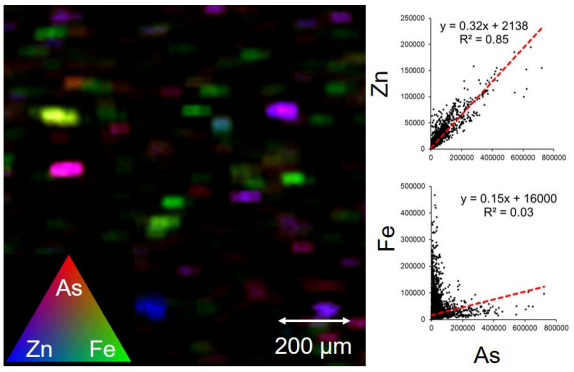


Fig. 1.

Fig. 1. Left: µ-XRF spectrum of the bulk soil mapped with As (red), Zn (blue), and Fe (green). Right: The correlations of the intensities of Zn (top panel) and Fe (bottom right panel) to As.