

Electro-osmotic removal of PAHs: A journey from the lab to the field

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Polycyclic aromatic hydrocarbons (PAH) are persistent and toxic contaminants of difficult removal from fine porous materials using conventional remediation techniques. Electro-osmosis is a potential remediation technique for the mobilization and cleanup of hydrocarbon contaminants [1-3]; it may be a promising and cost-effective technology for the removal of PAHs from clay-rich soil. By applying an electrical potential gradient, a flow of water, generally from the anode to cathode, is induced. Together with the movement of water, PAHs may be entrained towards the cathode as well. In order to demonstrate this process, we carried out studies with a custom made electro-osmosis cell (Figure 1), described elsewhere [4]. Clayey soil from Olst, the Netherlands, was used as it presents a unique study matrix: the site has been contaminated by asphalt industry for over 100 years. Using the experimental cell, up to 30% of PAHs were removed by electro-osmosis with the aid of Tween 80 [5].

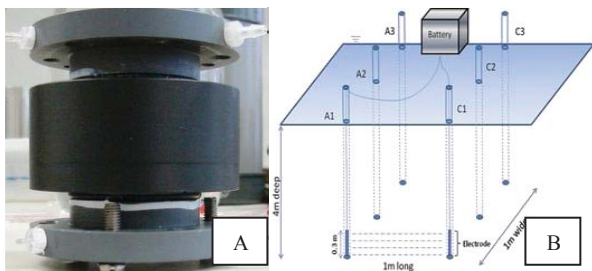


Figure 1: Picture of the electro-osmotic cell used for lab experiments (a) and design of the field experiment (b)

The Tween 80-assisted electro-osmotic clean-up was subsequently scaled up to the Olst field site (Figure 1). A release of PAHs from the soil was observed, with significant concentrations accumulating at the cathode after 90 days of continuous application of an electrical field [6]. However, most of the PAHs could not be remobilized. The percentages of PAHs that could be removed from the Olst soil, both in the laboratory and in the field, fall well below those reported for experiments with artificially spiked soils. This is likely due to the presence of PAHs in pure solid phase tar particles, from which release by dissolution is very slow. Aging effects with respect to sorption must also be taken into account when extrapolating laboratory tests to field conditions.

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Synchrotron XAS and single-crystal EPR study of arsenic speciation in struvite

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Abstract

Arsenic contamination in groundwater, natural or man-made, has become a major environmental concern worldwide, with adverse effects to human health[1]. The mobility, toxicity and bioavailability of arsenic in groundwater are known to strongly depend on its nature and speciation in source rocks. Also, when incorporated in the bulk rather than simply adsorbed on the surfaces, arsenic is less susceptible to secondary contamination. In this context, enormous efforts have been devoted to investigate arsenic uptake and speciation in minerals and synthetic materials[2]. Struvite, a common biomineral and increasingly important fertilizer recovered widely from sewage and waste water treatment plants, is known to accommodate a wide range of toxic metalloids, including arsenic. Experiments have been conducted to investigate the pH dependence of arsenic uptake in struvite. Microbeam synchrotron X-ray fluorescence (μ -SXRF) imaging shows heterogeneous distribution of arsenic in synthetic struvite. Arsenic K edge X-ray absorption near edge spectra (XANES) reveal that As in struvite occurs predominantly in the pentavalent oxidation state. Similarly, single-crystal electron paramagnetic resonance (EPR) spectra identified at least four varieties of paramagnetic $(\text{AsO}_3)^{2-}$ centers derived from diamagnetic $[\text{VAsO}_4]^{3-}$ precursors at the $[\text{PO}_4]^{3-}$ positions, further supporting the presence of lattice-bound As^{5+} in struvite.

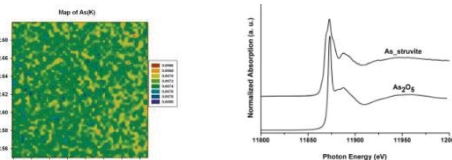


Figure 1: μ -SXRF map of As(K) and As K-edge XANES spectra

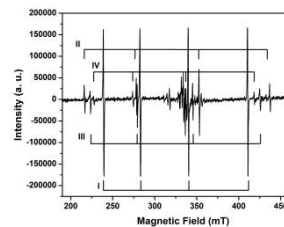


Figure 2: Single-crystal EPR spectrum of gamma-ray-irradiated struvite measured at the magnetic field \mathbf{B} approximately parallel to the crystallographic axis \mathbf{b} , showing four $[\text{AsO}_3]^{2-}$ centers with characteristic ^{75}As hyperfine structures (labeled I, II, III and IV).

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