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Bioremediation of high-As Acid Mine Drainage (AMD) from the Carnoulès mine (France) based on microbial iron and arsenic oxidation: performances and controlling factors.

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Arsenic is ubiquitous in Acid Mine Drainage (AMD). Natural attenuation involving bacterial ferrous iron oxidation and subsequent As co-precipitation can be exploited as a passive or semi-passive treatment for high-As AMD.

In this study, the removal of As from the Carnoulès As-rich AMD (Southern France) using biological oxidation by indigenous bacteria was investigated up to the pilot scale. One laboratory-scale pilot and two field-scale pilots were designed and tested successively. The main objective was to identify key factors controlling performance, while upscaling the system (from ~240 mL up to ~500 L). Arsenic speciation was monitored in liquid and solid phases. Elemental composition and mineralogy of the precipitates were determined. The main bacterial genera colonizing the systems were identified.

The bio-oxidation bioreactors were fed from one month to one year by the Carnoulès AMD containing up to ~100 mg/L As(III) and ~1000 mg/L Fe(II). They precipitated up to 80% As, using a residence time of ~9 h. The precipitate formed were mainly amorphous Fe(III)-As(V) phases. The main bacteria colonizing the systems were Fe-oxidizing genera. In field experiments, aeration and the use of a highly porous filling material improved performance compared to totally passive treatment. Changes in bacterial community structure did not affect performances. The solubility of As-rich precipitates at acid pH was identified as the main limiting factor.

These experiments enhanced understanding of the biogeochemical processes that took place in the different systems and their controlling factors. They provided theoretical and technical basis for full-scale treatment implementation as a first step in a multi-step treatment scheme.