Bio-precipitation of arsenic and antimony from acid mine water in a sulfate-reducing bioreactor

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Arsenic (As) and antimony (Sb) are considered by European Union as pollutants of priority interest due to their toxicity and potential carcinogenicity. These pollutants can be disseminated from mining sites to aquatic ecosystems by acid mine drainage (AMD). The precipitation of metal sulfides, based on sulfide production by sulfate-reducing bacteria (SRB) can be a promising treatment option. As and Sb present structural analogies, however the bio-precipitation of these two elements as sulfides, as a mixture of contaminants in a single AMD, has not been studied yet.

Our objective was to determine the possibility to remove concomitantly As and Sb from acidic waters by the activity of SRB in a fixed-bed column bioreactor. Experiment was performed at 25°C in a glass column (inner diameter of 36 mm and height of 360 mm) filled with a mixture of pozzolana and nutritive agar. The column was inoculated with an acid tolerant SRB consortium originating from the AMD of Carnoulès (France). The column was fed in continuous mode with the real AMD ([Fe] = 1150 mg/L, [As] = 100 mg/L, [Sb] = 1 mg/L, pH~2.8) adjusted at pH 4.5 filtrated (0.22 µm) and complemented with 0.5 g/L glycerol as substrate for the SRB. Increasing concentration of Sb was added as potassium Sb(III) tartrate : 0, 0.5 and one molar-equivalent of the arsenic naturally present in the AMD. Inlet and outlet waters were monitored over a 10 months period for pH, flow-rate, and concentrations of As, Fe and Sb. Vertical profiles of the water physico-chemistry and microbiology (diversity structure by 16S rRNA gene fingerprints, and abundance of SRB by qPCR targeting dissimilatory sulfite reductase dsr gene) along the column were determined at the end of each inlet Sb condition. Results showed that the addition of Sb in the feed water did not negatively influence the efficiency of As bio-precipitation. At the end of the experiment, Sb was removed efficiently (up to 97.9% removal) between the inlet and outlet of the bioreactor, together with As (up to 99.3% removal) at the three tested Sb conditions.