Monitoring biological oxidation and removal of arsenic and iron in a field bioreactor treating As-rich acid mine drainage

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Arsenic (As) is a toxic element ubiquitous in acid mine drainage (AMD). It represents a threat for freshwater ressources in the vicinity of closed and active mines. Passive bioremediation techniques based on biological iron (Fe) oxidation represent an opportunity to treat efficiently and economically this kind of pollution.

A field bioreactor was implemented at the Carnoulès mine (France) for the treatment of acid Reigous Creek (pH ~3.2) that contains ~120 mg/L As (81% As(III)) and ~1 g/L Fe (97% Fe(II)). It consisted in five shallow trays of 1.5 m^2 in series, continuously fed with AMD by gravitational flow. For 7 months, we monitored the physico-chemistry of the inlet and outlet AMD water, as well as the As speciation, the mineralogy and the bacterial community structure in the biogenic precipitate that formed inside the bioreactor.

The bioreactor removed 4 to 97% As, depending on the flow rate, whereas Fe oxidation and precipitation did not exceed 20% and 11%, respectively. The resulting biogenic precipitate was extremely As-rich; the As/Fe molar ratio and the As(V)% increased with the experiment duration, until 0.86 and 99%, respectively, indicating that As oxidation took place in the bioreactor. Analysis of the bacterial community structure associated with As and Fe removal also showed temporal variations.

This bioreactor provided information about the treatment perfomance and the biogenic precipitate production under field conditions, which may serve in designing future bioremediation system.