Bioremediation of Acid drainage waters (AMD) by laboratory-constructed passive system

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Introduction

A major environmental concern to the mining industry, both during the operational period and after closure is the generation of acidity, resulting from the oxidation of sulphide mineral wastes, catalyzed by acidophilic microorganisms. Acid drainage waters (AMD) in sulfide deposits are a serious environmental problem and their formation is associated with the activity of the hemolitotrophic microflora, including bacteria oxidizing reduced sulfur compounds and ferro ions.
Due to its damaging effects several strategies for control and remediation of AMD have been developed. One of the most efficient method for bioremediation of such waters is their treatment in natural or constructed passive systems.

Material and Methods

The main objective of the research was the treatment of acid drainage water samples by means of a permeable multibarrier in a laboratory-constructed passive system (Fig. 1). The treated samples originated from Kurilo uranium deposit and Tsar Asen sulfide deposit, Bulgaria (Fig. 2). The multibarrier had a volume of about 0.5 m^3 and was filled by a mixture of solid biodegradable organic substrates and crushed limestone and was inhabited by a microbial community consisting mainly of sulphate-reducing bacteria and other metabolically interdependent microorganisms.

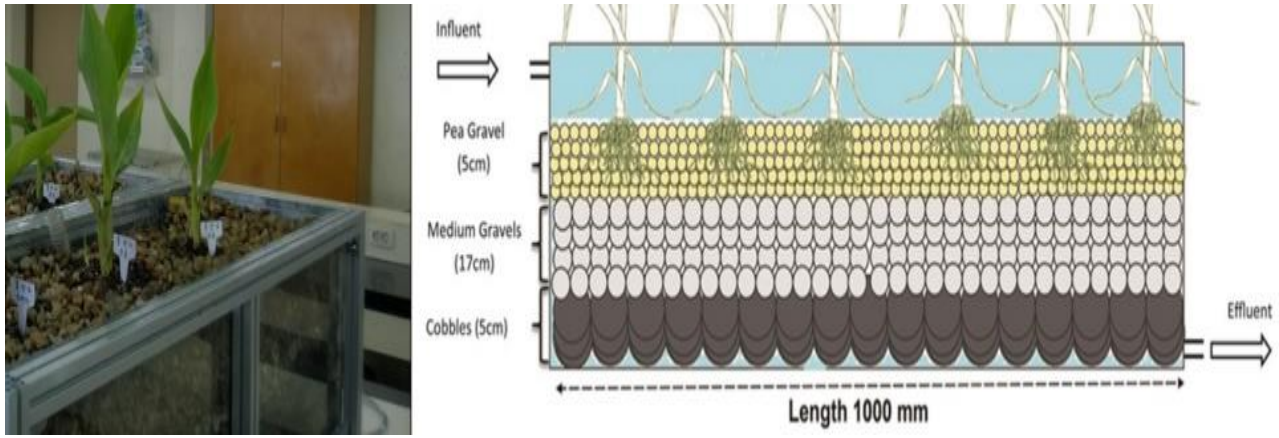

Fig. 1 Laboratory-constructed wetland

Fig. 2 Tzar Asen deposit location

Results

The taxonomical profile and quantitative share of the established microflora into the passive system was strictly monitored. An efficient removal of the heavy metals was achieved at residence times within 28-46 hours depending on metal concentrations. The removal of the pollutants was due to different mechanisms such as chemical neutralization, microbial dissimilatory sulphate reduction, sorption and accumulation by means of living and dead plant and microbial biomass, sorption by some inorganic sorbents such as clays, hydroxides, carbonates, etc., as well as by bacterial oxidation of Fe^{2+} and Mn^{2+}, followed by the precipitation of the of the oxidation forms Fe^{3+} and Mn^{4+}, mainly as $Fe(OH)_3$ and MnO_2.

Pollutants	Before treatment	After treatment	Permissible levels
U, mg/l	0.28 – 4.82	<0.10	0.6
Ra, mg/l	0.06 – 0.55	<0.05	0.15
Cu, mg/l	0.53 – 10.85	< 0.45	0.5
Zn, mg/l	0.60 – 15.40	< 0.40	10.0
Cd, mg/l	0.01 – 0.12	< 0.01	0.02
Pb, mg/l	0.09 – 0.90	< 0.10	0.2
Co, mg/l	0.25 – 2.95	< 0.10	0.5
Ni, mg/l	0.32 – 4.10	< 0.10	0.5
Mn, mg/l	1.04 – 28.4	< 0.5-1.2	0.8
Fe, mg/l	68 – 710	< 10-8.2	5.0
As, mg/l	0.01 – 0.51	< 0.01	0.2
SO_4^{2-}, mg/l	345 – 1292	< 240-812	400

Conclusions

Due to the described treatment the concentrations of the heavy metal ions in the AMD water samples were reduced to permissible levels for industrial application of the waters.