Chemical evaluation of the leaching solutions from sulfide and gossan mine wastes in environmental remediation processes with different treatments

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In São Domingos mine (Iberian Pyrite Belt) different wastes were disposed over a large area: dumps containing pyrite-rich materials and other sulfides produce acid drainage (pH<3) during all the year; and *gossan* materials having low contents of acid generator solid phases are naturally colonized by autochthones vegetation. The ecological rehabilitation of this mine area can be achived by wastes leaching minimization and/or improvement of the leachates characteristics by wastes remediation. This study aimed to evaluate the multielemental composition of aqueous leachates from *gossan* and sulfide wastes using amendments mixtures.

Initial sulfide wastes (crushed pyrite+smelting ashes) from São Domingos mine, with/without amendments, were incubated during four months under controlled conditions and then a superficial *gossan* layer (2-3 cm thick) with/without the same amendments was applied. The amendments used were a mixture (30 Mg/ha) composed of rockwool+agriculture wastes+wastes from *Arbutus* unedo fruits liquor distillation. To compare the treatments efficiency, control assays were carried out (*gossan*/pyrite and *gossan*/pyrite+amendments). Multielemental concentration, pH, and electric conductivity (EC) of wastes and leachates (obtained by percolation) were determined after three and nine months of incubation.

Initial sulfide wastes had pH≈2, large EC (7.4 mS/cm) and total concentrations of several contaminants (g/kg, As: 1.1; Al: 58.1; Cu: 2.1; Fe: 107.3; Pb: 11.7; S; 65.3; Zn: 1.1). *Gossan* materials presented less extreme chemical characteristics than sulfide wastes (pH=4.3; g/kg, Al: 24.8, As: 3.0, Cu: 0.2, Fe: 129, Pb: 9.2, S: 13.7, Zn: 0.04). All the organic/inorganic wastes used as amendments had chemical characteristics considered beneficial for the rehabilitation (pH>5; 0.9<Ec<3.5 mS/cm, small multielemental concentration). The amendments corrected slightly leachates characteristics from sulfide wastes (with or without gossan layer cover): pH increased ≈0.5 units, and EC was reduced (>35%). Although *gossan* leachates pH had varied between 3.6 and 4, gossan application over sulfide wastes was not adequate to increase their leachates pH.

The *gossan* materials (with/without amendments) leachates presented the smallest trace elements concentrations. The *gossan* application over sulfide materials (both without amendments) reduced Pb in leachates after nine months of incubation (from 2.0 to 0.6 mg/kg) and K concentration in both sampling periods (<0.4 mg/kg). Nevertheless, Cu, Mg, Mn, Fe, PO_4 and SO_4 leachates concentrations increased with *gossan* application after three months of incubation. The sulfide amended materials leachates showed K, Na and Pb reduction in both sampling periods, compared to the sulfide control. The application of amended *gossan* over amended sulfide wastes decrease Fe, Na, Pb, and SO_4 leachates concentration, however concentration of some nutrients (Cu, Mg, Mn, PO_4) increased after three months. The amendments addition (30 Mg/ha) or the superficial *gossan* layer cover of sulfide materials was not effective to minimize chemical elements leaching at nine months because similar concentrations of the same elements were observed.

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