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Effects of organic/inorganic amendments in geochemical evolution of trace elements dispersion by leachates from sulfide containing tailings

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The intense mining activity in massive sulfides from São Domingos (Iberian Pyrite Belt, SE Portugal) generated different types of wastes, namely large dumps containing pyrite and other metal sulfides. These sulfide containing tailings are characterized by total absence of vegetation, rill and gully erosion and, principally, continuous generation of acid drainage and dispersion of chemical elements on the environment. Different organic and inorganic wastes are used in rehabilitation of degraded and contaminated areas to improve physical, chemical and biological properties of mining tailings, but few studies were carried out with sulfides mine wastes. This study aimed to evaluate the effect of different amendments mixtures on the geochemical dispersion of trace elements dispersion by leaching and the improvement of sulfide materials characteristics.

Sulfide containing tailings comprised mainly roasted and brittle pyrites and smelting ashes. Three different mixtures (75 Mg/ha), composed of wastes available in the region and coming from the agriculture and distillation of fruits liquors, were used as amendments. Limestone rock wastes (<2 mm) were also added at 55 Mg/ha. Chemical characteristics (pH, electric conductivity (Ec), total C and N, and total content of chemical elements) of mining tailings and leachates (obtained by percolation) were monitored during one year of incubation in greenhouse. Mineralogical characterization of the efflorescences formed on the surface of materials was done by X-ray diffraction. Mining tailings presented extreme characteristics: coarse particle size (53 % in fractions >2 mm), pH ≈2, large Ec (7.4-7.5 dS/m) and low fertility. Large total concentrations (g/kg) of Al (58.1), As (1.1), Cu (2.1), Fe (107.3), Pb (11.7) and Zn (1.1) were found.

After one month of incubation was observed that the acidity of the leachates from treatments with amendments was decreased by the limestone rock wastes to pH ≈4. However, after four months, the pH of these treatments decreased to the initial value, similar to the leachates from control (pH ≈2), due to the continuous generation of acid drainage and carbonates dissolution. The pH values remained without any further change until the end of the experiment. Along the experiment, the amendments provided more than 50 % of reduction in electric conductivity of leachates.

The concentrations of Al, Cu, Zn and SO4 in the leachates from treatments with amendments decreased between 4-64 % and 22-79 %, after one and four months of incubation respectively, compared to control concentrations (2.6-3.2 g Al/L; 657-831 mg Cu/L; 837-1012 mg Zn/L; 54-112 g SO4/L). After four months of incubation, concentrations of Al, Cu and Zn in leachates from treatments with amendments were larger than control. Nevertheless, the amendments contributed to the reduction of As and Pb in leachates, compared to control, during more than six months of incubation (Treatments with amendments: 0.6-10 mg As/L and 0.1-7898 mg Pb/L; Control: 14-171 mg As/L and 2-23245 mg Pb/L).

From the X-ray analysis, performed to give some light into the processes of retention/remobilization/availability of trace elements during the mining rehabilitation, different efflorescent salts were identified. Aluminocopiapite and aluminocoquimbite were only identified in control. Jarosite and alunogen were the main sulfate minerals identified in treatments with amendments. The formation of these reasonably soluble salts agrees with the larger concentrations of Al found in the leachates resulting from the amendments treatment.

The addition of the studied amendments was an efficient solution to minimize trace elements dispersion and seems to contribute to enhance the tailing materials characteristics, which may allow the ecological rehabilitation processes.