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Characteristics improvement of different tailings from São Domingos mine for vegetation development by amendments addition

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Metal mining in São Domingos (SE of Portugal) generated large volumes of tailings, composed of different types of waste materials, most of them unable to support plants due to their characteristics. However, some tailings, like gossan, are sparsely colonized by autochthones and tolerant vegetation that provide a natural rehabilitation system. Thus, the improvement of these species development with organic/inorganic amendments can be a strategy for mine wastes remediation. Cistus ladanifer L. is a pioneer species growing in different mine areas from Iberian Pyrite Belt and considered a good option for phytostabilization.
This study aimed to evaluate the influence of different amendments for chemical characteristics improvement of different tailings for Cistus ladanifer development, and contaminants spread by leaching.
Composite samples of two different mining wastes (1-gossan materials; 2-crushed pyrite+smelting ashes) were collected at the São Domingos mine area. Amendments used were mixtures (75 Mg/ha) of rockwool (RW), two agriculture wastes (AW) and wastes from Arbutus unedo (ArbW) or Ceratonia siliqua (CerW) fruits liquor distillation. Four treatments were carried out (control, RW+AG+ArbW; RW+AG+CerW; RW+AG+ArbW+CerW) in pots, in triplicate, under controlled conditions in greenhouse. Limestone rock wastes were only added, at 55 Mg/ha, to pyrite materials to increase pH for similar values of gossan.
Germination, plant growth and chemical characteristics of materials from treatments (NPK, Corganic, total and DTPA-extractable concentration of trace elements) and their leachates obtained by percolation (pH, electric conductivity, trace elements concentrations) were monitored for six months. Organic/inorganic wastes were also chemically characterized.
Initial pyrite materials presented chemical characteristic unable to support plants (pH≈2 and smaller fertility with Pextractable<detection limit) compared to gossan materials (pH=4.3; Pextractable: 1.3 mg/kg; Kextractable: 83.3 mg/kg; Ntotal: 39.9 mg/g; Corganic: 12 g/kg). Total trace elements concentrations in pyrite materials were highest (g/kg): (Al: 58.1; Cu: 2.1; Pb: 11.7; Zn: 1.1; Mn: 134). However, gossan materials also present high concentrations (g/kg) of As (3.0) and Pb (9.2). Amendments used had a pH>5 and concentrations of Corganic, nutrients and trace elements were adequate for mine wastes remediation. Trace elements concentrations of DTPA-extractable and leachates in pyrite materials were higher, independently of treatment applied, than in gossan.
After one month of incubation, the amendments addition to pyrite materials was not sufficient to promote seeds germination. In these materials, after one and four months, the application of all amendments decreased leachates concentrations of Al, As, Cu, Pb, Zn, K, Na and sulfates (23-99 % depending on the chemical element). However, after six months, pyrite+amendments leachates presented higher concentrations of Al, Cu and Zn than in control, while As and Pb decreased 31 and 87 %, respectively, when compared to the control. The amendments addition to gossan materials decreased the elements concentration in leachates for levels lower than detection limit, however in control the values were already low (<0.5 mg/L for Cu, Zn and Pb).
In gossan assays, seeds germination was observed and amendments stimulated significantly the germination and coverage of materials (more than 80 % of coverage with amendments). One month after sowing, treatments with amendments showed higher plants development than in control, but the treatments with CerW promoted the highest plant height and leaves length (5.5-6 and 1.5-2 cm, respectively, after six months).
The application rate of amendments in pyrite wastes was not enough to increase fertility and pH at levels to support vegetation. For further characteristics improvement, other amendments combination and/or concentration increase should be applied. For gossan materials, the amendments applied were adequate for chemical characteristics of materials and leachates improvement and seems to be a suitable procedure to ensure phytostabilisation of these mine wastes.