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Pioneer plant species contributing to phytoestabilization of contaminated soils in mine areas

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Young and mature leaves from several plant species of the genus Cistus L. (C. crispus, C. ladanifer, C. monspeliensis, C. salviifolius), Erica australis L., and Lavandula sampaioana (Rozeira) Rivas Mart., T.E. Díaz& Fern. Gonz., as well as soils where plants grew, were sampled in various areas of São Domingos abandoned mine. The São Domingos mine, dating from pre–Roman times, is 60 km SE of Beja, Southeast Portugal. This mine belongs to the world class metallogenetic province of the Iberian Pyrite Belt. Sampling occurred throughout spring and winter to better understand plant behaviour and natural attenuation of contaminated soils. Multiple Correspondence Analysis (MCA) was used to synthesize the information and group characteristics that could justify different chemical concentrations. Soils are extremely acid (pH between 3.4 and 5.2) and present a wide range of Corganic concentrations (10.2–109 g/kg). Total nitrogen and extractable phosphorus concentrations are low to very low, but extractable potassium show medium to high concentrations. Chemical elements concentrations, analysed for total fraction, were great in soils, especially arsenic and lead that can attain 7.6 g/kg and 17.2 g/kg, respectively. However, only a small percentage (in general < 1%) of the total concentration of the chemical elements were water soluble (extracted by DIN 38414-S4 method) or extracted with the DTPA or ammonium acetate aqueous solutions. Cistus plants showed different behaviour on the trace-elements uptake and translocation. Winter and spring variations in most chemical elements concentrations in the plants leaves are not significantly different, except for arsenic, probably because plants were not exposed to important dry conditions during the sampling seasons. Nevertheless, MCA of the individuals makes a clear distinction between winter and spring leaves. Generally, mature leaves have higher concentrations of arsenic, copper, iron, lead, manganese and zinc than younger ones. However, in this study, sulfur concentrations show an opposite behaviour. Soil total and available fraction concentrations of the chemical elements have similar behaviour between sites. Chemical elements concentrations in plant leaves are independent of the same elements concentrations in soils where plants were developed. The obtained results showed the difficulty to understand the soil–plant system in heterogeneous materials such as mining sites. Other parameters such as plant physiology are responsible for the different uptake in the same species, contributing to the uncertainty of the remediation strategies. The studied native plants are well adapted to soils or spoils with different characteristics and high content of hazardous chemical elements. These species are adequate for stabilization strategies of a great variety of substrata. To improve and optimize remediation programs for mine areas in the Mediterranean region it is important to use several pioneer plants at the same time. This can contribute to reduce the costs of remediation with less environmental impact.