Accumulation and translocation of Al, Ag, Ba, Be, Bi, Cd and Sr in Cistus Salvifolius l. from Caveira, Chança and São Domingos mine areas

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Cistus salvifolius L. is a shrub well adapted to mediterranean conditions and multielementar contaminated mining soils. This species was identified in several mine areas from the Iberian Pyrite Belt (IPB). Soil colonization by tolerant vegetation is essential to minimize environmental impacts caused by mining activity and its abandonment. This study aimed to compare the accumulation and translocation of Al, Ag, Ba, Be, Bi, Cd and Sr (trace elements non-essential to plants) in *Cistus salvifolius* populations growing in Portuguese IPB mining areas (Caveira, Chança and São Domingos). Composite samples of soils (n=15) and C. salvifolius plants (roots and aerial parts) growing on these soils were collected. Soil characteristics (pH, NPK and $C_{Organic}$) and multielemental concentration of soils (total and available fraction) and plants were determinated. These mine soils were developed on different mining wastes which contribute to their heterogeneity. .pH values of soil varied between 4.3 and 6.9 and fertility range was high (0.01-3.4 g N_{total}/kg; 1.3-182.4 mg $P_{extractable}$/kg; 0.1-3.8 g $K_{extractable}$/kg; 12.0-201.4 g $C_{organic}$/kg. Soils from Caveira showed the highest concentrations of Ag (3.7-30.3 mg/kg) whereas Cd (0.6-2.1 mg/kg) was the highest t in São Domingos. Total soil concentrations of other trace elements were similar among mining areas. Considering Canadian soil quality guidelines, total concentrations of all studied trace elements were below residential/parkland, comercial and industrial land use values. The available soil fraction concentrations of trace elements were small (<5 % of total concentration for most of the elements and areas) and were not related to total soil concentrations, pH and Corganic. Caveira and São Domingos soils presented higher available concentrations of Cd, Ba, Be and Bi than Chança.

Significant inter-populational variability was observed in elements concentrations in roots (Ag, Al, Cd and Bi) and shoots (Ag, Al and Sr). In some cases, plant trace elements concentrations were related to the soil concentrations of the same elements in total and available fractions (r>0.9). In the aerial part, trace elements concentrations were lower than phytotoxic values for plants. Macro and micronutrients concentrations in aerial parts (B, Ca, Cu, K, Mg, Mn, Ni, Se and Zn) were considered normal and sufficient for plants development, except for Mo (deficiency) and Fe (above the range considered normal for plants). However, common visible symptoms of Mo deficiency or Fe toxicity were not observed. The non-essential elements studied in the aerial part did not influence the concentrations of Mo and Fe. The trace elements translocation from roots to aerial parts did not show a regular pattern for each trace element and mining area. São Domingos plants were Ag accumulators and in some plots Cd and Sr accumulators (soil-plant transfer coefficient >1). On the other hand, Caveira and Chança plants were Al accumulators.

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