



Behaviour of *Cistus populifolius*, *Cistus salviifolius* and their hybrid in polymetallic contaminated mine areas

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Plants belonging to the *Cistus* genus show a great plasticity and are able to grow both in contaminated and non-contaminated soils. *Cistus salviifolius* L. is well adapted to areas with several degrees of air and soil humidity, but *Cistus populifolius* L. is only found in regions or small areas with high humidity. *C. salviifolius* was identified in several mine areas of the Portuguese Iberian Pyrite Belt (PIPB) while *C. populifolius* was, for the first time, identified in 2009 in Chança and Caveira mines. In these mine areas was also identified a hybrid of both species *Cistus x hybridus* Pourr.

The aim of this study was to compare the biogeochemical behaviour of the three *Cistus* species growing in the polymetallic mine areas of Caveira, Chança and São Domingos (PIPB). Nineteen composite soil samples (homogenate of three trial points with 20 cm depth) were collected from rizosphere area of the studied plant species, in the three mine areas. In each sampling soil site were also collected composite plant samples (roots and aerial parts - leaves and twigs): seven *C. populifolius*; five *C. x hybridus*; fifteen *C. salviifolius*.

The mine soils were developed on waste materials of different characteristics: gossan materials, modern slags, and mixtures, in different proportions of pyrites ashes mixed with slags and host rocks. The soils are thin and presented small fertility with variable values of Pextractable < detection limit to 182.4 mg/kg; Kextractable from 0.035 to 3.5 g/kg; Ntotal from 0.76 to 3.4 g/kg. Soil pH and organic carbon ranged from 4.33 to 6.92, and 2.3 to 85 g/kg, respectively.

Soils from Caveira and São Domingos areas presented great concentrations of antimony (30-486 mg/kg), arsenic (0.13-3.03 g/kg), copper (0.16-1.75 g/kg), lead (1-9 g/kg) and zinc (0.04-1.0 g/kg), while soils from Chança mine present relatively small concentrations of these chemical elements (108-118 mg As/kg; 30-137 mg Cu/kg; 105-186 mg Pb/kg; 13-45 mg Sb/kg; 49-95 mg Zn/kg).

The three plant species showed tolerance for moderate acid soils, with low fertility and multielemental contamination. None species exceed, in shoots, the concentrations of As, Pb and Sb considered phytotoxic. Only in Caveira mine area, where the soils are richest in Zn (mean: 450 mg/kg), the three species showed concentrations, in this essential element, within the range considered toxic (180, 192 and 250 mg/kg in *C. x hybridus*, *C. salviifolius*, and *C. populifolius*, respectively). Compared with the normal range in plants, Sb concentrations were very small (<0.5 mg/kg) in all species, both in roots and shoots. *C. salviifolius* showed, in each mine area, different elemental concentrations: As (3.9 mg/kg) and Cu (11.8 mg/kg) are the largest in São Domingos, and Pb (23.5 mg/kg) and Zn (192 mg/kg) are the greatest in Caveira; populations from Chança mine presented the smallest values. The three species growing in the same mine area, presented the following behaviour in Caveira: *C. x hybridus* had the largest concentration in Cu, while As, Zn and Pb concentrations were similar to *C. salviifolius*; *C. populifolius* had the greatest concentrations in Zn (96-480 mg/kg), and the smallest in As and Pb (0.73 and 11.3 mg/kg, respectively). In Chança mine area the three species showed, in general, similar concentrations of the studied elements. Besides the different concentrations of the chemical elements in *Cistus* plants, the translocation capacity from roots to shoots for the same element is, in general, similar for all species: As, Pb and Sb were accumulated in roots (translocation coefficient (TC < 20-30%)) while Cu and Zn were translocated to shoots (TC > 60%), being Cu an exception for *C. salviifolius* in São Domingos where TC lies between 21 and 59%.