Geophysical Research Abstracts
Vol. 16, EGU2014-1376, 2014
EGU General Assembly 2014

Hyperaccumulator of Pb in native plants growing on Peruvian mine tailings

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Tailings usually provide an unfavourable substrate for plant growth because of their extreme pH, low organic matter and nutrients, high concentrations of trace elements and physical disturbance, such as bad soil structure, and low water availability. Heavy metal contamination has also been one serious problem in the vicinity of mine sites due to the discharge and dispersion of mine-waste materials into the ecosystem. Moreover, Pb is considered a target metal when undertaking soil remediation, because it is usually quite immobile and not readily accumulated in upper plant parts. The presence of vegetation reduces water and wind erosion, which may decrease the downward migration of contaminants into the groundwater and improve aesthetical aspects. Plants growing on naturally metal-enriched soils are of particular interest in this perspective, since they are genetically tolerant to high metal concentrations, have an excellent adaptation to this multi-stress environment. Efficient phytoextraction requires plant species combining both high metal tolerance and elevated capacity for metal uptake and metal translocation to easily harvestable plant organs (e.g. shoots). Soil and plant samples were taken in Peru, at a polymetallic mine (mainly Ag, Pb and Cu) in Cajamarca Province, Hualgayoc district. Top soils (0–20 cm) were analysed for physical and chemical properties by standard methods. Total Pb concentrations in top soils were determined by ICP-OES. Pb content in plants were analysed separately (aerial and root system) by ICP-MS. Ti content was used as an indicator for contamination of plant samples with soil particles. Translocation Factor (TF) and Shoot Accumulation Factor (SAF) were determined to assess the tolerance strategies developed by these species and to evaluate their potential for phytoremediation purposes. The non-polluted soils had near neutral pH (6.8$\pm$0.1), a great content of organic carbon (42 $\pm$ 4.0 g•kg^{-1}) and a silt loamy texture. Soil and plant samples were taken at four locations (CA1, CA2, CA3, CA4) with different levels of Pb. The Pb soil content (mean $\pm$ standard deviation) in mg•kg^{-1} is as follows: CA1 3992 $\pm$ 301; CA2 10128 $\pm$ 2247, CA3 14197 $\pm$ 895, CA4 16060 $\pm$ 810. The non-polluted value around the mine was Pb 124 mg•kg^{-1}. Unusual elevated concentrations of Pb (over 1000 mg kg^{-1}) and TF greater than one were detected in shoots of 6 different plants species (Ageratina sp., Achirodine alata, Cortaderia apalothica, Epilobium denticulatum, Taraxacum officinalis and Trifolium repens). The location CA4 has the maximum content of Pb in the shoots of Ageratina sp. (5045$\pm$77 mg•kg^{-1}), C. apalothica (3367$\pm$188 mg•kg^{-1}), E. denticulatum (13599$\pm$848 mg•kg^{-1}), T. officinalis (2533$\pm$47 mg•kg^{-1}) and T. repens (2839$\pm$231 mg•kg^{-1}). However, the BF (Bioaccumulation Factor) was smaller than one. Despite the low BF index, the great TFs for Pb indicate that these plant species effectively translocate this metal (i.e. 2.4 for Ageratina sp., 2.3 for C. apalothica, 1.6 for T. repens, 1.5 for A. alata, 1.3 for T. officinalis and 1.2 for E. denticulatum). It seems that the BF is not a reliable index when the metal soil concentration is extremely large. Controlled-environment studies must be performed to definitively confirm the Pb hyperaccumulation character of cited plant species.