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Relationship between wild trees and heavy metals on the Hop waste-rock dump (Rosia Montana mining area, Romania)

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Heavy metal pollution from mining activities is a significant environmental problem, as mine dumps are source of dispersion of toxic elements in the nearby ecosystems. Waste-rock dumps can be colonized by metallophyte plant species, able to grow and reproduce on substrates characterised by high metal contents. In this work, the relationship between soils or earth materials and trees growing on the Hop waste-rock dump, from the Roşia Montana gold mine (Romania), were investigated using bio-geochemical analyses.

The Roşia Montana hydrothermal ore deposit is hosted in andesites and dacites of Neogene age piercing the prevolcanic sedimentary basement as breccia pipes [1]. They host polymetallic sulphides and Au-Ag-Te mineralisations, present in epithermal veins, mineralized phreatomagmatic breccias and stockworks [2]. The ore deposit was mined both underground and in open pit for more than 2000 years. Intensive alteration due to AMD processes is testified by acid sulphate waters and by the precipitation of large amounts of secondary minerals.

On the Hop waste dump (2.5 ha area), a portion of Cetate open pit, where the waste has been piled up between 1998 and 2000, 10 plant samples, made by leaves, roots, branches and buds, belonging to Salix sp., Popolus tremula and Betula pendula species, were pulled together with the corresponding rizosphera. Earth material and soil samples were collected from 15 to 40 cm depth and the grain size fraction < 2 cm was separated for geochemical analyses (pH, EC, ABA test for AMD characterization [3]). Total Cu and Zn concentrations in both earth and plant samples were determined by ICP-AES. Bioaccumulation Factor (BF) and Traslocation Factor (TF) were also calculated for plant data set.

Results have shown that all plant species are able to grow on acid substrates, with pH values ranging from 3 to 5. Moreover, they can tolerate the presence of AMD processes, as they live on soils and earth materials characterised by positive NAPP values, which correspond to an acid production ranging from 10.8 to 79 kg H2SO4/t. Unlike a general low average content of metals in soils and earth materials, metal contents in plant tissue is always high: Cu and Zn average concentrations are 53 and 382 ppm respectively, reaching the greatest values in Betula pendula leaves (where Cu is 90 ppm and Zn 1,026 ppm). BF values are almost always >1: particularly for Cu they range from 0.8 to 4.5, while for Zn from 1.2 to 56. TF values show a preferential allocation of metals in leaves.

Plant data set has shown that the tree species growing on Hop waste-dump can tolerate acid substrates and AMD processes. The high Cu and Zn contents are the evidence for a metal-tolerance strategy based on accumulation, as confirmed by BAC and TF values. These results appear interesting for phytoremediation purpose, also for the surrounding areas not still vegetated; on the other hand, they highlight that eco-toxic elements are actually moving from substrates to living beings, with a potential geochemical hazard.

[1] Roşu, E. et al. (2004) Schweiz. Mineral. Petrogr. Mitt., 84/1-2, 153-172 [2] Wallier, S., et al. (2006). Econ. Geol., 101, 923–954. [3] Azzali, E. et al. (2010) Acta Min.-Petr. 6, IMA, 341