Chemical stabilization of heavily contaminated mine soils using Technosols made from non-hazardous industrial wastes

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INTRODUCTION

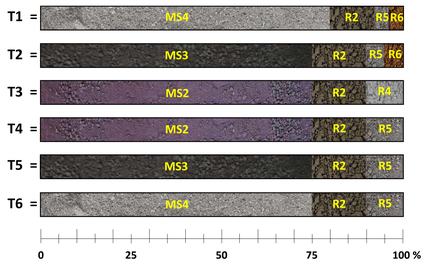
Mine soils often have lost their natural resilience and adaptive capacity to retain potentially toxic elements (PTE) and act as secondary source areas of acid and harmful pollutants into surface and pore waters. To address this issue, a batch leaching test was conducted to assess the effects of tailored combinations of non-hazardous industrial wastes on the chemical stabilization of heavily contaminated mine soils around the Rio Tinto mine (Spain).

MATERIALS AND METHODS

Three different mine soils were considered as case studies:

- Mine soil contaminated with roasted pyrite waste (**MS2**)
- Mine soil contaminated with copper slag waste (**MS3**)
- Mine soil contaminated with leached sulfide waste (**MS4**)

Technosols (T) were made by mixing, at a ratio of 60:40 (w/w), organic (R2) and inorganic (R4, R5 and R6) waste materials, as follows:



Organic amendment

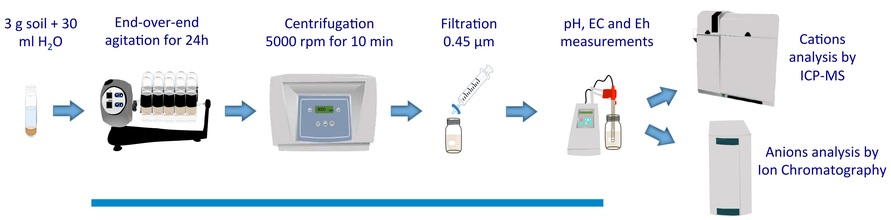
R2 = sludge from the clear treated water

Inorganic conditioners

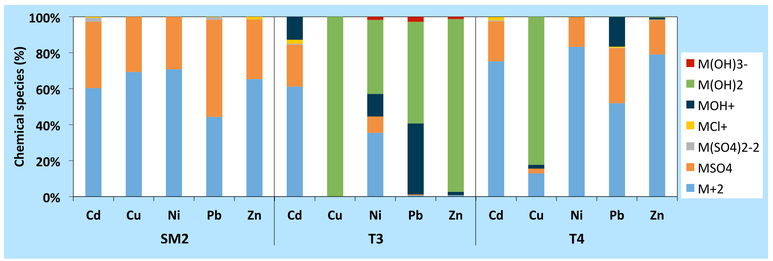
R4 and **R5 =** slags from the iron and steel making industry (acid-neutralizing capability)

R6 = red gypsum from the titanium dioxide industry (adsorbent properties)

The leaching test was performed according to the **standard EN-12457-4**, at a liquid-to-solid ratio of 10 L kg^{-1} with constant agitation for 24 h.



- Dominant **chemical species** of PTE in leachates.



KEY MESSAGES

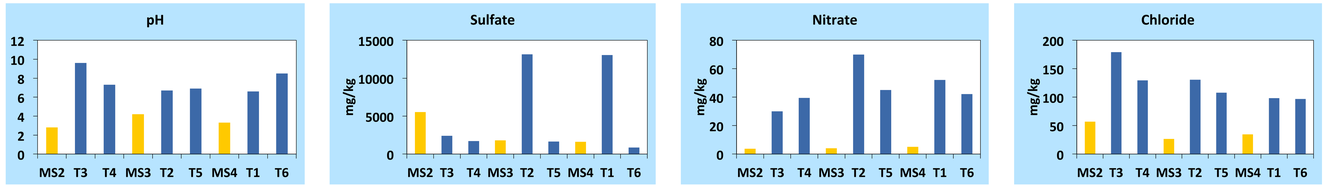
The application of artificial soils made from non-hazardous industrial wastes was effective in reducing the acid generation potential of the tested mine soils and for boosting the PTE stabilization processes.

The use of Technosols constructed with recycled wastes or by-products may be a sustainable choice for soil remediation at historically contaminated sites in view of the circular economy.

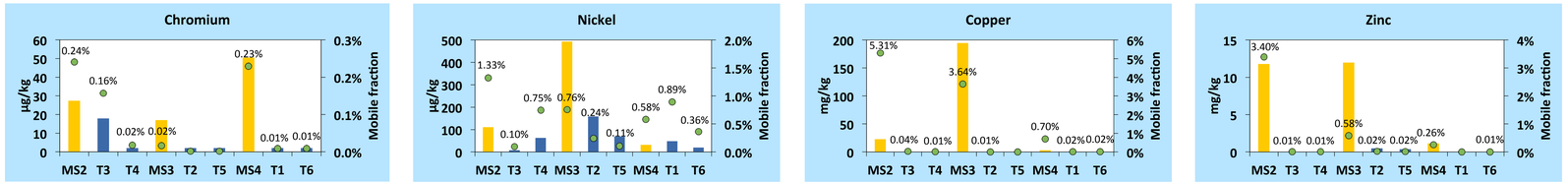
RESULTS

Technosol application was able to buffer the soil pH to average values of 7.6, thus enhancing the attenuation of PTE by chemical fixation.

- Mean **pH** values and **anion concentrations** (mg/kg) in the eluates.



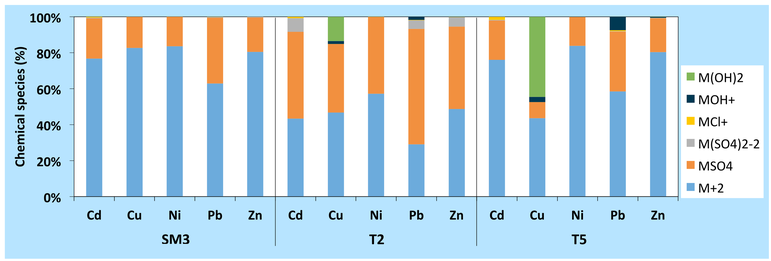
- **Concentration of PTE** in the eluates and **mobility** (%) with respect to the total concentration in soil.

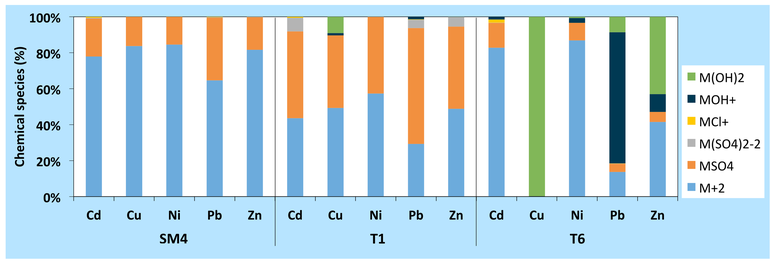


The mobile fraction of PTE was rendered virtually negligible (<0.10%). T3 was the most effective for reducing the mobility of Cd, while T4 and T5 showed promise for assisting in the attenuation of Cu

Chemical speciation calculations (PHREEQC) predict that most of the PTE leached from untreated MS are in the form of sulfate complexes, comprising 62-77% of the dissolved fraction, and to a lesser extent as free ion.

Upon treatment, the activity of such species decreased noticeably with increasing pH, while the contribution of hydroxyl complexes was shown to increase.





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