Ore processing and metallurgy technologies applied to soil washing: Feasibility studies in the Linares area (Andalucía, Spain)

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For centuries, an important mining industry was developed in the area of Linares (Andalucía, Spain). This activity produced a large quantity of waste materials, which were accumulated in the surrounding of the exploitation and ore processing sites, affecting the qulity of several Ha. of soil [1]. In this work, we have assessed the viability of physical separation of toxic elements, given that soil washing is a suitable remediation technique to reduce the volume of contaminated soil [2, 3]. On this purpose, we have conducted a feasibility study by means of chemical analyses, and a detailed edaphic and mineralogic characterization of the soils, followed by grain-size, gravimetric, and magnetic separation pilot-scale tests.

Chemical analyses revealed anomalous concentrations of Sb, Cu, Ag, Cd, Mn, Pb and Zn, exceeding both natural backgrounds and the maximum levels permitted by Spanish environmental laws. In this context, we propose an approach based on similar ore processing and metallurgy strategies to those used in the past to recover Pb and other metals in the study area [4]. Thus, wherever geochemical data indicated that the contaminants are predominantly present as free minerals (areas mainly related with mining waste), a treatment by means of grain-size classification methods is feasible. On the other hand, in soils with ancient metallurgy affection, the contaminants are more uniformly distributed in all size fractions; therefore the complexity is higher, and as a consequence, other treatments such as hydrodynamic separation (hydrocycloning), or magnetic separation (HGMS) are needed to complement grain-size classification.

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Thermal stability of soils and the detection of use-induced changes

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Several investigations on soils are currently focused on sustainable land use. However, there are still no common laboratory method to distinguish soils from carbon containing substrates (CCS). This makes the detection and evaluation of use-induced soil changes not easy.

We tried to fingerprint natural soils using thermogravimetry. The goal was to create a reference base for easier detection of use-induced soil changes with a simple detection method. For this purpose, over 150 samples under natural vegetation were collected and analysed from natural parks, biosphere reserves and other protected regions in US, Europe, South America and Russia.

Using different statistical approaches, it was not possible to directly derive common characteristics of natural soils from peaks or curves from thermogravimetric data.

But, the thermal mass loss allows a reliable detection of organic carbon, nitrogen, clay and carbonates in soils with high accuracy [1]. Further, typical relationships were found to exist between mass losses in distinct temperature areas in soils under natural vegetation.

For example, nearly all natural soils characterised by a correlations between mass losses around 125 °C and 525 °C with high coefficient of determination (0.7 – 0.9). This correlation can easily be explained by the long term influence of clay minerals on water sorption (mass losses around 125 °C) and on accumulated of humic substances [2] (mass losses around 525 °C). In contrast, CSS are ususally a result of shorter time periods or prevalence of non biotic processes. Additional water binding by plant residues can modify mass losses aroun 125 °C and disturb the correlation. At 525 °C the decay of black carbon has a similar effect.

Further investigations should clarify to what extend the correlations found in natural soils can be used to distinguish soils from carbon containing substrates and to detect influences of cultivation, fertilization and other land use technologies.

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