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A multi-approach, environmental study into the phytotoxicity of the soils at Rodalquilar, an abandoned metal-mining area in Almería, SE Spain.

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The epithermal Au-Cu-(Pb-Zn-Ag) deposit at Rodalquilar (Almeria, SE Spain) are hosted in calcoalkaline volcanic rocks [1], in which a wide variety of sulphides and sulphosalts can be found as primary minerals. Different sulphates, oxides and hydroxides have also been encountered as alteration minerals. Since the nineteenth century this area has been mined, mainly for gold and lead but also to a lesser extent for other metals such as copper, zinc and silver, thus producing great quantities of waste piles, tailings, etc.

The aim of this study has been to establish the levels of pollution and toxicity caused by this mining waste via a multi-disciplinary approach applied to water, soils and plants samples collected in the zone, including ICP-MS and P-XRF for quantification purposes, bioassays of the germination percentage (SG) and root elongation (RE) of Lactuca Sativa L. (LS) to assess the potential acute phytotoxicity of soils, and pattern-recognition techniques to establish a model to reduce costs and redundant analyses in environmental studies. The phytoextraction capacity of representative autochthonous floral species has also been evaluated.

Analyses of water samples revealed high values for Zn, Cu, Co and Mn (up to 50, 10, 5 and 5 ppm respectively) in samples taken from sites close to sulphide-rich waste piles, which provides evidence for the gradual seepage of acid mine drainage (AMD).

The high total concentrations of As, Cu, Mn, Pb y Zn found in the soils studied (up to 2700 and 600 for Pb and As respectively) do not imply high toxicity of the samples because most of the RE and SG values calculated using LS bioassays do not exceed the -0.5 established as the criterion for phytotoxicity, as this depends on other factors such as solubility, bioavailability and the persistence of the pollutants.

The mobility of the elements in the soils (expressed as a percentage of the solubilized fraction) is lower than 1% for Cu and Zn in 95% of the samples analyzed and for Pb, Mn and As in all of them. On the basis of the percentages found, the tendency of element mobility in the studied area is Pb < Mn < As < Zn < Cu. A high mobility of the elements as a whole was also detected in samples of anthropic soils deriving from mining activity in the area, which once again bear witness to the slow seepage of AMD, allowing for features such as the semi-arid climate with short periods of very intense rain and flash-flooding of dry watercourses.

The metal(loid) contents of autochthonous plants revealed that they have developed a high capacity to extract and retain metal(loid)s, especially in the case of lavender and broom, which might be used in any future remediation schemes.

It can be concluded that although the soils/sediments in the Rodalquilar mining area can be regarded as potentially contaminated, phytotoxicity and mobility studies lead us to the belief that the area does not present a special toxic risk for the environment.

[1] Arribas et al. (1995) Econ. Geol. 90: 795-822.