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Use of Bioassay test for the environmental evaluation of mining residues and their leachates: the singular case of the Portman Bay (SE, Spain)

Maria Jose Martínez-Sánchez (1), Maria Luz García-Lorenzo (1), Carmen Pérez-Sirvent (1), Jose Molina (2), Maria Luz Tudela (2), and Manuel Hernández-Córdoba (3)

(1) Faculty of Chemistry, Agricultural Chemistry, Geology and Pedology, Murcia, Spain (melita@um.es, 34 968 364148), (2) Departament of Geography, Faculty of Letters. , (3) Department of Analytical Chemistry

The aim of the present study was to evaluate the toxicity of sediments and their pore-water extracts from sites contaminated by mining activities using two assays: bacteria and plants. The acute toxicity in pore-waters was determined using the Microtox® bioassay, which uses the naturally luminescent marine bacterium Vibrio fischeri. Phytotoxicity in soil samples was tested by way of the seed germination and root elongation technique in three plant species, Sorghum saccharatum, Sinapis alba and Lepidium sativum. The aim of applying these assays is to establish a method for evaluating the real risks within a risk analysis process, considering both present and future risks, bearing in mind that the uses to which soil is put (urban, recreational or industrial) may change. In the zone studied, mining activities have led to heavy metal contamination with the risk of runoff and wind dispersion of the contaminated material. For this study, 6 sediment samples were collected from Portman Bay (Murcia, SE Spain). The soil extract was prepared by saturation with distilled water and allowing it to stand for four hours. Then, the soil was subjected to a vacuum pressure to extract the soil solution through filter paper.
The Zn and Fe content was determined by flame atomic absorption spectrometry (FAAS). The Pb, Cd and Cu content was determined by electrothermal atomization atomic absorption spectrometry (ETAAS). The As content was analysed by atomic fluorescence spectrometry using an automated continuous flow hydride generation (As-AFS) spectrometer.
Total Pb concentration varied from 600 to 2500 ppm, with a mean value of 1200 ppm. The average content of Zn was 5300 ppm. The mean concentration of Cd and Cu was 23 and 59 ppm, respectively. Total As concentrations varied from 180 to 470 ppm, with an average value 280 ppm. Finally, the total Fe content ranged from 37% to 47%, with an average value of 40%. Pore-water samples showed neutral pH values and average electrical conductivity was 8.4 ds m-1. Mean heavy metal content in leachates from Portman Bay was 6.8 ppm for Pb, 0.1 ppm for Zn, 17 ppb for Cd, 5.6 ppb for Cu, 3.7 ppb for As and 0.6 ppm for Fe.
The bioassays showed different sensitivities to the target metals. The Vibrio fischeri luminescence inhibition assay showed less sensitivity to the toxicants in the sediments than phytotoxicity assay. According to our results it is highly advisable to complement chemical analyses with environmental toxicity testing to characterise the risks presented by contaminated soils. Finally, these methods satisfy the requirements of environmental toxicology in their reliability, sensitivity, reproducibility, rapidity and low cost.