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Monitorization of technosols in old mining sites treated with calcareous fillers

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A large number of soils around the world are contaminated by heavy metals due to mining activities, generating adverse effects on human health and the environment. In response to these negative effects, a variety of technologies to remediate soils affected by heavy metals have been developed. Among them, in situ immobilization by means of soil amendment is a non-intrusive and cost effective alternative, that transforms the highly mobile toxic heavy metals to physico-chemically stable forms, reducing their mobility and environmental risks. Limestone filler is a good selection for such a purpose, because of its low permeability and low solubility, due to its high degree of physical-chemical stability and because is a non-toxic material with a high finely divided calcium carbonate content. In addition, the use of this amendment could revalorize the residues, reducing the costs of the process.
The objective of this work was to evaluate the effectiveness of a immobilization technique in sediments contaminated by heavy metals as a results of mining activities.
The study area was Portman bay, located close to the mining region of La Unión and subjected to mining from the time of the Roman Empire to 1991. Wastes from mining activities mainly consisted in ore materials (galena, pyrite and sphalerite), phyllosilicates, in addition to siderite, iron oxides and sometimes alteration products such as jarosite, alunite, kaolinite and greenalite. These materials have suffered a concentration process by floatation with sea water and, as a result of the discharge, the whole of the bay has filled up with wastes which also extend into the Mediterranean Sea. Two experimental areas, approximately 1 Ha each one, were selected and technosols were developed as follows: original sediments from the bay, sediments mixed with limestone filler in a 1:1 proportion, gravel to avoid capillary and natural soil to allow plant growth. After the remediation technique was applied, monitorization of experimental areas was done in 18 sampling points in which sediment and water samples were collected and analyzed. Monitorization was carried out during a 4 years period, samples being obtained at two month intervals.
The pH and the electrical conductivity were determined, in naddition to the heavy metal concentration. The Zn content was determined by flame atomic absorption spectrometry. The Pb, Cd and Cu content was determined by electrothermal atomization atomic absorption spectrometry. The As content was measured by atomic fluorescence spectrometry using an automated continuous flow hydride generation spectrometer. In addition, Microtox bioassay was applied in order to study ecotoxicity of collected water samples.
Sediments before the remediation technique showed acidic pH, high EC values and high trace elements content. The results obtained after the immobilization showed that sediment samples had neutral pH (average value of 8.3) low electrical conductivity (1.32 dS m-1) and low trace elements concentration, in some cases below the detection limit.
When water samples obtained in the piezometers were evaluated, the results indicated that these samples correspond to rainfall waters and were characterized by neutral pH and trace elements concentration below the detection limit. In addition, none of them showed toxicity when submitted to the selected bioassay
Then, we can conclude that the use of limestone filler constitutes an excellent option in sediments polluted by trace elements, because of risk for human health or ecosystem does not exist or is decreased in a large extent after the intervention. In addition, the designed experience allows stabilizer proportion to be optimized and may suppose a big cost-saving in the project in areas affected by mining activities.