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Using bioavailable soil fraction to assess the bioconcentration factor of plants in phytoremediation of mine soils

Núria Roca (1), Javier Rodríguez-Bocanegra (1,2), and Jaume Bech (1)

(1) Laboratory of Soil Science, Faculty of Biology, University of Barcelona, Avd. Diagonal 643, 08028 Barcelona, Spain, (2) Departament de Mineralogia, Petrologia i Geologia Aplicada, Facultat de Ciències de la Terra, Universitat de Barcelona, Martí i Franquès s/n, 08028 Barcelona, Spain.

Polluted soils by heavy metals are characterized to present great concentrations of these pollutants. Ure wrote the following in 1996: "For understanding the chemistry of the heavy metals in their interaction with other soil components such as the clay minerals, organic matter and the soil solution, or to assess their mobility and retention as well as their availability to plants, the usual approach is to use selective chemical extraction". However, nowadays to assess the bioconcentration factor of plants in phytoremediation, the pseudototal or total concentration has been used. Strong mineral acids attack part of the silicate soil matrix and as consequence part of the heavy metals obtained are included in the structures of the mineral fraction. A different approach may, therefore, be more productive in the study of phytoremediation and the use of extractants, as EDTA or DTPA, can perhaps best be exploited by considering them in their role of bioconcentration factor. Moreover, EDTA and DTPA, which form strong complexes with many metals, can extract also organically complex metals.
Properties of the soils collected in mining areas presented great variability, as they depend on materials where soils were developed, the complex mixture of heterogeneous wastes and the mining age. In the case of Caroline Mine in Hualgayoc (Perú), the mining is relatively modern and the available fraction of heavy metals of mine soils is low. The small available fraction concentration is due partly to both a few developed soil structure and low organic matter content. The only exception was the copper, with ranging from 1.2 to 36.2 % of total soil fraction. All plant species that were investigated in previous studies have a good ability to transport potential hazardous elements from the roots to the shoots and they have the ability to accumulate more than 1000 mg•kg-1 of heavy metals in the shoots. However, the bioconcentration factor was smaller than one for all the studied plants in every polluted site. The small bioconcentration values are due partly to both the large metal burdens of the mine soils and the fact that here the total concentration and not the extractable soil fraction concentration of the elements was used. When available fraction was used, the bioconcentration factor with DTPA was greater than one in all cases. The elevated Pb and Zn bioconcentration factor (>100) could be a good measure of the high capacity of these native plants to accumulate metals.
The soils of the ancient Espinosa mine in Catalonia (Spain) presented great available concentrations of Cu, Pb and Zn and represent more than 50% of the total fraction in almost every polluted studied site. Therefore, the use of the bioconcentration factor doesn't show a relevant difference between total or extractable fraction because of the elevated extractable fraction of the total content. Therefore, the bioconcentration factor calculated with extractable fraction could be a good measure of plant capacity to accumulate metals.