EXTRACTION OF SOIL METALS BY DILUTE HYDROCHLORIC ACID: AN ALTERNATIVE TO SEQUENTIAL EXTRACTION FOR ESTIMATION OF AVAILABLE METAL CONTENTS IN URBAN SOILS?

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Although the total contents of toxic metals in soils are generally used for estimation of the degree of pollution of a given site, only a fraction of the metal content is likely to have a significant role in environmental processes. Also, in many cases of moderate pollution a decrease in metal availability in soil may be feasible using relatively cheap techniques, while a decrease in the total contents requires much more difficult treatments and their application is often questionable. Therefore, obtaining a good estimate of metal availability is of the utmost importance in soils with relatively high total contents. Extraction with EDTA is usually considered an estimate of metal availability in soils (Quevauviller et al., 1997). The technique proposed by the European IRMM for sequential extraction of metals in soils distinguishes 3 fractions (Rauret et al., 1999), while those metal forms not included in them are considered of no environmental significance. Sutherland (2002) proposed a simpler extraction with 0.05 M HCl as a good analytical assessment of metal pollution.

Several samples of surface soils taken in public green areas of Sevilla, with moderately high contents in some metals, were chosen for the present study. A general description of heavy metal distribution in urban soils of Sevilla has been published elsewhere (Madrid et al., 2002). Metals were extracted using 0.5 M EDTA, 0.05 M HCl, and the 3-step sequential extraction technique proposed by the IRMM. For comparison purposes, an agricultural soil from a field experiment, which had received different treatments and did not show particularly high metal contents was also included.

No chemical nature was attributed to each fraction obtained in the sequential extraction procedure. However, it can be considered that fraction 1 mainly includes adsorbed metal forms and those bound to calcium carbonate, fraction 2 is constituted by metals related with reducible soil components, especially Fe and Mn oxides, and fraction 3 includes metals bound to oxidisable matter, particularly organic matter. In the case of Cu, Pb and Zn, fraction 1 is significantly smaller than 2 and 3, and fraction 3 is often greater than 2. This result suggests the relationship of these metals with organic matter. In other metals, as in the case of Mn or Cd, the distribution is more uniform, but with a slightly greater fraction 2 for Mn and smaller values of fraction 3 for both.
Madrid et al. (2002) observed that different behaviours were found between metals of anthropogenic (termed “urban” by some authors) origin and those that can be considered of natural origin. The former group usually includes, among several others, Cu, Pb and Zn. Cadmium has also been considered as of “urban” nature, but in the case of urban soils in Sevilla relatively low contents (comparable to the background contents, see Madrid et al., 2002) were found for this metal. Therefore, in our case, Cd can be excluded from the group of urban metals. In the case of Cu, Pb and Zn, a strong relation is found between the sum of the 3 sequential fractions and the amount extracted by dilute HCl, with correlation coefficients $r \geq 0.9$ and reduced major axes with slopes close to 1, while in the case of many other metals, e.g. Mn or Cd, no relation was found at all (see figure). Therefore, HCl extraction can be used as estimate of available metals in those cases where pollution of some metals is likely, but its use for that purpose cannot be considered as of general applicability. Metals extracted by EDTA can be only partially related with the amounts solubilized by dilute HCl.

REFERENCES