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Is magnetic susceptibility a good proxy for geochemically reactive potentially toxic elements in soils?

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Magnetic susceptibility (χ) has been long considered as a simple and cost-effective proxy to monitor contamination by potentially toxic elements (PTEs) in various environmental media. At the same time, partial extractions are much more meanigful for assessing the mobility and potential toxicity of PTEs compared to total [1]. Aiming at exploring if χ could be used as a proxy for the geochemically reactive fraction of PTEs, we investigated its relationships with total, reactive (0.43M HNO_3 extractable), and residual contents of well-known anthropogenic PTEs (Cu, Pb, and Zn) in soil from areas of various land uses in Greece, including urban (n=59), rural (n=20), agricultural (n=45), and mining (n=60). The reactive concentration [2] is considered potentially available for uptake by biota and as such environmentally relevant. The residual fraction was defined here as the difference of reactive from total contents. Magnetic susceptibility exhibited the lowest values (Kruskal-Wallis test; $p<0.05$) in agricultural soils (0.185–2.122 $m^3\ kg^{-1}$), whereas no significant differences were found among soils of other land-uses (0.170–12.492 $m^3\ kg^{-1}$). The highest contents of all PTEs were found in mining soil, whereas urban and rural soils had the lowest Cu contents and agricultural soils the lowest Pb and Zn contents. Statistically significant correlations between χ and PTEs were systematic (urban, agricultural, and mining soils and all methods) for Pb and occassional for Cu and Zn. In all cases, the residual fraction explained to some extent the relationships with magnetic phases. However, in urban soils, correlation coefficients of χ and PTEs were higher for the residual, rather than the reactive fraction, probably because both magnetic phases and PTEs derive, at least partly, from industrial and traffic- related combustion processes. Because exposure to magnetite particles pose a possible hazard to human health [3], we conclude that the non-residual fractions of PTEs can not be disregarded in risk assessment studies of urban settings.

References

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