

Study of trace elements reactivity in polluted soils: Measure of Cd, Zn, Cu and Pb lability by using DGT and isotopic dilution methods

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Industrial production and more precisely the metallurgy led to the dissemination of chemical contaminants in the environment. According to the metallurgical processes, this contamination can be more or less strong and induce, locally, grounds, water and plants pollutions.

In this study we try to quantify the labile pool of various trace elements in cultivated gardens, located around an industrial area.

The concentrations of heavy metals (As, Cu, Zn, Cd and Pb) measured in various cultivated vegetables are significantly higher than the european reference values (EC466/2001). The accumulation in plants differs in leaf, roots and fruits vegetables and is clearly correlated with the pH of the soils. In order to describe the heavy metal soil/plant exchanges, we tried to determine the concentrations of metals in the labile pool of the soils and to relate it to phytoavailability.

An isotopic dilution method (ID) using spiking with stable isotopes [1] and [2] has been performed in these polluted soils to determine the labile pool whereas a Diffusive Gradient in Thin film (DGT) method realised in the same soils permitted to mimic the heavy metal uptake by the roots of the plants [3]. The comparison between these two complementary methods allowed to describe the soil-solution transfer and demonstrated the different behaviours of the measured metals: relationships between labile pool measured by DGT and phytoaccumulation are observed for some of them, such as cadmium or zinc, but not for lead.

The kinetic aspects of the soil/solution exchanges were also described by performing ID and DGT, from 1h to 2 weeks. Modelization of these kinetics gave us the parameters describing the exchange properties and the desorption of the metal from soil to solution. These parameters varied with metal concentration, pH or organic carbon content in the soils.

References

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Organic microanalysis by time-of-flight secondary ion mass spectrometry

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Time-of-flight secondary ion mass spectrometry (TOF-SIMS) is based on the analysis of positive or negative secondary ions emitted from a solid surface during bombardment by energetic ions. The technique has during the past decades become a well established surface analysis technique in materials science, in particular in the field of semiconductors and polymeric materials [1]. This is due to the attractive combination of high analytical sensitivity (in terms of absolute detection limits) and excellent imaging capability, with lateral resolution in the ~100 nm range. The application of the technique to more complex materials and molecular analysis was, however, for a long time hampered by the fact that the ionization process on which the technique is based lead to extensive fragmentation of and low yields (sensitivities) for organic analyte molecules of masses higher than a few 100 u. This was in turn due to the properties of the primary ions used for accomplishing the sputtering and ionization of the sample under study.

During the last few years, there has been a strong development around TOF-SIMS for the analysis of organic materials and molecules. In particular, the development of new cluster primary ion sources (e.g., Au₃⁺, Bi₃₋₇⁺, C₆₀⁺) have lead to dramatic improvements (typically by a factor 100-1000) in the detection sensitivity for organic molecules in the range from a few 100 u to 2000 u [2]. Due to the developments in instrumentation, in combination with a rapidly growing data base of reference spectra and the use of multivariate statistical tools for spectrum interpretation, TOF-SIMS is now emerging as a highly useful analytical tool for organic microanalysis, for example, in the field of biomedicine.

The presentation will give an introduction to TOF-SIMS, and illustrate the capabilities of the technique for analysis of organic materials. Opportunities for applications in the field of organic geochemistry will also be discussed.

References

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