The role of biotic cycling in determining the soil residence time of industrial pollutants

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Humans continue to alter global biogeochemical cycles as metals are extracted from rock and dispersed to the land surface as industrial byproducts. Although atmospheric transport of metals potentially impacts broad regions, we do not currently know the extent of dispersal or what effect these deposited metals have on Critical Zone processes. We demonstrate that atmospheric deposition from industrial sources has enriched soils with Mn at the Susquehanna Shale Hills Observatory (SSHO), a small watershed in central Pennsylvania, U.S.A.. Furthermore, we use soils datasets to show that Mn addition to soils may be common in industrialized regions and investigate how biota contribute to Mn retention in soils.

SSHO is a forested first-order watershed developed on grey shale. As part of the Critical Zone Exploration Network, SSHO is undergoing detailed biogeochemical, hydrological, and geomorphological characterization. In addition to understanding the natural development of the watershed, we can use these studies to understand how human perturbation has influenced the chemical evolution of the system over industrial time-scales. Here, we integrate measurements of soil geochemistry with foliar nutrition to show that vegetation stores large quantities of Mn and may act as a 'capacitor' that sequesters Mn and releases it to pore waters slowly as organic matter is decomposed. Mechanisms of biogeochemical Mn cycling are investigated using x-ray absorption spectroscopy to characterize redox reactions. Mn-compounds are highly reactive in soil systems and can affect the geochemical behavior of other heavy metals and P, a limiting nutrient in many ecosystems. Furthermore, Mn toxicity can affect both humans and vegetation, necessitating a better understanding of how industrial Mn inputs move through the Critical Zone.

Development of a fast method of mineralization for routine analysis of matrix of the agricultural production

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The determination of trace metal concentrations in solid samples needs a preparation step which generally consists in an acid digestion assisted by microwave. However a rigorous step of washing must be carried out before each run mineralization to avoid contaminations. The analytical challenge was therefore to develop a new method of mineralization for trace metal analysis of different kind of solid samples from the agricultural production by using a simple device that reduces risk of contamination and increases productivity.

A mineralization procedure using the Digiprep® system was developed and compared to a conventional microwave assisted mineralisation. Different matrix were tested: soil, maize, sunflower, manure, sewage sludge and peach leaves. After an optimisation step, trueness, repeatability, reproducibility and robustness were evaluated. For each matrix, three replicates were carried out by three different manipulators. Then Zn, Cd, Pb, As, Cu, Fe and Mn were analysed by inductive coupled plasma mass spectrometry (ICP-MS) in the obtained extracts and results were compared.

Reference material study of a plant of maize showed that digiprep® allowed to obtain fast results in agreement with certified values (Figure 1).
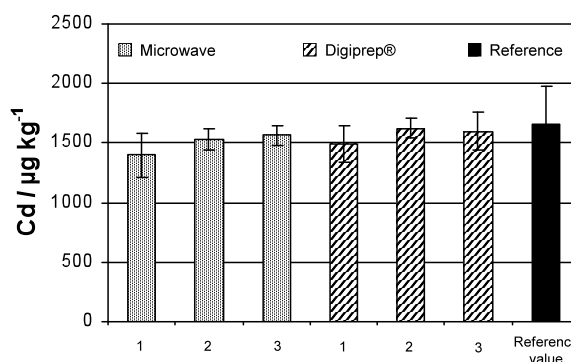

Figure 1: Comparison of total Cd determination according the mineralization method with the reference value in maize plant.