Determining detection limits for uptake of metals in mixtures from soils using PRSTM and DGT probes

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Metal contamination in soils often occurs as mixtures of more than one metal. Although there have been numerous studies on how single metals are taken up by plants from soil, the accumulation and toxicity of metal mixtures remains largely unstudied. Furthermore, tools for risk assessment of mixtures of metals in soils are lacking. One possible addition to the toolkit is the use of ion exchange resins as proxies for plant root accumulation of metals from soil. Plant root simulator (PRSTM) probes have their origins in testing for soil nutrient bioavailability, but have been applied to use in metal bioavailability. Diffusive gradients in thin film (DGT) were originally created for measuring bioavailability of metals in water, but were also adapted for use in soil. The application of these methods to metals in soil is not yet universal, and the implications of the multiple metals for these tools remain unknown. These tools show promise for applications in risk assessment in situations with metals in mixtures. In order to evaluate the usefulness of these tools for risk assessment of metals in mixtures, we must first determine if the probes are as sensitive as plants are in detecting the presence of metals at elevated concentrations, especially when there is more than one metal of concern. To this end, the detection limits of PRSTM and DGT probes are being determined. The probes are deployed into soils with a known range of metals in combination (Ni, Cu and Co), including field soils collected from around Ni mining and smelting activities. The uptake of these metals by the resin devices will be compared to the total and bioaccessible metal concentrations in the soil. From this study, we will determine detection limits for PRSTM and DGT relative to total and bioaccessible soil metals.

Arsenic dynamics in paddy rice fields in temperate climate

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The reason why rice can become a source of arsenic (As) in human diet lies with the enhanced As phytoavailability during the prolonged soil submersion, and the microbially mediated changes in the redox equilibria involving Fe and/or As species. The microbial activity, in turn, depends on, and contributes to determining the quality and quantity of available organic matter and hence, drives the organo-mineral interactions occurring under alternating redox conditions. Water management practices that involve different durations and intensities of field flooding may strongly influence As dynamics in paddies and consequently As content in rice as well as the composition and activity of the microbial communities.
Under continuous flooding, As concentration in solution increased drastically after the first three-four weeks and then tended to stabilize or even decrease in the second part of the cropping season, similarly to other redox-sensitive analytes, such as Fe and Mn. Flooding also resulted in an increase in the concentrations of dissolved organic carbon coupled with a gradual increase in the aromatic character during the cropping season. During soil flooding, rhizospheric microbial populations involved in As cycling are markedly selected with a concomitant increase in Fe-reducing bacteria.
Conversely, in soils under aerobic conditions soil solution As concentrations were negligible and those of Fe, Mn and organic carbon remained much lower. Although aerobically cultivated rice showed a much lower As content in grain, the yields decreased markedly.
In the flooded systems, the introduction of a relatively short drying period before rice flowering was effective in keeping As concentrations in soil solution low, limiting contents in the rice grain without compromising the yield. The effect of this strategy on As biogeochemical cycling is still under evaluation.