Iron-specificity of plant and microbial siderophores in soils

STEPHAN M. KRAEMER[1], CORNELIUS ZELLER[1], WALTER D.C. SCHENKEVELD[1],

[1]University of Vienna, Dept. of Environmental Geosciences and Environmental Sciences Research Network, Althanstrasse 14 (UZA II) 1090 Vienna, Austria,

Metallophores are biogenic ligands that are exuded by plants and microorganisms requiring the uptake of metal ions as nutrients from the extracellular space. The specificity of the ligand for the targeted metal nutrient is considered to be a an important property of a metallophore. However, previous work in controlled model systems has demonstrated that microbial siderophores such as desferrioxamine-B (DFOB), where the target metal is iron, form strong complexes with a range of competing metal ions.

In the work presented here, we aim to investigate if and how limitations to iron specificity of DFOB and the plant siderophore deoxy-mugienic acid (DMA) influence or impair iron mobilization in complex natural systems. To this end, we study iron mobilization in oxic calcareous agricultural soils, where plant or microbial iron limitation is most likely to occur. We contrast experiments on the kinetics of mobilization of iron and competing metal ions from the soils in the presence of the siderophores with multi-surface thermodynamic modelling. From the observations we conclude that a view of metallophore specificity based only on the stability of the iron complex relative to complexes with competing metal ions (‘thermodynamic specificity’) is not the only strategy of target metal mobilization in natural systems. We suggest that sufficient specificity can in some cases be attained by a higher rate of mobilization of the target metal relative to competing metals (‘kinetic specificity’). This strategy is successful even if a non-target metal outcompetes the target metal for complexation by the siderophore on longer time scales.