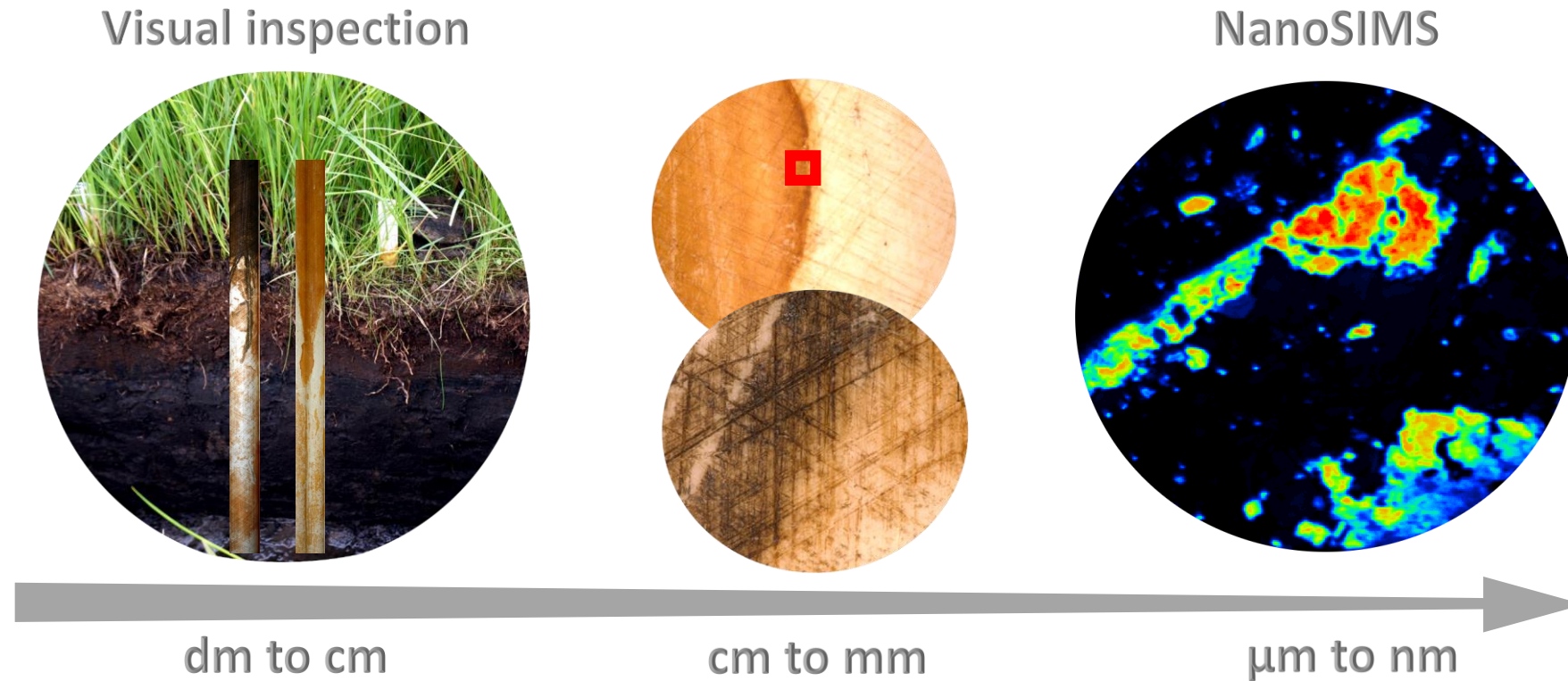


Soil organic matter and phosphate sorption on natural and synthetic Fe oxides under in situ conditions

Lydia Pohl^{a,b}, Kristof Dorau^c, Christopher Just^a, Carmen Höschen^a, Kristian Ufer^d, Tim Mansfeldt^c, Carsten W. Mueller^{a,e}



a
b
c
d
e

Chair of Soil Science, Technical University of Munich, Germany

Chair of Soil Protection and Recultivation, BTU Cottbus-Senftenberg, Germany

Institute of Geography, University of Cologne, Germany

Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany

Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark



Introduction

In redoximorphic soils, Fe and Mn-oxides undergo reduction with subsequent oxidation of their reduced counterparts (Fe^{2+} and Mn^{2+}) impacting nutrient sorption and the stability of soil organic matter (SOM).

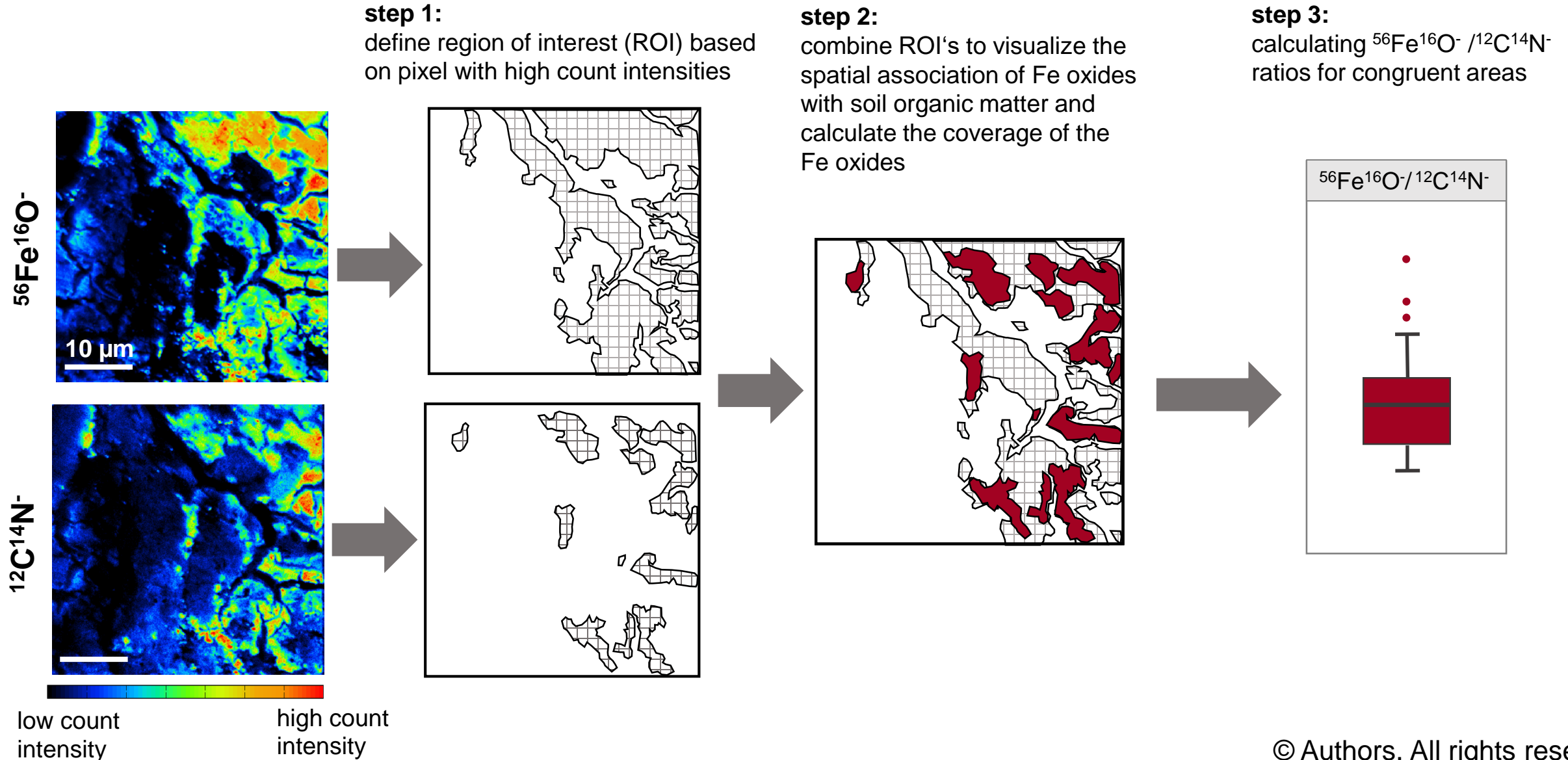
investigation tool: PVC bars coated with synthetic Fe and Mn oxides (installation for 30 days in a Mollic Gleysol)

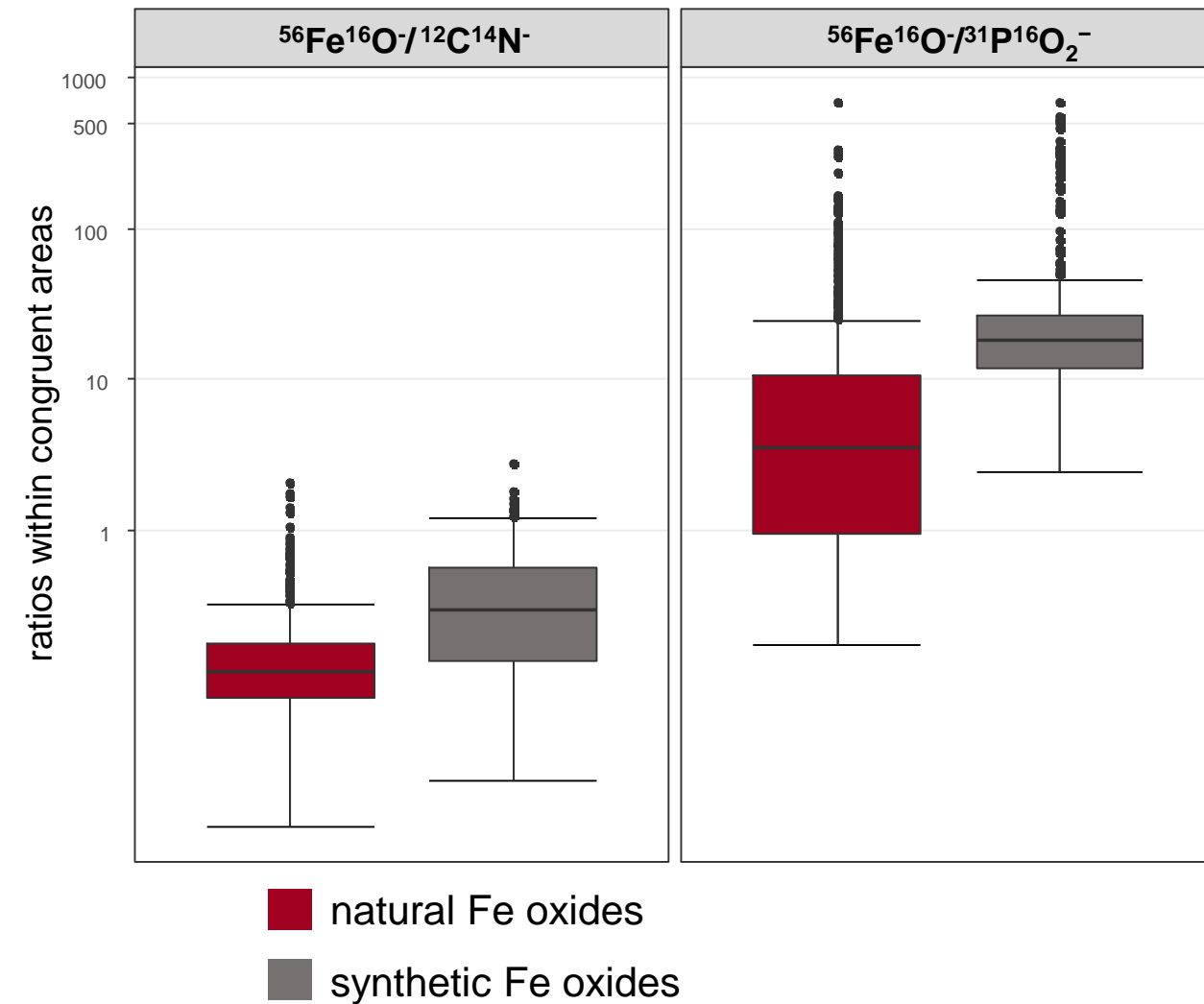
Mn oxide coating facilitated a non-enzymatic redox reaction under anoxic conditions, while Fe^{2+} from the soil solution is oxidized to Fe^{3+} along the Mn oxide coating and Mn^{2+} is removed from the PVC surface. In consequence, in situ ('natural') Fe oxides formed along the Mn oxide coatings.

This enables us to differentiate between sorption occurring onto the surfaces of '**synthetic**' Fe oxides from the Fe bar versus '**natural**' formed Fe oxides along the Mn bar. They were analysed by nanoscale secondary ion mass spectrometry (NanoSIMS) to study the distribution of Fe ($^{56}\text{Fe}^{16}\text{O}^-$), SOM ($^{12}\text{C}^{14}\text{N}^-$), and phosphorus ($^{31}\text{P}^{16}\text{O}_2^-$).

Methods

NanoSIMS is a spectromicroscopic imaging technique with high lateral resolution (about 100 nm) and enables us to examine the spatial distribution of SOM and phosphorous at the microscale within the intact organo-mineral matrix by using image analysis.





Results and Conclusion

Image analysis of individual Fe oxide particles revealed a close association of Fe, SOM, and P resulting in coverage values up to 71% for synthetic and natural iron oxides.

Furthermore, ion ratios between sorbent ($^{56}\text{Fe}^{16}\text{O}^-$) and sorbate ($^{12}\text{C}^{14}\text{N}^-$; $^{31}\text{P}^{16}\text{O}_2^-$) were smaller along the natural oxides when compared with those for synthetic Fe oxides.

Both natural and synthetic Fe oxides rapidly sequestered SOM and P (i.e., within 30 days) but that newly, natural formed Fe oxides sorbed more SOM and P than synthetic Fe oxides.

For more
details please
check:

Soil Organic Matter and Phosphate Sorption on Natural and Synthetic Fe Oxides under in Situ Conditions

Kristof Dorau,^{*,†,‡,§} Lydia Pohl,^{‡,‡} Christopher Just,[‡] Carmen Höschen,[‡] Kristian Ufer,[§] Tim Mansfeldt,[†] and Carsten W. Mueller[‡]

[†]University of Cologne, Faculty of Mathematics and Natural Sciences, Department of Geosciences, Institute of Geography, Albertus-Magnus-Platz, D-50923 Köln, Germany

[‡]Research Department Ecology and Ecosystem Management, Lehrstuhl für Bodenkunde, Technische Universität München, Emil-Ramann-Straße 2, D-85354 Freising, Germany

[§]Federal Institute for Geosciences and Natural Resources (BGR), Stilleweg 2, D-30655 Hannover, Germany

Supporting Information

ABSTRACT: Iron (Fe) oxides in soils are strong sorbents for environmentally important compounds like soil organic matter (SOM) or phosphate, while sorption under field conditions is still poorly understood. We installed polyvinyl chloride plastic bars which have been coated either with synthetic Fe or manganese (Mn) oxides for 30 days in a redoximorphic soil. A previous study revealed the formation of newly formed (“natural”) Fe oxides along the Mn oxide coatings. This enables us to differentiate between sorption occurring onto the surfaces of synthetic versus natural Fe oxides. After removal of the bars, they were analyzed by nanoscale secondary ion mass spectrometry (NanoSIMS) to study the distribution of Fe ($^{56}\text{Fe}^{16}\text{O}^-$), SOM ($^{12}\text{C}^{14}\text{N}^-$), and phosphorus ($^{31}\text{P}^{16}\text{O}_2^-$) at the microscale. Image analysis of individual Fe oxide particles revealed a close association of Fe, SOM, and P resulting in coverage values up to 71%. Furthermore, ion ratios between sorbent ($^{56}\text{Fe}^{16}\text{O}^-$) and sorbate ($^{12}\text{C}^{14}\text{N}^-$ and $^{31}\text{P}^{16}\text{O}_2^-$) were smaller along the natural oxides when compared with those for synthetic Fe oxides. We conclude that both natural and synthetic Fe oxides rapidly sequester SOM and P (i.e., within 30 days) but that newly, natural formed Fe oxides sorbe more SOM and P than synthetic Fe oxides.

