# Functional group chemistry at the mineral-organic interface in soils

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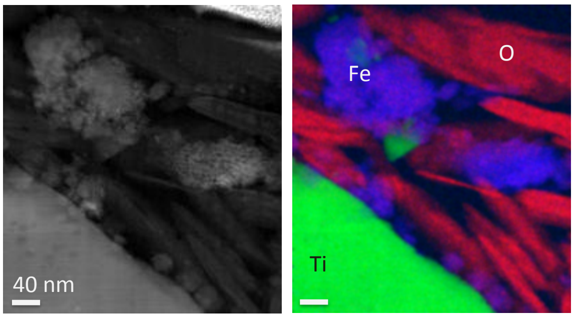
We know that most organic matter enters the soil as readily recognizable plant and animal detritus, and is mineralized within short timescales of one or two years. The remaining organic C, however, is stabilized for longer timescales of up to thousands of years in the presence of Fe, Al, Mn oxide and hydroxides, phyllosilicates and other soil minerals. Changes in mineralogy can enhance the soil C storage potential several fold. It is, therefore, all the more astonishing that the precise mechanism for the interaction between minerals and C in soils is still largely unknown. One of the major limiting factors to past investigations of soil C sequestration is the fact that these processes operate well below the scale that most researchers have been able to observe. We have made significant progress over the past five years to examine C properties at sub-micrometer level using scanning transmission electron microscopy coupled with near edge x-ray absorption fine structure - STXM-NEXAFS spectroscopy, and clearly demonstrated, for the first time, the importance of the spatial distribution of organic C on a 25-100 nm scale. Here we show in addition aberration-corrected scanning transmission electron microscopy (STEM) combined with electron energy loss spectroscopy (EELS) enabling three-dimensional and high-resolution imaging, elemental identification and studies of nearest-neighbor bonding at the atomic scale of the organo-mineral interface in soils.



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# Uncoupled enrichment of $^{15}$N and $^{18}$O in nitrate – Constraints on nitrate regeneration in various aquatic environments

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Measuring the nitrogen (N) and oxygen (O) isotope ratios in nitrate has been used to track N sources and transformations in freshwater and marine ecosystems. The deviation of nitrate N and O isotope values from parallel trends in $\delta^{15}$N and $\delta^{18}$O expected for nitrate uptake or denitrification has been taken as indication for nitrate production by nitrification. It still remains unclear, however, what controls O-isotope signatures of new nitrate in nature and, in turn, how sensitive the dual nitrate isotope signature is towards nitrate regeneration by nitrifying bacteria.

We will present nitrate isotope data from the open ocean, marine sediments, hydrothermal systems and a freshwater lake. Using a simple numerical model, nitrate isotope data are put into a quantitative framework for assessing nitrate production in net nitrate-consuming environments, and potential mechanisms involved in the generation of characteristic dual nitrate isotope signatures and anomalies in the various aquatic environments will be discussed.