Chemistry and mineralogy of Fe-rich marine nanoparticles, West Coast of South Africa

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Iron nanoparticles are of particular interest in marine systems due to their vast structural variability, importance in redox chemistry and high affinity to scavenge phosporus. Iron is also essential for the growth of organisms, and it has been receiving increased attention by the scientific community for its role as a limiting nutrient in some marine environments, particularly the High Nutrient Low Chlorophyl (HNLC) regions in the Southern Ocean. This study attempts to characterize the chemistry and mineralogy of Fe-phases and their bioavailability in the marine systems.

This study incorporates a range of x-ray and infrared spectroscopy and microscopy techniques to characterize samples from the complex St Helena Bay upwelling system which is conveneitely located proximally to the Southern Ocean. Rivers draining the west coast of South Africa are also sampled and analysed so as to determine the particle variability and the role that these fluvial systems may play as a source for enhancing productivity in the Southern Ocean.

Our studies show that a variety of Fe-oxide particles, such as ferrifydrite and amorphous Fe-oxides, exist in the marine water column and that ferrous-rich phases are also present particularly at greater depths. Furthermore, Al is often incorporated into the Fe-oxide structure and its variability, both in terms of speciation changes and depth-related concentration, is even more diverse. The occurrence and nature of these Al-substituted Fe phases is of great significance to the biogeochemical community as it may have implications for marine Fe-nano-particle properties such as solubility, sorption capacity and bioavailability. Results of these studies and their implications for the Fe-chemistry in oceans will be presented.

Environmental nanoparticles: Distribution and behaviour of main and trace elements at the nanoscale

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Environmental nanoparticles play important roles in the transport and fixation of trace metals. The overall picture of the nanoparticles involved and the processes taking place at the nanoscale is however still blurred. The variety of particle types and the complexity of processes involving natural nanoparticles is making their elucidation difficult.

We are collecting increasing evidence that especially mineral particles in the size range of a few nm to few tens of nm, containing i.e. iron and titanium as main elements, are controlling phases for the binding and also the transport of trace metals as i.e. lead and arsenic. Apart from this some elements which are regarded as trace metals, are able to form nanoparticles themselves as oxides, sulphides or carbonates and can be found in natural sediments.

Looking at the distribution of trace elements between organic nanoparticles as humic substances and similarly sized mineral nanoparticles with high resolution size separation and multi-elemental analysis we can show that both phases have significantly different affinities to trace elements. Expectedly copper and zinc show a predominant binding to organic nanoparticles with sizes at about 2 nm, while vanadium, titanium and lead are distributed equally between both phases or have a stronger tendency to bind to the mineral nanoparticles. Furthermore we have determined size-, type- and element-specific desorption of trace elements from the natural nanoparticles.

To complement the existing data and relate them to surface properties of the particles x-ray techniques as XAS, SAXS and XTM are needed.