Nd & Hf concentrations and isotopic compositions in the Baltic Sea

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Abstract

Within a process study in the framework of the international GEOTRACES program and led by the Institute of Oceanology of the Polish Academy of Sciences (IOPAN) a two-week cruise on the R/V Oceania sailed in November 2011 to investigate the distribution of trace elements and their isotopes in the Baltic Sea. The scientific goals were particularly focused on compiling trace element budgets for the Baltic Sea including in- and outflow, as well as to investigate elemental behavior and isotopic fractionation associated with the redox gradients of the Baltic Sea water column and the permanently anoxic conditions within its deep basins (i.e. Gotland Deep, Landsort Deep).

The Baltic Sea is a shallow, brackish inland sea with an average salinity of ~7 psu in the mixed layer. It is fed by the Bothnian Sea in the north, by the Finland Sea in the east, as well as by numerous rivers from Scandinavia and the Baltic states, and it is drained through the Danish Strait into the North Sea. In the opposite direction, a denser bottom water mass enters the Baltic Sea through deeper channels from the Danish Strait successively filling the deep basins northward. Below 130 m water depth, the water column is permanently anoxic.

Here we present the first combined data set of Nd and Hf concentrations and isotopic compositions for the Baltic Sea. A total of 21 water samples (60L volume per sample) including two water column profiles from the deeper basins were filtered (0.45 μm) and Nd and Hf were extracted and analysed following the accepted GEOTRACES protocols. The distribution patterns of the two elements and their isotopic compositions are compared to hydrographic data and oxygen measurements and provide information on sources and mixing of water masses, as well as on exchange processes with the underlying sediments, which are influenced by the prevailing redox gradients.

Acknowledgements

Stability of engineered nanoparticles in aqueous environments: measurements and modeling

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Aqueous stability of engineered nanoparticles (ENPs) plays a crucial role in their environmental fate, transport, bioavailability and biological consequences. ENPs, once disposed into aqueous enviornments, may undergo aggregation and dissolution or ion release. In this study, we systematically investigated aggregation kinetics of serval selected ENPs through assessment of the environmental effects (e.g., ionic strength) and modeling approaches. Particularly, CeO_2, due to its broad industrial applications, was chosen as a model ENP to study the aggregation kinetics under different concentraions and species of electrolyte (K^+ and Ca^{2+}) [1] and natural organic matter (NOM) [2] using time resolved-dynamic light scattering (TR-DLS). Expeirmental results were further evaluated by theoretical models developed on the basis of Extended Derjaguin−Landau−Verwey−Overbeek (EDLVO) theory. Based on the EDLVO theory and the von Smoluchowski's population balance equation, a model accounting for diffusion-limited aggregation (DLA) kinetics was established. Furthermore, a new approach was presented for assessing the attachment efficiency (a measure of relative aggregation kinetics) of ENP aggregation based on the Maxwell-Boltzmann distribution coupled with the DLVO theory [3], which is a first attempt to the best of our knowledge. The modified attachment efficiency equation was proposed and the equation successfully interpreted the effects of ionic strength, NOM, and temperature on aggregation kinetics [3], showing the balanced consideration of interfacial energy and Brownian motion in evaluating the aggregation kinetics of NP dispersions. For chemically reactive ENPs, silver NPs (or AgNPs) was selected to investigate the disolution kinetics and effects of particle size and concentration, and other factors (e.g., aggregation) [4]. An Arrhenius-based equation was developed for the first time to describe and simulate the Ag^+ release kinetics. Oxidative dissolution of AgNPs was accompanied by particle aggregation, which differed in kinetics with or wihtout the presence of disssolved oxygen [5]. The knowledge gained from this research proivdes insight into the aqueous stability of ENPs and using expeirmental and modeling approaches, allowing us to better undertand and predict environmental fate of ENPs at nanoscale.

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