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Rare Earth element partition coefficients in the subpolar North Atlantic (GEOVIDE cruise)

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We present the first basin-scale section of Rare Earth element (REE) partition coefficients, Kd. This parameter represents the ratio of the particulate concentration of a given element on its dissolved concentration multiplied by the suspended particle mass (SPM). Although Kd data are very scarce in the literature, it is a key parameter of element cycle modeling, reflecting the scavenging efficiency by particles. So far, because of the lack of data, Kd are simply optimized in model. This shortcoming likely contributes to the difficulties to represent properly both Nd concentrations and isotopic compositions in models. Along the GEOVIDE section, Kd(REE) were determined at 10 stations, calculated from dissolved and particulate REE concentrations previously published, and from suspended particulate matter concentrations (SPM) established in this study. Our results show that:

- the profiles show that Kd(REE) tend to be minimum at the surface, varying in the upper 400 m and increasing with depth
- Kd(Nd) values of this study are higher than those parametrized in models, revealing an underestimation of Nd scavenging
- the expression of Kd(REE) as a function of SPM concentrations shows that manganese oxides (MnO_2) are the main driver of REE scavenging, followed by the lithogenic phase and iron hydroxides ($Fe(OH)_3$).
- REE scavenging preferentially depends on the relative proportion of these three phases rather than on their absolute concentrations. These conclusions are confirmed by a Pearson correlation test
- Kd(Nd) can be parametrized as a function of the particulate phase proportions. We did two parametrizations, one including MnO_2 and $Fe(OH)_3$, phases that are currently not represented in Nd cycle models, when the other one does not. Both parametrizations show a good agreement between observed and calculated Kd(Nd), that is stronger when (hydr)oxides are included (R^2=0.84 vs R^2=0.71).

These results demonstrate a lack in Nd (and more generally REE) representation in models. Determining these Kd values is promising and therefore recommended in the future for improving Nd cycle models and our REE cycle understanding.