Dissolved rare earth element concentrations from the Barents Sea to the central Arctic

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Rare earth element (REE) concentrations in the ocean track input and transport pathways of trace elements and provide information on marine geochemical processes. To identify these pathways and processes in the Arctic Ocean is of particular interest because of the unique conditions that characterize this ocean basin, such as extended shelf areas, high river input, seasonal sea ice cover, and low particle fluxes. This study will provide insight into REE cycling in the Arctic Ocean.

During GEOTRACES cruise GN04 (R/V Polarstern cruise PS94) from the Barents Sea to the central Arctic, we collected seawater samples for REE analyses from 20 stations and up to 16 depths per station. Samples were filtered and collected adhering to accepted GEOTRACES protocols, and were preconcentrated and analyzed using a seaFAST-pico and isotope dilution ICP-MS. The results show variable REE concentrations in surface waters with values ranging from 14 pmol/kg to 45 pmol/kg for neodymium (Nd), with highest concentrations in the central Arctic and close to the Norwegian coast. The negative correlation of surface REE concentrations with salinity in the central Arctic suggests transport of low salinity, REE-rich waters within the Transpolar Drift surface current. High REE concentrations are likely added to Arctic surface waters by rivers and the extended Siberian shelves. Below the surface, REE concentrations rapidly decrease, reaching uniformly low concentrations of 14-17 pmol/kg for Nd at 500 m water depth that persist all the way to the bottom at all stations. This is contrary to what is observed in all other ocean basins, where REE concentrations typically increase with depth due to release from particles and lateral water mass transport. Our observation can be explained by the residence time of REEs exceeding the mixing time of the intermediate to deep water column. Additionally, very low particle fluxes as a result of seasonal sea ice cover and low primary production in the Arctic contribute to the invariant REE concentrations.