Neodymium in the Oceans: Assessment of a modern tracer and implications for paleoceanography

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The neodymium (Nd) isotopic composition of seawater has been considered a promising water mass tracer for many years, and has been used extensively to reconstruct ocean circulation on million year, glacial-interglacial, and even sub-millennial timescales. While published Nd isotope records show intriguing co-variations with other climate indicators, our understanding of the modern cycling of Nd in the ocean has been rather limited. However, a good understanding of modern processes is critical before a paleoceanographic tracer can be applied with confidence to study the past.

Here we present a new global database for seawater Nd isotopes and concentrations in the context of hydrography and macronutrients. We further compare the first two high resolution Nd isotope datasets produced by the international GEOTRACES program in the western and eastern North Atlantic. This comparison provides invaluable insights into the relative roles of physical mixing and vertical water column processes in setting observed water mass signatures, with the former dominating in the west, and the latter having more prominence in the east. In addition, we explore Nd isotopes in the North Atlantic in 'tracer-tracer' space. Inspired and facilitated by the assembly and publication of the first GEOTRACES intermediate data product (IDP2014), we carry out a regional comparison of Nd isotopes and concentrations with another lithogenic tracer, aluminum (Al). Jointly, the two tracers reveal novel insights into boundary exchange, advective tracer transport, and vertical cycling.

Finally, we reflect on the application of Nd isotopes as an ocean circulation tracer for the past oceans. In particular, we discuss the challenges that have emerged out of the growing number of modern observations, including potential changes of global endmembers through time, spatially varying effects of boundary exchange, and the role of internal cycling. There are numerous challenges left before we fully understand the marine Nd cycle, but it is clear that the wealth of new seawater data, to be produced in the next five to ten years, will revolutionise our understanding of Nd as a tracer in a way rarely every achieved in (paleo) oceanography.