Water mass formation in the Labrador Sea based on coupled Hf-Nd isotope and rare Earth element distributions

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Combining radiogenic Hf and Nd isotope compositions is a powerful tool to trace water mass circulation and weathering inputs in the present and past ocean. However, the exact mechanisms controlling the behavior of Hf and Nd in seawater and their inputs are still not fully understood and more seawater measurements, in particular of Hf isotopes, are required. Here we present the first detailed combined dissolved Hf-Nd isotope compositions and REE distributions, sampled and prepared according to GEOTRACES protocols, of four full water depth profiles and three shallow casts from the Labrador Sea, one of the important areas for North Atlantic Deep Water formation.

Typical shale normalized seawater REE patterns including enrichment in heavy REEs and a pronounced negative Ce anomaly are found. The open ocean Nd concentrations have distinctive depth profiles with slight enrichments at the bottom. Higher concentrations are observed at shallow stations near the Canadian coast. Hf concentrations are less variable than those of Nd and show a slight decrease with water depth. No significant enrichment in Hf is observed in the samples near the coast.

The Nd isotope patterns (ε_{Nd}) of all full water depth profiles are similar and range from -16.4 at the surface to -11.0 at depth. Samples collected in the shallow waters off the coast of Canada are significantly less radiogenic at values near -25. Hf isotope signatures (ε_{Hf}) on the other hand are highly variable ranging from -11.7, which is the most negative value ever recorded in seawater, to +0.3. Newly ventilated Labrador Sea Water (LSW) is characterized by distinct salinity, temperature and oxygen signatures and by ε_{Nd} values around -14. In contrast ε_{Hf} signatures are more variable and range between -1 and -2 in the upper part of LSW. In contrast, intermediate depths below 1700m show values of up to -4.9. This layer is likely explained by the presence of strongly modified colder and denser LSW formed in the early 1990s, as documented by long term observations in the area.