

Variation in the rate and position of deep-water formation in the North Atlantic is thought to play a fundamental role in the climate of that region and, indeed, the whole world. North Atlantic Deep Water (NADW) contains at least two components - one forming in the Labrador Sea (LSW) and the other forming in the Greenland seas (GDW). However, the relative importance of these components on timescales $>10^3$ years has not been well studied. Given the known climatic importance of decadal variability in deep water formation (e.g. Dickson 1997), longer-period variations may be important in the climate system. The water from the two source regions are depleted in nutrients, hence nutrient-like proxies cannot differentiate between them and are not able to quantify changes in the mixture of LSW and GDW in the past. However, the two source regions contribute very distinct Nd-isotope signatures to NADW. Present-day NADW has a uniform ϵ_{Nd} of -13.5 and consists of a mixture of LSW ($\epsilon_{Nd} \sim -20$) and GDW ($\epsilon_{Nd} \sim -8$). The ϵ_{Nd} composition of NADW is very sensitive to changes in the relative contribution of LSW and GDW. The problem with using ϵ_{Nd} to assess past variability has been the lack of a suitable substrate which records NADW ϵ_{Nd} values at sufficient time resolution. Shallow-water aragonite typically contains very low Nd concentrations (< 0.1 ppm (Sholkovitz & Shen 1995)), which upon deposition in deep water, may act as an almost Nd-free substrate for the scavenging of Nd from water at the sediment-water interface. The Nd-isotope composition of aragonite may therefore reflect the Nd-isotope composition of seawater at core-top depth.

In this study, we have tested the use of shallow-water aragonite as a recorder of deep-water ϵ_{Nd} with carbonate sediment from the Providence Channel, Bahamas. Several grain sizes were separated from core-top sediment and then subjected to heavy-liquid separation (using sodium polytungstate) to separate aragonite and high-Mg calcite from the sediment. Mg calcite separates at 30- 60 and 63 -125 μm have Nd concentrations of 2.2 and 2.0 ppm respectively, rather similar to other Atlantic shallow water calcites (Vance and Burton 1999). Aragonite separates at the same grain sizes have Nd concentrations of 1.6 and 0.8 ppm respectively. These aragonite Nd concentration are significantly higher than observed in shallow-water aragonite and suggest the presence of significant scavenged deep-water Nd. The large amounts of scavenged Nd on such young sediment may imply rapid growth of Fe-Mn coatings, which is often associated with the oxygen minimum layer. Preliminary isotope data on the same separates confirm that the aragonite separates capture a NADW ϵ_{Nd} value of -13.5, as shown in Figure 1. Calcite separates and bulk sediments have higher ϵ_{Nd} values that reflect incorporation of Nd from surface waters ($\epsilon_{Nd} = -9.5$)

and/or detrital matter ($\epsilon_{Nd} \sim -10.5$). This suggests that while calcite contains significant amounts of Nd of surface water origin, aragonite principally contains Nd incorporated from deep-water, at the sediment-water interface.

These data suggest that aragonite separates from Bahamas carbonate sediment provide a proxy for past NADW ϵ_{Nd} and hence for the relative contribution of LSW and GDW to NADW. Results will be shown of two down-core records at high resolution from Box cores at ~ 1400 m water depth. These will constrain the ϵ_{Nd} composition of NADW and enable variations in the relative strengths of the two source regions of NADW to be identified over the Holocene.

Figure 1: ϵ_{Nd} for seawater and core-top sediment from the Bahamas. Water data is from north of the Bahamas (Piegras & Wasserburg 1987). In deep-water, the aragonite separate captures the NADW ϵ_{Nd} values of -13.5, whilst calcite and bulk fragments contain significant amounts of Nd of surface water origin and/or detrital contamination.

Dickson B, *Nature*,