

Oxygen and deuterium stable isotope signals in Northeast Atlantic waters

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Material and Methods

A comprehensive study of seawater stable isotope properties in the mid-latitude North Atlantic is still missing [1], especially for the intermediate and deep water masses. To fill this gap seawater samples were collected along various transects in the Northeast Atlantic. During the Atlantic Meridional Transect (AMT) 18 expedition the upper 300 m were sampled between 46.6 and 24.7°N. RV Poseidon cruises P334, P349, P377, and P383 to the Azores Front region (38.3–30°N; 22–20°W) generally yielded samples down to 2000 m. High resolution sampling over the whole water column was performed during the OVIDE 2010 (Portugal to Reykjanes ridge) and KN199-4 cruises. Cruise KN199-4 implemented the section from Lisbon to the Cape Verde Islands of the US GEOTRACES North Atlantic transect. AMT 18 and P cruise samples were analyzed for $\delta^{18}\text{O}$ using the Delta E mass spectrometer at the Leibniz Laboratory (Kiel, Germany). Analysis of $\delta^{18}\text{O}$ and dD in the OVIDE 2010 and KN199-4 samples was done at the Godwin Laboratory (Cambridge, UK) using the PICARRO L2120 water isotope analyzer. Splits of some of the KN199-4 samples were also analyzed for both isotope ratios at the University of Chicago using a GasBench II linked to a Delta V Plus mass spectrometer.

Results and Conclusions

Along the AMT 18 transect, i.e. in the central basin, a clear boundary is visible with $\delta^{18}\text{O}$ values in the upper 100 m of 0.75–1.15 permil north of 38°N and 1.3–1.5 permil south of it. The range narrows in the North Atlantic Central Water (NACW) to 0.9–1.2 permil with the stations in the subtropical gyre, as expected, showing the higher values. In the eastern basin variability in the upper mixed layer (<300 m) is much larger with values ranging from 0.4 to 1.6 permil. The high variability can be attributed to seasonal mixing processes at the Azores Front, upwelling along the Iberian margin and the influence of riverine water at KN199-4 station 1 positioned in the Setubal canyon. Below 300 m the subpolar and subtropical NACW can clearly be distinguished in the isotope profiles. Along with temperature, $\delta^{18}\text{O}$ values decrease with depth to generally less than 0.7 permil below 2000 m. Along the Iberian margin this trend is, however, interrupted between 500 and 1500 m due to the Mediterranean Outflow Water (MOW). The different cores of the MOW are clearly visible in the $\delta^{18}\text{O}$ and dD (which is highly correlated to salinity) profiles, especially those close to the Iberian margin. Results for many of the OVIDE and GEOTRACES stations are pending and when they are available it will be possible to better define the isotopic properties of the subsurface water masses, especially the North Atlantic Deep Water and the Antarctic Bottom Water.

[1] LeGrande & Schmidt (2006) *Geophys. Res. Lett.* **33**, L12604.

Carbonate diagenesis in the Pacific Equatorial Age Transect (PEAT) Sites and the preservation of geochemical signals in foraminifera

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The calcite shells (tests) of foraminifera used for reconstructions of oceanic and climatic conditions in the past can be altered after deposition by a process where the original biogenic calcite is replaced by secondary (inorganic) calcite. It is important to quantify changes in the elemental and isotopic composition of the tests caused by this recrystallisation process and thus the reliability of the proxy data. We present initial results from a multi-component study of recrystallisation in sediments from the IODP Expedition 320/321 Pacific Equatorial Age Transect (PEAT), where sediments of similar age and initial composition have been subjected to different diagenetic histories.

⁸⁷Sr/⁸⁶Sr ratios of bulk carbonate leachates and the associated pore waters generally suggest that recrystallisation occurred relatively rapidly as the values are indistinguishable (within 2 σ uncertainties) from contemporaneous seawater [1]. Notable exceptions include Site U1336, where pore waters and the bulk carbonates in sediments older than 20.3 Ma have lower ⁸⁷Sr/⁸⁶Sr ratios than contemporaneous seawater, most likely resulting from the upward diffusion of Sr from older recrystallised carbonates.

Furthermore, the lower Sr/Ca ratios of bulk carbonates from Site U1336, compared to the other PEAT sites, suggest more extensive diagenetic alteration as less Sr is incorporated into secondary calcite. Although the recrystallisation of bulk carbonates is well documented, the fate of foraminiferal chemistry is potentially different. To investigate this, laser ablation ICP-MS element/Ca ratio depth profiles through tests of the planktonic foraminifera *G. venezuelana* from Sites U1336 and U1338 were obtained for two time intervals (13.9 Ma and 15.5 Ma). The depth profiling technique reveals heterogeneity of Mg/Ca and Mn/Ca ratios through the wall of the tests comparable to those reported for modern foraminifera from sediment traps [2]. The Sr/Ca ratios show little heterogeneity and fluctuate around 1.1-1.2 mmol/mol as also observed for modern tests. The Sr/Ca ratios exhibit no systematic difference between the sites and time intervals. Therefore, the intra-test element/Ca heterogeneity suggests that foraminifera react differently to bulk carbonates (nanno-fossils) during diagenetic recrystallisation and much of the original geochemical proxy signal may have been retained.

[1] McArthur *et al.* (2001) *The Journal of Geology* **109**, 155-170

[2] Hathorne *et al.* (2009) *Paleoceanography* **24**, PA4204