Holocene temperature evolution of the subpolar North Atlantic recorded in the Mg/Ca ratios of surface and thermocline dwelling planktonic foraminifers

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Core Locations and Hydrography

Fig. 1 shows core locations in the North Atlantic, with simple surface circulation. Both sites are dominated by the warm, saline North Atlantic Current (NAC). Figs 2a and b show the hydrography of each core site and the development of seasonal thermoclines (Levitus, WOA, 1998).

Species Ecology

Globigerina bulloides (Fig. 3)
- Largely subpolar species but also associated with zones of upwelling such as along the west African coast.
- A wide ranging species with well defined temperature thresholds, with abundances declining sharply below 8°C.
- δ18O records from G. bulloides correlate strongly with measured summer sea surface temperatures
- Surface or near-surface dwelling

Globorotalia inflata (Fig. 4)
- Abundant in temperate waters associated with the NAC but also ranges to subpolar and subtropical waters.
- Temperature range of 9-18°C.
- Deep dwelling – associated with the base of the seasonal thermocline and the upper 100m of the water column.

Holocene Variability - MD99-2251 (57°26’N, 27°54’W, 2620 m water depth)

- Chronology based on a series of 14C dates (see Ellison et al., 2006).
- G. bulloides and G. inflata were analysed at the 300-355 μm size fraction, with ~30 specimens per sample.
- Mg/Ca samples were run using the intensity calibration ICP-AES method of de Villiers et al. (2002). More information on the instrumental set up can be found in Farmer et al. (2008).

- Fig. 5 illustrates the contrast between Mg/Ca ratios in the different planktonic species. Mg/Ca ratios vary between ~1.6 - 2.6 mmol/mol for G. bulloides and 1.0-1.7 mmol/mol for G. inflata.
- Fig. 6a uses a shifted scale to highlight similarities in amplitude and variability between the two species.
- Fig. 6b focuses on 5 - 9.5 ka, emphasising the common features of the records through this interval of more detailed sampling.

This multi-species analysis suggests that a large part of the variability seen in the surface ocean is translated into the deeper, with the thermocline species exhibiting a similar amplitude and scale of variability to the surface dwelling species. The most notable differences occur in the early and very late Holocene.

Mg/Ca – Temperature Calibration for G. inflata

There is a wide selection of potential Mg/Ca to temperature calibrations ranging from general to species specific calibrations. Three calibrations for G. inflata are presented here.

- Fig. 7 shows the G. inflata coretop data of Cleroux et al. (2008).
- Coretop data from the subpolar area were added to extend the range of the calibration into that of the MD99-2251 core site. These sit well with the existing Cleroux dataset. G. inflata calibrations from Thornalley et al. (2009) and Anand et al. (2003) are also plotted. The errors on these calibrations range from 1.13 to 1.4 °C.

- Fig. 8 presents the G. inflata Mg/Ca data from MD99-2251 plotted as temperatures using these three different G. inflata calibrations.

The presentation of a number of G. inflata calibrations and the resultant temperature records highlights the differences between the range of calibrations available and the importance of selecting the most appropriate calibration for the core site and sample preparation method. Surface hydrography (Fig. 2a) indicates modern temperatures at the MD99-2251 site, in the typical depth habitat for G. inflata (~100m), are in the range of 8-10 °C (marked on the Mg/Ca Temperature axis of Fig. 8).

References and Acknowledgements