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δ^{18}O and trace element calibrations for 3 deep-dwelling planktonic foraminifera species : potential recorders of past thermocline temperature

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Most previous paleoceanographic studies focused on past surface water or deep-water conditions by analysing surface-dweller or benthic organisms. However, little information is available on temperature variations in the upper 500 m of the water column, where most of the energy storage and heat transport occur. Deep-dwelling planktonic foraminifers, which inhabit the top few hundred meters of the ocean constitute potential recorders of thermocline conditions.

We measured the oxygen isotopic composition of the deep-dwelling foraminiferal species *Globorotalia inflata*, *G. truncatulinoides* dextral and sinistral, and *Pulleniatina obliquiloculata* in 29 modern core tops raised from the North Atlantic Ocean. We compared calculated isotopic temperatures with atlas temperatures and developed ecological models for each species. All species live preferentially at the base of the seasonal thermocline but under temperature stress (when the base of the seasonal thermocline is warmer than 16˚C) *G. inflata* and *G. truncatulinoides* live deeper in the main thermocline.

In the same set of core-tops, we measured Mg/Ca and Sr/Ca ratios of these deep-dwelling species and of surface-dwelling foraminiferal species *Globigernoides ruber* and *Globigerinoides bulloides*. We analyzed the thermo-dependence of those trace element ratios relative to isotopic temperatures. Mg incorporation in the test is a function of temperature in all species but only *G. inflata* and *G. truncatulinoides* show a good

correlation between Sr/Ca and temperature. Our calibrations of the Mg/Ca thermometer in *G. ruber* and *G. bulloides* fit well with the published relations for these species, respectively by ..*Elderfield and Ganssen* [2000] and *Anand et al*. [2003]. Species-specific calibrations showed that incorporation of Mg and Sr have similar sensitivity to temperature for the three deep-dwelling species. Given the current knowledge on these proxies we to group those data to establish multi-deep-dwelling relationships with significant coefficient correlations. These calibrations areas are as precise as species-specific relations and provide thermocline temperature estimates with an error of $\pm$ 1.8°C for Mg/Ca ratio and $\pm$ 1.4°C for Sr content as long as Sr geochemistry in ocean is constant through time.