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# Quantifying and overcoming bioturbation in marine sediment cores: dual 14C and $\delta$18O analysis on single foraminifera

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Marine sediment cores used in palaeoceanography form the basis of our current understanding of past global climate and ocean chemistry. Precision and accuracy of geochronological control in these sediment cores are crucial in unravelling the timing of rapid shifts in palaeoclimate and, ultimately, the interdependency of global climate mechanisms and their causality. Aware of the problems associated with bioturbation (the mixing of ocean sediments by benthic organisms) palaeoceanographers generally aim to retrieve sediment cores from locations with high sediment accumulation rates, thus minimising the influence of bioturbation as much as possible. However, the practice of concentrating only on areas of the ocean floor with high sedimentation accumulation rates has the potential to introduce a geographical bias into our understanding of global palaeoclimate. For example, global time averaged sediment accumulation rates for the ocean floor (excluding continental margins) indicate that vast areas of the ocean floor have sediment accumulation rates less than the recommended minimum advised sediment accumulation rates of 10 cm/ka or greater. Whilst many studies have focussed on quantifying the impact of bioturbation on our understanding of the past, few have attempted to overcome the problems associated with bioturbation.

Recent pioneering developments in 14C AMS at the Laboratory of Ion Beam Physics at ETH Zürich have led to the development of the Mini Carbon Dating System (MICADAS). This compact 14C AMS system can be coupled to a carbonate handling system, thus enabling the direct AMS measurement of gaseous samples, i.e. without graphitisation, allowing for the analysis of carbonate samples of <100 $\mu$g. Likewise, while earlier isotope ratio mass spectrometry (IRMS) technology required a minimum of 100 $\mu$g of carbonate to produce a successful $\delta$18O measurement, more recent advances in IRMS technology have made routine measurements of as little as 5 $\mu$g possible. Combining both analytical techniques enables palaeoclimate reconstructions that are independent of depth. Here, we present work on a low sedimentation core ($\sim$ 2 cm/ka) core in the North Atlantic (core T86-10P, 37° 8.13' N, 29° 59.15' W) on single shells of the benthic species of foraminifera, Cibicidoides wuellerstorfi. Preliminary downcore single specimen 14C data display a large scatter in 14C ages for the various discrete 1 cm depth intervals analysed. In the case of depth intervals where three or more single specimens have been analysed, we find that the standard deviation in 14C age varies between 1210 and 9437 14C yr, with the mean variation for all such discrete depths being 3384 14C yr.