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Highly-resolved radiocarbon measurements on shells from Kalba, UAE, using carbonate handling system and gas ion source with MICADAS

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ABSTRACT

The Mini Carbon Dating System (MICADAS) represents a flexible AMS system for measuring radiocarbon samples either in the form of graphite or CO_2 gas. We used the possibility to attach a carbonate handling system (CHS) to the gas ion source (GIS) to measure smaller amounts of carbonates (< 500 µg) than is usually required for graphite samples (1 mg). We determined a blank correction for different sample sizes ($F^{14}C$ ranging from ~0.0045 to ~0.017) from graphs. The use of OXA II as solid target and as gas fed through the GIS is presented. Cross-contamination is detected to be in the range of ~6%, but depends on the sample size and ^{14}C content of the previous sample. Our system delivers reliable data for sample sizes down to 30 µg C when enough blanks (here > 3) are used to clean the system. We tested the CHS-GIS combination on heated and unheated archaeological shells of *Anadara uropigimelana* from Kalba, Sharjah Emirate, United Arab Emirates (UAE). Even though the amount of carbon in the samples was small (4–22 µg C) the performance of the CO_2 dating system permits the comparison of trends in the ^{14}C data to stable isotope measurements ($\delta^{18}O$ and $\delta^{13}C$). With 10–20 µg C, however, our sample sizes were too small, suffering from cross-contamination and elevated blanks, and our blank samples prior to the small samples were not enough. Hence, an interpretation in combination with the stable isotope data was not possible beyond comparison of trends.

1. Introduction

Mollusc shells are often used for radiocarbon dating, especially to answer archaeological questions regarding chronologies when no organic material is preserved [37,4,19]. Interdisciplinary studies have revealed that shells can also contribute to modern climate studies and serve as paleoclimate archives [5,7,2,10,18]. In this context, sclerochronology including shell growth patterns, element analyses and stable isotopes provides an important tool to gain information about life history of the animal and environmental conditions that occurred during its lifetime such as salinity, freshwater inflow, changes in temperature of the seawater, and food resources to name but a few [8,16,25,34,41].

Combining radiocarbon, sclerochronology and stable isotope data, sheds light on local environmental effects and changes in these over time. The change in $\delta^{18}O$ for example often shows a periodicity which reflects seasonal changes in temperature and salinity over the lifespan of the mollusc [16]. A change of 1‰ in $\delta^{18}O$ corresponds to a temperature change of ca. 4 °C [14,15]. Therefore, knowing the seasonal and inter-annual amplitudes of environmental variables allows us to derive a temperature range for the site. The $\delta^{13}C$ signal on the other hand depends on different sources including food resources and changes in water composition. Freshwater input can change the $\delta^{13}C$ significantly if the freshwater carries a lot of carbonate, e.g., when it flows through limestone-rich areas and manages to dissolve some of the limestone [1,12]. Hence the interpretation of this signal is not straightforward as it might overlap with different or changing food resources at the same time. As most of the carbon responsible for the $\delta^{13}C$ should have the same origin as ^{14}C in the shell, measuring radiocarbon along the shell might help to better interpret $\delta^{13}C$ data. The same origin here can represent different influences on the respective signal. For example, old carbon brought in from limestone, possibly dissolved in freshwater, will shift $\delta^{13}C$ towards more positive values, but at the same time will be depleted in radiocarbon, hence shifting the signal towards older ages. In other studies, an enrichment in $\delta^{13}C$ in algae and cyanobacteria - a food resource for molluscs – during

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