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Rapid and high precision C-14 analysis in small DIC seawater samples and its future application as an ocean tracer

Núria Casacuberta, Maxi Castrillejo, Anne-Marie Wefing, Silvia Bollhalder, Kayley Kündig, Hans-Arno Synal, and Lukas Wacker
ETH Zurich, Zurich, Switzerland (ncasacuberta@phys.ethz.ch)

Carbon isotopic measurements in oceanic dissolved inorganic carbon (DIC) contribute to many oceanographic fields. For instance, radiocarbon (^{14}C) has been essential to elucidate aspects related to ocean circulation, air-sea exchange, carbon cycling and biogeochemistry. Despite its importance as a tracer in oceanography, oceanic ^{14}C has been less well studied than other tracers (e.g. CFCs) as disentangling the natural from the artificial component is not trivial. Another major limitation was the large volume seawater samples required for the decay counting of ^{14}C. Advances in Accelerator Mass Spectrometry (AMS) allowed the reduction of the sample volume to a couple of liters, permitting to obtain spatially better resolved distributions of oceanic ^{14}C during repeated GO-SHIP sections. Yet, methods for sample preparation were borrowed from decay counting and not optimized for AMS. Here, we present a method that we recently developed in the Laboratory of Ion Beam Physics (ETHZ) that allows the rapid (<5 hours) measurement of $DI^{14}C$ in small seawater samples with unprecedented precision (<2‰) (Casacuberta et al., 2019). The setup consists of an automated sampler designed to extract $DI^{14}C$ from 50 - 60 ml samples, by sparging the acidified seawater with helium gas to extract CO_2. The fully automated method is controlled via a LabVIEW program that runs through all consecutive steps: catalyst preconditioning, CO_2 extraction, CO_2 trapping and thermal CO_2 release from the trap into the reactor for graphitization, which is performed simultaneously for 7 samples. The method is optimized by introducing a Cu-Ag furnace that improves and accelerates the graphitization to less than 2 hours. As a proof of principle, we will show two sections of ^{14}C corresponding to two recent expeditions carried out in the North Atlantic (OVIDE section) and the Fram Strait in 2018. The high precision of the results allows for the characterization of different water masses in the subpolar North Atlantic Ocean, which reflect the export of anthropogenic carbon to the abyssal waters as a result of deep-water formation in the Iceland-Scotland Overflow Water and the Denmark Strait Overflow Water. Results will be also compared to previously published oceanic $\Delta^{14}C$ data in those regions. These studies already demonstrate the potential to use $\Delta^{14}C$ as a powerful and cost-efficient tool to resolve oceanic circulation patterns, especially with respect to ventilation of the water column.

Casacuberta, N., Castrillejo, M., Wefing, A.-M., Bollhalder, S., & Wacker, L. (2019). High Precision ^{14}C Analysis in Small Seawater Samples. Radiocarbon, 00(00), 1–12. https://doi.org/10.1017/rdc.2019.87