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Premises and physical mechanisms to explain plateau boundaries in marine planktic 14C records as absolute age markers

Michael Sarnthein (1) and Pieter M. Grootes (2)

(1) (michaelsarnthein@yahoo.de) Institut für Geowissenschaften, University of Kiel, D.24098 Kiel, Germany, (2) (pgrootes@leibniz.uni-kiel.de) Leibniz Labor, University of Kiel, D.24098 Kiel, Germany

Changes in marine planktic reservoir age variations hamper severely our ability to age calibrate and use marine records as atmospheric 14C records. Genuine atmospheric 14C changes may overlap with changes induced by massive changes in surface ocean hydrography. However, the deglacial Cariaco Basin record (tuned to U/Th ages of the Hulu record) forms a rare case, where the near-surface ocean and its planktic foraminifera may be in reasonably good exchange with the atmosphere, undisturbed by upwelled old deepwater masses. Accordingly, this core was used to connect IntCal09 with the marine record. High-density dating of this core resolved a suite of $\sim$8 sediment sections over glacial-to-interglacial intervals of 400-1500 yr, where planktic 14C ages stay largely constant ("plateaus"), interspersed with sections, where 14C ages rapidly increase with depth ("jumps"). In harmony with IntCal09 we don't discard this pattern and its potentially important information as mere noise but accept it as real, per analogy to 14C plateaus and jumps established for the tree ring calibrated Holocene. This plateau suite was used for plateau tuning in 8 other high-sedimentation rate and high sampling rate (75-200 yr) deep-sea cores. Here, the plateaus with their characteristic internal structure can hardly be ascribed to irregular pulses of extremely high hemipelagic sedimentation rates leading to 5-50 cm long but otherwise undisturbed sediment sections with constant 14C age. The favored explanation is varying atmospheric 14C concentrations reflected in the near-surface ocean. The age difference between locally measured and atmospheric plateau ages in the reference record serves for deducing local planktic reservoir ages. However, occasional but rare millennial-scale events of changing admixture of old deep-ocean waters may disrupt the atmospheric plateaus in deep-sea cores. The latter influence is distinguished by evaluating the complete deglacial plateau suite in each core, keeping resultant sedimentation rate changes to a minimum, minimizing resultant planktic reservoir ages, and monitoring strict criteria regarding realistic paired benthic reservoir ages, e.g., by testing alternative models of 14C plateau tuning. Being applied to eight cores this approach led to realistic estimates of absolute and 14C reservoir ages as well as of sedimentation rates for various key regions of the ocean.

Refs.: Reimer, P. et al., 2010, Radiocarbon, 51 (4), 1111-1150.
Sarnthein et al., 2007, in: A. Schmittner et al., AGU Monograph 173, 175-196.