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Towards centennial-scale absolute age control of glacial-to-deglacial changes in South Pacific oceanography

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Glacial-to-interglacial changes in atmospheric $pCO_2$are considered as largely controlled by processes in the Southern Ocean. In particular, the upwelling system along the Polar Front is regarded as a major pathway of old CO_2 from the deep ocean up to the sea surface and atmosphere. Hence, it plays an important role in regulating the CO_2 exchange between ocean and atmosphere. At the beginning of the last glacial termination, changes in ocean overturning circulation in the Southern Ocean probably triggered two huge events of CO_2outgassing from a deep-ocean reservoir into the atmosphere as revealed by Antarctic ice core records (1) They parallel two intervals of rapidly decreasing atmospheric δ^{13}C (2) and Δ^{14}C (3) probably concurrent with two intervals of enhanced ocean upwelling, directly linking increased ventilation of the deep ocean to the deglacial rise in atmospheric CO_2. To constrain the precise timing and origin of released CO_2 we used paired records of marine ^{14}C reservoir ages from the Pacific sector of the Southern Ocean, established by means of the ^{14}C Plateau Tuning method (4). Surface ocean reservoir ages reflect the difference between coeval atmospheric and surface ocean ^{14}C ages, with high values serving as tracer for upwelled old water masses. They were obtained from our centennial-scale resolution planktonic radiocarbon records of sediment cores off southern New Zealand (and southern Chile). During the last peak glacial our ^{14}C ages reveal planktonic reservoir ages of 1600-1800 yr exceeding previous estimates (5,6) by 400-1000 yr, but well agree to the previously reported high value of 1970 yr (7). Right at the onset of the last deglacial our record suggests an extreme drop down to a very low reservoir age of $\sim$200 yr matching the low estimates of 300-400 yr by (5,6,7). During terminal Heinrich-1 times, the values once more reached 1100 yr. This pattern of increased reservoir ages during peak glacial times (and the B/A) and strongly reduced values during the early deglacial precedes the δ13C trends of atmospheric CO_2 each and has great implications for both constraining the history of past deep-water ages and related changes in the CO_2 (1‰ Δ^{14}C $\cong$ -1.22 μmol DIC kg^{-1}; (4)) storage of South Pacific deep waters.

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(2) Schmitt et al. 2013, Science Vol. 336, 711

(3) Bronk Ramsey et al. 2012, Science Vol. 338, 370

(4) Sarnthein et al. 2013, Clim. Past Vol 9, 2595

(5) Pahnke et al. 2005, Science Vol. 307, 1741

(6) Ronge et al. 2016, Nature Comm. Vol. 7, 11487

(7) Sikes et al. 2000, Nature Vol. 405, 555