Lack of a late deglacial carbonate compensation signal in the intermediate depth Amundsen Sea

M. GUTJAHR[1,2]*, D. VANCE[1], J.W.B. RAE[1],
G.L. FOSTER[2], C.D. HILLENBRAND[3] AND G. KUHN[4]

[1]Bristol Isotope Group, Department of Earth Sciences, University of Bristol, Queens Road, Bristol BS8 1RJ, UK (*correspondence: marcus.gutjahr@noc.soton.ac.uk)
[2]School of Ocean and Earth Science, National Oceanography Centre, Southampton, UK
[3]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET, UK
[4]Alfred Wegener Institute for Polar and Marine Research, Am Alten Hafen 26, 27568 Bremerhaven, Germany

The Southern Ocean (SO) is an important component in deglacial ocean circulation- and climate change. Ice core-derived temperature and atmospheric pCO_2 records show a deglacial rise as early as 17.9 ka [1, 2], thereby leading Northern Hemisphere warming by about three thousand years [3]. The atmospheric CO_2 rise occurred alongside increasing bioproductivity around Antarctica, providing evidence that reinvigorated upwelling of Circumpolar Deep Water (CDW) around Antarctica led to large-scale degassing of Dissolved Inorganic Carbon (DIC) stored in the glacial deep ocean [4].

Changing CDW circulation patterns should also find their expression in variable CDW DIC/alkalinity relationships. In broad terms, the release of previously deep-sea stored DIC to the atmosphere should leave deglacial CDW more alkaline until the excess alkalinity is removed from the water column. To test this hypothesis we have measured the boron isotopic composition (expressed in $\delta^{11}B$) of calcitic scleraxonian cold-water corals sampled in intermediate water depths in the Amundsen Sea (~123°W, ~69°S, 2500 m to 1430 m water depth). We will present an assessment of the genus-specific biological fractionation (c.f. [5, 6]) alongside fossil-coral $\delta^{11}B$ values dating back to the Antarctic Cold Reversal. Our corals appear to be internally homogenous and modern samples have only slightly elevated $\delta^{11}B$ compared to that of ambient intermediate water borate ion. We find that modern and early Holocene coral display fairly constant $\delta^{11}B$ compositions, whilst deglacial coral $\delta^{11}B$ are slightly elevated. This suggesty that the deglacial evolution of the deep Southern Ocean carbonate system is more complicated than a simple degassing and carbonate compensation model may indicate.

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The emergence of metabolism: Prebiotic simulations of shallow sea hydrothermal vents

MARCELO I. GUZMAN

Department of Chemistry, University of Kentucky, Lexington, KY 40506, USA (marcelo.guzman@uky.edu)

The origin of metabolism has been one of the most challenging and intriguing issues in the origin of life research. All known carbon fixation pathways used by living organisms, including the reductive tricarboxylic acid cycle, share at least one common intermediate [1]. The implications are that 1) all carbon fixation mechanisms are linked, and 2) a prebiotic mechanism of carbon fixation should have used some of the key organic compounds that participate in central anabolism today. The prebiotic system should have implemented the core reactions involved in central metabolism abiotically and nonezymatically [2]. The model is based on sulfur-containing semiconductor minerals, *in situ* produced in a shallow sea hydrothermal vent [3]. The advantage of the model is to use free energy from sunlight photons to drive otherwise unviable reactions in the absence of enzymes using photocatalysts.

Current work examines the origin of metabolism in a simulated prebiotic shallow water hydrothermal vent. Zinc sulfide (ZnS, sphalerite) was used as a candidate mineral to jumpstart the origin of metabolism in chemoautotrophs. Photochemical reactions of simple organic compounds with carbon dioxide occur at the semiconductor interface. The experimental results show the production of C2, C3, C4, C5, and C6, intermediates of central metabolism [4]. Starting from CO_2, and by consecutive reactions, we observed formate, acetate, oxalate, glyoxylate, glycolate, lactate, pyruvate, succinate, α-ketoglutarate, and isocitrate. The mechanism provides a way to capture energy from the environment while producing carbon feedstock useful in anabolism. The results of this study suggest that central metabolites could have participated in a viable enzyme-free cycle for carbon fixation in a shallow sea hydrothermal vent, where light, sulfide minerals, carbon dioxide, and other organic compounds interacted on the prebiotic Earth to generate an autonomous chemical cycle [5].

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