Evaluating sedimentary chlorins as a proxy for primary productivity and nutrient utilization

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Elucidation of the role of the marine carbon cycle in the glacial-interglacial cycles of CO2 is vital to our understanding of the key feedbacks operating in the present-day Earth system. Since 1997, global chlorophyll-a concentration on the ocean surface has been measured by satellite and used to estimate primary productivity, which is the driving factor in the marine carbon cycle. Many efforts have been made to estimate primary productivity in the past, but the different proxy availables only provide partial insights on past ocean carbon fluxes. One of the most informative approaches relies on the estimation of surface ocean nitrogen utilization using nitogen isotopes, but it is constrained by diagenetic processes.

In this study we evaluate the use of sedimentary chlorins, diagenetic derivatives of chlorophyll, as a proxy for both primary productivity and nutrient utlization. This chlorin proxy is directly produced by primary producers, as chlorophyll is the primary compound used in photosynthesis. Moreover, as chlorins have 4 nitrogen atoms, they can provide information on nitrogen utilization by measuring d15N in sedimentary chlorins. Hence, we can obtain complementary information on carbon cycle processes at the ocean surface from the same proxy, which simplifies the interpretation of palaeorecords.

To validate, calibrate and constrain the chlorin approach we have compiled a suite of surface marine sediments, and the pigment concentrations and d15N data are compared to satellite (Seawifs), field and Earth system models data on primary productivity and nitrate d15N. The correlation between these sediment and modern data indicate that indeed primary productivity is the most important factor in determining sedimentary chlorin concentrations and in driving chlorin isotopic signatures.