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Phytoplankton productivity in the Bransfield strait recorded in isotopes of sedimentary chlorophyll-*a*

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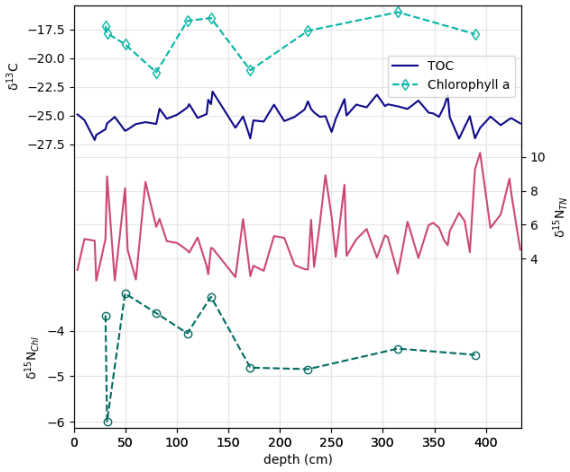

Southern Ocean is an ecologically active zone with massive phytoplankton blooms in spring and summer, supported by nutrient-rich waters supplied by deep-water upwelling. In the seasonal ice zone, where the sea-ice cover completely melts in summer, the relationship between sea-ice dynamics, nutrient availability, and phytoplankton blooms is still unclear. Recent studies showing that blooms initiate while sea-ice is still present challenge the view that sea-ice melting conditions the phytoplankton growth. Exploring the past variability of sea-ice development and phytoplanktonic activity may help understand the biogeochemical dynamics of the seasonally ice-covered ocean.

In this study, we aim to characterize primary productivity in the Antarctic peninsula region during the past 2000 years by analysing the chloropigments preserved in a sediment core collected in the Bransfield Strait (61.99°S, 55.09°W). We measured the concentration of chlorophyll-*a* and its main derivatives as well as their carbon and nitrogen isotopic compositions, which reflect the physiology and ecology of the phytoplankton and the surface water chemistry.

The $\delta^{13}C$ values of chlorophyll-*a* ($\delta^{13}C_{chla}$) fluctuate substantially throughout the core (from -21‰ to -16‰), and are correlated positively ($p_{value} < 0.05$) with chlorophyll-*a* concentrations. Rapid growth during phytoplankton bloom can primarily explain both the ^{13}C-enrichment in chlorophyll and a rapid sinking followed by deposition that resulted in enhanced preservation of organic matter. The $\delta^{15}N$ of chlorophyll-*a* ($\delta^{15}N_{chla}$) ranges from -6.0‰ to -3.2‰. The $\delta^{15}N$ values of the primary producers, mainly diatoms throughout the core, are estimated to range from -1.2‰ to 1.6‰, based on an empirical relationship between $\delta^{15}N$ of bulk cell and chlorophyll for eukaryotic phytoplankton ($\delta^{15}N_{cell} = \delta^{15}N_{chla} + 4.8‰$; Ohkouchi et al., 2006). The $\delta^{15}N$ range of phytoplankton indicates partial consumption of surface water nitrate, as similarly observed in modern Southern Ocean. The +1‰ increase in $\delta^{15}N$ in the second half of the last millennium may indicate enhanced nitrate consumption without reaching complete depletion, because of higher productivity and/or reduced nitrate pool due to stronger stratification from sea-ice meltwater. These results constitute the first chlorophyll-specific isotopic analysis in a paleoclimate record, providing unprecedented insights on the past primary productivity of the Southern Ocean.