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Probing the use of coccolith vital effects as a proxy for past CO_2 concentrations – Insights from Termination II in the Northern Atlantic Ocean

CAMILLE GODBILLOT[1], MICHAËL HERMOSO[2] AND FABRICE MINOLETTI[1]

[1]Sorbonne Université

[2]Université du Littoral Côte d'Opale

Presenting Author: camille.godbillot@sorbonne-universite.fr

For geological periods where direct measurements of pCO_2 performed on ice cores are not possible, the reconstruction of this key paleoclimatic parameter can only be done through the study of proxies. Calcite biominerals, produced for example by foraminifera, have been key in determining past sea surface temperatures and pH (using $\delta^{18}O$ and $\delta^{11}B$, respectively). Coccoliths, despite being ubiquitous in marine carbonate sediments, have remained under-exploited in paleo-environmental studies. This is due in particular to their minute size, which makes them difficult to isolate from the rest of the sediment. Results from culture studies of their producers, the coccolithophores, have shown that coccolith isotopy is sensitive to variations in the ambient CO_2 concentrations, which these algae rely on to sustain their metabolic activity. These results, and those from numerical modeling methods, have opened the way for the use of this archive in paleoclimate reconstructions. Here, we make use of a micro-separating protocol to attempt a calibration of the isotopic response of a natural assemblage of coccoliths from marine sediments to changes in surface ocean CO_2 during the Quaternary.

The calibration, first step of this study, relies on the carbon and oxygen isotopic analyses of purified fractions of coccoliths from the North Atlantic core MD95-2037 across Termination II (*ca.*140-130 ka). Using the alkenone-based SST record available at the site and atmospheric CO_2 concentrations from the Vostok core, we derive values for surface ocean CO_2 concentrations across the deglaciation. We study the response of coccolith isotopy to this established CO_2 forcing and derive a transfer function between the two parameters. We compare this calibration, obtained from the natural environment, to those stemming from culture studies. As a second step of this study, we discuss the possible application of this calibration to more ancient periods, where direct measurements of pCO_2 are not available.