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Probing the record of seawater carbonate chemistry in coccolithophore calcite

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Previous works on the biogeochemistry of the ubiquist coccolithophore Calcidiscus leptoporus quantified an oxygen isotope fractionation of about -2.2 ‰ with respect to equilibrium. New cultures experiments and core top study of this taxon enable the calibration of the temperature dependance recorded in δ18O of this coccolith providing a new tool to decipher surfaces water temperatures through the Cenozoic. These findings, concordant in the two approaches show a reduced range of vital effect (-1.1 ‰).
Other cultured and isolated species (Gephyrocapsa oceanica, Emiliania huxleyi and C.pelagicus) show similar patterns that raise the question of a possible overestimation of isotopic disequilibria in coccolith calcite.
A promising research topic in palaeoceanography consists of exploiting interspecific isotopic fractionation because species respond differently to ambient changes in carbonate system chemistry. While E.huxleyi or G.oceanica are isotopically sensitive to changes in dissolved inorganic carbon speciation or concentration, others such as C.leptoporus remains almost unaffected. This may indicate that in addition to traditional δ18O temperature proxy, coccolith interspecific isotopic offsets can provide an innovative means to constrain the carbonate chemistry of the mixed-layer.
We investigated this hypothesis with a study case of the last Pleistocene deglaciation that appears to be a good candidate by his abrupt changes in temperatures, oxygen isotope composition of seawater and atmospheric pCO_2. While numerous studies have investigated climate changes at high latitudes, we present here the first coccoliths-based isotopic record of mixed-layer temperature at the border of North Atlantic Subtropical Gyre (southwards of the polar front). From Site DSDP 607 we successfully isolated fractions of coccolithophore species C.leptoporus, G.oceanica, E. huxleyi and C.pelagicus over the last 17 kyr. Oxygen isotope variations from these fractions exhibit a shift of about -1.9 ‰ between the Younger Dryas and the Early Holocene SSTs that can be translated into a warming of about 7-8 °C. This result closely matches with previously reported temperatures derived from foraminiferal and alkenone records and confirms that coccoliths can be used as a complementary or alternative substrate to foraminiferal shells for isotopic analyses and paleoclimate reconstructions. Differential oxygen and carbon isotopic offsets between Calcidiscus spp. and small Noelaerhabdacea coccoliths are almost constant and present an overall agreement with culture predictions. Although further results are needed this may imply that an increase of about 80 ppm pCO_2 as recorded in Antarctica ice sheet over this time period is not sufficient to effect variations in calcification and intensity of fractionation in these two common species.