Abstract

Human activities largely impact on the climate due to the massive release of CO_2 into the atmosphere. The consequences of such climate upheavals for ocean organisms and the carbon cycle are still poorly understood. Similar warming events, known as hyperthermals, have already occurred during the early Paleogene (66-23 Ma), which can be considered as ancient analogues of modern climate change and can provide essential insights into the biogeochemical consequences of anthropogenic CO_2 emissions.

The main objective of my thesis was to better identify and quantify the response of calcareous nannoplankton to environmental upheavals occurring during the Paleocene-Eocene transition, as well as to better understand the biogeochemical feedbacks exerted by nannoplankton on carbon cycle dynamics. To meet these objectives, I reconstructed and compared high-resolution calcareous nannofossil fluxes and carbonate microfossil fragmentation, which represents an indirect estimate of seafloor calcium carbonate saturation, across an interval lasting ~4 Ma (57.5-53.5 Ma) recorded in sediments cored at ODP Site 1209, Shatsky Rise (North Pacific Ocean), and spanning at least 10 hyperthermal events.

The comparison between calcareous nannofossil fluxes and proxies of seafloor calcium carbonate saturation revealed a partial coupling between these two parameters, and only at the onset of some hyperthermal events. This observation calls into question our standard view of such events, which places deep-sea chemistry as the sole factor controlling calcium carbonate accumulation at the seafloor. On the contrary, the results obtained here indicate a strong inverse coupling between variations in calcareous nannofossil fluxes and the temperature of intermediate waters during hyperthermals. The analysis of multiple micropaleontological and geochemical proxies suggests that this coupling can be explained by the influence of temperature on the surface productivity and by the strong thermo-dependence of microbial remineralization of organic matter in the mesopelagic zone, which in turn has modulated the intensity of supralysoclinal dissolution and the transfer efficiency of inorganic and organic carbon to the seafloor.

These results therefore suggest that estimating the CO_2 exchanges during hyperthermal events based on $CaCO_3$ records requires a careful consideration of changes in surface productivity, organic matter remineralization and supralysoclinal carbonate dissolution in the mesopelagic zone. It is also crucial to consider these temperature-dependent parameters over longer time periods recording significant warming and cooling in order to appreciate their effect on oceanic carbon burial.

Considering the ongoing hyperthermal we are facing, a major weakening of the carbon pump is very likely to occur in the near future, decreasing the capacity of the oceans to absorb atmospheric CO_2.

Keywords: Carbon cycle, Paleocene-Eocene, hyperthermals, calcareous nannofossils.