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Calcareous nannofossil paleofluxes as proxy for pCO_2 during the Aptian

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The Aptian (∼121 to ∼113 Ma) has been characterized by super-greenhouse climate and profound environmental perturbations, including the early Aptian Oceanic Anoxic Event (OAE 1) a, an episode of widespread organic matter burial in oxygen-depleted oceans. The OAE 1a is thought to be related to the emplacement of the Ontong Java Plateau which probably introduced in the atmosphere a large amount of CO_2 with consequent impact on biota, climate and ocean chemistry. The major perturbation of the carbon cycle is mirrored by the carbon isotopic record which shows a negative shift at the beginning of OAE 1a followed by a positive excursion which persisted also after the event.
The aim of this study is to reconstruct variations in biogenic carbonate production of calcareous nannofossils through the Aptian in order to detect if and how it has been affected by high pCO_2. Calcareous nannoplankton is an excellent proxy for reconstructing present and paste surface water conditions, being extremely sensitive to changes in physical and chemical conditions of the oceans (pH). Calcareous nannoplankton act both as biological and carbonate pump, thus changes in nannoplankton assemblages affect the organic and inorganic carbon cycles. This makes coccolithophores key-organisms for understanding the biological pump and adsorption of atmospheric CO_2 into the oceans. Experiments on living coccolithophores indicates that coccolith type, abundance and degree of mineralization depend on chemical-physical-trophic conditions as well as on pCO_2. Production of dwarf/malformed coccoliths has been documented in the geological record through OAE 1a.
Here we present quantitative analyses of nannofossil micrite in thin sections, reconstructing nannofossil absolute abundances and calcite paleofluxes in three drill sites: the Cismon core (Northern Italy), Piobbico core (Central Italy) and DSDP Site 463 in the mid-Pacific Mountains. In these sites, nannofossil absolute abundances and paleofluxes show a progressive drastic reduction starting in the latest Barremian related to a decrease in the rock-forming nannoconids, “nannoconid decline”, that culminates with the “nannoconid crisis” just prior to OAE 1a. At the end of OAE 1a, nannofossil biocalcification increases again, but it never reaches pre-anoxia values. In the late Aptian, nannofossil paleofluxes reach high values during the Nannoconus truittii acme, followed by a final decrease through the Aptian/Albian boundary interval.
Calcite paleofluxes fluctuations reveal a drastic reduction in nannoplankton calcification interpreted as the adaptive response of these organisms to perturbed surface-water conditions that favoured small and less calcified forms and caused false extinction among heavily calcified nannoconids (Lazarus effect). We conclude that, despite metabolic processes, CO_2 concentrations influence the ocean chemistry and the carbonate system. In particular, the correlation between reduced biocalcification rates and intervals of intense volcanism, suggest that mid-Cretaceous nannoplankton biocalcification and nannofossil paleofluxes were strongly controlled by excess volcanogenic CO_2.