Geophysical Research Abstracts
Vol. 18, EGU2016-6741, 2016
EGU General Assembly 2016

Paleoclimate and paleoecology of the mid Cretaceous traced by calcareous nannofossils

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The Aptian – early Turonian time interval was marked by major environmental changes at regional to global scale. Specifically, it was a time of super-greenhouse conditions and the climate–ocean system experienced phases of stability perturbed by transient, sometimes prolonged, anomalies of the global carbon cycle. Several regional to global episodes occurred over this time interval: the early Aptian Oceanic Anoxic Event (OAE) 1a, the early Albian OAE 1b, the latest Albian OAE 1d, the Mid-Cenomanian Event (MCE I) and the Cenomanian – Turonian OAE 2. Decades of multidisciplinary research focused on OAEs since they constitute ideal case-histories for the understanding of our planet functioning during perturbations of the C cycle. They were, in fact, characterized by excess CO_2, intense volcanism, and altered climate and oceanic chemistry. A useful tool for reconstructing the marine ecosystem dynamics of the past, is calcareous nannoplankton, since it is extremely sensitive to changes in surface waters parameters like temperature and nutrient content and interacts with the C cycle through biological processes and production of calcareous oozes.
Here, we gathered new quantitative nannofossil data for the Tethys Ocean (Umbria Marche Basin, Italy) to derive climatic fluctuations and changes in ocean fertility during the late Albian – early Turonian. Over this time interval, the Tethys Ocean was characterized by phases of rhythmic black shale deposition controlled by orbital forcing. The Pialli Level is the Tethyan sedimentary expression of the latest Albian OAE 1d, characterized by large-scale occurrence of black shales and a δ13C positive excursion recognized in several deep-marine settings. The other prominent δ13C anomaly coincides with the OAE 2 represented, in Italy, by the Bonarelli Level. Between these two main C-isotopic excursions, a double-spiked minor anomaly identifies the MCE I, lithologically represented by a shift to black shales and black chert bands alternating with whitish limestones.
The new dataset has been integrated with the nannofossil data previously collected for the Aptian – early Albian time interval to provide a compilation of temperature and surface water variations on the long-term throughout the Aptian – early Turonian interval. The nannofossil Temperature and Nutrient Indices outline warm conditions for the OAE 1a which was followed by a cooling trend culminating soon after the N. truittii acme interval. Progressively increasing temperature characterized instead the latest phases of the Aptian and warmer conditions were reached in the Albian – Cenomanian, although interrupted by relatively cooler phases, as for example in correspondence of the MCE. Highest nannofossil-derived paleotemperatures were reached across OAE 2. Surface water fertility resulted instead to be relatively high during most of the early-middle Aptian, exception made for the N. truittii acme interval when a significant decrease occurred. The latest Aptian – early Albian interval was marked by intermediate trophism in surface waters, with intervals of higher fertility during black shales deposition. During the interval comprised between the OAE 1b and the OAE 1d, fertility was relatively high while it decreased in the Cenomanian. A distinct fertility pulse was detected prior to OAE 2.