Geophysical Research Abstracts
Vol. 19, EGU2017-3731, 2017
EGU General Assembly 2017

Mid-Cenomanian Event I (MCE I, 96 Ma): elemental and osmium isotope evidence for sea level, climate, and palaeocirculation changes in the NW European epicontinental sea

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Cenomanian times (100.5–93.9 Ma) represent perhaps the best documented episode of eustatic rise in sea level in Earth history and the beginning of the Late Mesozoic thermal maximum, driving global expansion of epicontinental seas and the onset of widespread pelagic and hemipelagic carbonate (chalk) deposition. Significant changes occurred in global stable-isotope records, including two prominent perturbations of the carbon cycle – Mid-Cenomanian Event I (MCEI; ∼96.5–96.2 Ma) and Oceanic Anoxic Event 2 (OAE2; ∼94.5–93.8 Ma).

OAE2 was marked by the widespread deposition of black shales in the deep ocean and epicontinental seas, and a global positive carbon stable-isotope excursion of 2.0 – 2.5‰ δ13C in marine carbonates. Osmium isotopes and other geochemical data indicate that OAE2 was associated with a major pulse of LIP-associated volcanism, with coincident changes in eustatic sea level, rising atmospheric pCO_2 and warming climate, but including a transient phase of global cooling – the Plenus Cold Event.

MCEI, by contrast, shows a <1‰ δ13Ccarb excursion, and has no associated black shales in most areas, yet it also displays evidence of two episodes of cooling, comparable to the Plenus Cold Event. MCEI marks a major breakpoint on long-term carbon-isotope profiles, from relatively constant to very slowly rising δ13C values through the Lower Cenomanian, to a trend of generally increasing δ13C values through the Middle and Upper Cenomanian. This represents a significant long-term change in the global carbon cycle starting with MCEI.

Here, we present new high-resolution major- (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K, P) and trace-element (Ba, Cr, Re, Os, Sr, Zr) data and 187Os/188Os isotope results for MCEI from an English Chalk reference section at Folkestone. Our results are compared to published δ13Ccarb, δ18Ocarb, δ13Corg stable isotope and neodymium isotope εNd(t) data from the same section. Elemental proxies (Mn, Ti/Al, Zr/Al, Si/Al) define key sequence stratigraphic surfaces, providing a basis for refining relative sea-level curves. Cyclical small-scale transgressive events within the mid-Cenomanian TST of depositional sequence Ce IV are accompanied by coupled increases in εNd(t) and decreases in 187Os/188Os ratios. Osi ratios of 0.8 – 0.9 prior to MCEI, peak at 1.2 in the lower peak of the isotope excursion, coincident an influx of boreal fauna and the lowest εNd(t) values in the section (<-10), and show a stepped fall thereafter. Highly unradiogenic Osi values of $\leq$ 0.2 occur immediately above MCEI, in an interval of high εNd(t).

These geochemical data are interpreted to represent cyclical changes in water mass sources and distribution in the Chalk sea, driven by sea-level and climate change. The remarkably low Osi values recorded following MCEI indicate a dominance of hydrothermal/mantle-like sourced Os in southern England waters at that time.