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What controlled black shale sedimentation in the Coniacian-Santonian western tropical Atlantic? – Indicators for land-ocean interaction on Milankovitch time-scales during the Oceanic Anoxic Event 3

B. Beckmann (1), S. Schouten (2), J. S. Sinninghe Damsté (2), T. Wagner (3), P. Hofmann (1)

1. University of Cologne, Institute for Geology and Mineralogy, Zülpicher Str. 49a, 50674 Köln, Germany (bbeckman@uni-koeln.de)
2. Dept. of Marine Biogeochemistry and Toxicology, Royal NIOZ, PO Box 59, 1790 AB Den Burg, Texel, The Netherlands
3. School of Civil Engineering and Geosciences, University of Newcastle, Newcastle upon Tyne, NE1 7RU, United Kingdom

Oceanic Anoxic Events (OAEs), relatively short periods of enhanced formation of organic carbon-rich sediments, i.e. marine black shales, have played a fundamental role in rapid global change and late Mesozoic climate evolution. Nevertheless, underlying causes and effects of these events, especially regarding the influence of orbital forcing on the Cretaceous atmosphere-continent-ocean system, are still poorly constrained.

This study develops an orbital-scale reference profile for the Coniacian-Santonian Oceanic Anoxic Event 3 (OAE 3) at ODP Site 1261, drilled on Demerara Rise off Suriname. Terrigenous and marine proxy records including TEX_{86}-based sea surface temperatures, pyrolytic, and XRF data are used to investigate the organic matter-rich sediments from the western tropical Atlantic. Using these records we reconstruct the evolution of black shale formation in response to continental climate and run-off, marine productivity, and the development of oceanic anoxia/euxinia.

The Coniacian - Santonian interval at Site 1261 consists of finely laminated calcareous black shales (approx. 2-15% TOC), the organic matter is of mainly marine origin. The nannofossil-rich marls contain between 90% and 10% carbonate and display a

distinct cyclic pattern interrupted by some carbonate turbidites. Cycle analysis, after identification and removal of the turbidites, on the bulk carbonate content indicates a signal with dominant eccentricity frequency. Further supporting this data, several geochemical proxies, e.g. for redox-intensity and weathering-intensity reveal the same cyclic pattern. Variations in weathering intensity on the South American continent point towards fluctuations between more arid and more humid intervals during the upper Cretaceous. This observation is supported by climate modelling results for the equatorial regions of South America and western Africa, which show a pronounced seasonal cycle with a wet and a dry season (Beckmann et al., 2005).

The occurrence of highly branched isoprenoids (HBI) as diagnostic markers of siliceous plankton productivity in several samples from the investigated interval, suggest high nutrient levels in the contemporaneous ocean. Unexpected for these OC-rich sediments, few samples contain low quantities of isorenieratene derivates indicative of photic zone euxinia. This might indicate a more or less permanent oxic upper water column. Records of redox-sensitive trace-metals (Zn, Ni, Mo) however support that the sediment water interface was mainly anoxic during deposition.

Reference:

Beckmann et al. (2005) Orbital forcing of Cretaceous river discharge in tropical Africa and ocean response. Nature, v. 437, p. 241-244.