Geophysical Research Abstracts
Vol. 16, EGU2014-3797, 2014
EGU General Assembly 2014

Integrated stratigraphy of the Cenomanian-Turonian boundary interval: improving understanding of Oceanic Anoxic Events

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The Cenomanian-Turonian boundary (CTB) interval ∼ 94 Ma represented a period of major global palaeoenvironmental change. Increasingly detailed multidisciplinary studies integrating sedimentological, palaeontological and geochemical data from multiple basins, are enabling the development of refined but complex models that aid understanding of the mechanisms driving changes in ocean productivity and climate. This paper reviews some of the exciting new developments in this field.
Facies change characterizes the CTB interval in most areas. In the Chalk seas of northern Europe, a widespead hiatus was followed by the deposition of clay-rich organic-lean beds of the Plenus Marl and its equivalents, and then nodular chalks. In the North Sea basin and its onshore extension in eastern England and northern Germany, black shales of the Black Band (Blodøks Formation, Hasseltal Formation) occur. Similarly, in northern Tethys, a brief interval of black shale accumulation within a predominantly carbonate succession, is exemplified by the Niveau Thomel in the Vocontian Basin (SE France), and the Livello Bonarelli in Italy.
Widespread deposition of organic-rich marine sediments during CTB times led to 12C depletion in surface carbon reservoirs (oceans, atmosphere, biosphere), and a large positive global δ13C excursion preserved in marine carbonates and both marine and terrestrial organic matter (Oceanic Anoxic Event 2). Significant biotic turnover characterises the boundary interval, and inter-regional correlation may be achieved at high resolution using integrated biostratigraphy employing macrofossils (ammonites, inoceramid bivalves), microfossils (planktonic foraminifera, dinoflagellate cysts) and calcareous nannofossils. Correlations can be tested against those based on comparison of δ13C profiles – carbon isotope chemostratigraphy, supplemented by oxygen isotope and elemental data.
Interpretation of paired carbonate – organic matter δ13C data from multiple CTB sections implicates rising atmospheric pCO_2 linked to volcanic outgassing as a major forcing mechanism for palaeoclimate warming and palaeoceanographic change accompanying OAE2. New marine 187Os/188Os isotope stratigraphy further reveals the interaction of volcanism and ocean circulation during OAE2, and provides a further chemostratigraphic tool. Li isotope (δ 7Li) data may be interpreted as evidence that increased silicate weathering promoted by rising pCO_2 acted as both a forcing and negative feedback mechanism driving OAE2 history. Neodymium and sulphur isotopes offer further insights into interactions between global biogeochemical cycles and ocean circulation changes.