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Carbon-isotope stratigraphy: key to Tethys – Boreal and marine – terrestrial correlation and palaeoenvironmental reconstruction?

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Carbon stable-isotope profiles through the Cenomanian – Campanian stages of the Upper Cretaceous, obtained from the analysis of bulk pelagic sediments (chalks), or marine or terrestrial organic matter, show consistent stratigraphic trends that provide a basis for high-resolution global correlation. Recently, an international δ^{13}C reference curve for this interval has been published by Jarvis *et al.* (2006), based on a composite constructed using multiple sections through the English Chalk. Key markers are provided by positive δ^{13}C excursions of up to + 2‰: the Albian/Cenomanian Boundary Event; Mid-Cenomanian Event I; the Cenomanian/Turonian Boundary Event; the Bridgewick, Hitch Wood and Navigation events of Late Turonian age; and the Santonian/Campanian Boundary Event. More than 80 lesser isotope events offer additional tie points for international correlation. Correlation with pelagic sections at Gubbio, central Italy, demonstrates general agreement between biostratigraphic and chemostratigraphic criteria in the Cenomanian–Turonian stages, confirming established relationships between Tethyan planktonic foraminiferal and Boreal macrofossil biozonations. However, correlation of the Coniacian–Campanian stages is less clear cut: magnetostratigraphic evidence for placing the base of Chron 33r near the base of the Upper Santonian is in good agreement with the carbon-isotope correlation, but generates significant anomalies regarding the placement of the Santonian and Campanian stage boundaries with respect to Tethyan planktonic foraminiferal and nannofossil zones. Correlation of the UK reference curve with data from Campanian – Maastrichtian chalk successions onshore and offshore Tunisia confirms the consistency of δ^{13}C trends in the higher Cretaceous. Overall, isotope stratigraphy offers a

more reliable criterion for detailed correlation of Cenomanian–Campanian strata than biostratigraphy.

The Cenomanian–Campanian carbon-isotope curve is remarkably similar in shape to supposedly eustatic sea-level curves: increasing δ^{13}C values accompanying sea-level rise associated with transgression, and falling δ^{13}C values characterizing sea-level fall and regression. The correlation between carbon isotopes and sea-level is explained by variations in epicontinental sea area affecting organic-matter burial fluxes: increasing shallow sea-floor area and increased accommodation space accompanying sea-level rise allowed more efficient burial of marine organic matter, with the preferential removal of ^{12}C from the marine carbon reservoir. During sea-level fall, reduced seafloor area, marine erosion of previously deposited sediments, and exposure of basin margins led to reduced organic carbon burial fluxes and oxidation of previously deposited organic matter, causing falling δ^{13}C values. Additionally, drowning of carbonate platforms during periods of rapid sea-level rise may have reduced the global inorganic relative to the organic carbon flux, further enhancing δ^{13}C values, while renewed platform growth during late transgressions and highstands prompted increased carbonate deposition. Variations in nutrient supply, changing rates of oceanic turnover, and the sequestration or liberation of methane from gas hydrates may also have played a role in controlling carbon-isotope ratios.

Jarvis, I., Gale, A.S., Jenkyns, H.C. & Pearce, M.A., 2006. Secular variation in Late Cretaceous carbon isotopes: a new δ^{13}C carbonate reference curve for the Cenomanian – Campanian (99.6 – 70.6 Ma). *Geological Magazine*, **143**: 561-608.