



Re-Evaluating the Stratigraphic Completeness of the Bonarelli Level (OAE 2) in the Umbria–Marche Basin (Central Italy) Using High-Resolution Organic-Carbon Isotopes

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Abstract Oceanic Anoxic Event 2 (OAE 2; ~94 Ma) is globally recorded by a pronounced perturbation in the carbon cycle, although its stratigraphic expression varies considerably among depositional settings. In the Umbria–Marche Basin (central Italy), OAE 2 is represented by the Bonarelli Level, a carbonate-poor interval that limits the application of carbonate-based isotopic proxies and calcareous microfossil biostratigraphy. As a result, the duration and completeness of this unit remain debated.

We present a new high-resolution organic-carbon isotope ($\delta^{13}\text{C}_{\text{org}}$) dataset from two Bonarelli Level successions and evaluate these records through comparison with well-dated OAE 2 sections from other basins. The observed isotopic trends suggest that the characteristic OAE 2 carbon-isotope excursion is recorded in its entirety within the Bonarelli Level, despite stratigraphic condensation. This finding contrasts with earlier interpretations invoking a substantial stratigraphic gap near the top of the unit.

Variations in total organic carbon (TOC) and lithofacies are synchronous across the basin, pointing to a basin-wide depositional response. These results support a revised palaeoceanographic model in which the Tethyan Umbria–Marche Basin during OAE 2 was dominated by anoxic to euxinic conditions, promoting enhanced preservation of marine organic matter and episodic reworking of biogenic silica in the form of radiolarian tests.

Key words OAE2, Cenomanian/Turonian boundary, chemostratigraphy, Western Tethys, basin-scale correlation