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Palaeoceanographic model for the Early Toarcian black shales in the Maglio section (Southern Alps, Italy): palynological, calcareous nannofossil and stable-isotope analyses

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The early Toarcian Oceanic Anoxic Event (T-OAE, ∼183 Ma, Early Jurassic) represents a period of widespread to global deposition of organic-rich sediments in a variety of marine settings. It is one of the most dramatic palaeoceanographic episodes in Earth history leading to (extremely) high rates of organic-carbon burial and a general decrease in calcium carbonate deposition. The T-OAE is associated with large global carbon-isotope anomalies in carbonate and/or organic matter, caused by a major perturbation of the global carbon cycle. An overall positive carbon-isotope excursion (dated as *tenuicostatum* to *falciferum* ammonite zones) is over-printed by a short-lived negative isotopic shift (*exaratum* ammonite sub-zone) in marine and terrestrial reservoirs. The negative anomaly has been interpreted to indicate raised atmospheric CO_2 caused by oxidation of isotopically light methane released either from marine gas hydrates or magma-intruded coal-bearing strata.

Although the chemical changes that occurred in the ocean/atmosphere system during the T-OAE are well described, the adaptation of planktonic communities remains to be fully understood, particularly in the low-latitude Tethyan region, where carbonate-free, stratigraphically condensed and incomplete successions are common. This study is focused on a stratigraphically expanded, complete and clay-rich pelagic section (Maglio) located in the Southern Alps (Northern Italy). Biostratigraphic investiga-

tions and quantitative analysis based on palynomorphs and calcareous nannofossils were undertaken, using the relative abundance of single species for palaeoecological and palaeoceanographic reconstructions. Carbon- and oxygen-isotope stratigraphy on the same samples has aided correlation with other well-characterized coeval sections. These isotope curves show relatively low δ^{13}C and δ^{18}O values, typical of the negative excursion characteristic of the interval, as well as some anomalously negative 'spikes' attributed to diagenesis.

Based on the obtained dataset, a palaeoceanographic model, characterized by three distinctive phases, is proposed. In this model, the black shales deposited during the T-OAE are assumed to have been deposited under warm and humid conditions, with relatively high wind speeds, precipitation rates and continental runoff, related to an accelerated hydrological cycle (increase of sporomophs and meso-eutrophic calcareous nannofossils - Phases 1–3). This palaeoenvironmental change could not only have forced an increase in organic productivity due to accelerated nutrient flux to the oceans but also accentuated thermohaline stratification, further aiding development of anoxic conditions in the bottom waters: both factors (enhanced productivity, enhanced preservation) would have favoured accumulation of organic matter. In this model, a dinoflagellate cyst event ("*Luehndea* spike" - Phase 2) indicates a relative drop in temperature and/or rise in surface-water salinity with respect to the other phases.