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High-resolution geochemical records of the Early Toarcian anoxic event in the Valborbia section, Umbria–Marche Apennines, Italy

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During the Jurassic period, the Early Toarcian oceanic anoxic event (T-OAE) coincided with a major climatic and biological perturbation. This event is characterized by exceptionally high rates of global organic-carbon burial, high palaeotemperatures and significant mass extinction and its sedimentary record indicates dysaerobic/anoxic/euxinic conditions in the lower and upper water column. Various mechanisms have been invoked to explain the global distribution of organic matter-rich sediment and the associated perturbation of the carbon cycle, as indicated by both positive and negative δ^{13}C excursions.

The aim of this study is to document changes in palaeoproductivity and redox conditions in response to the T-OAE in the Valdorbia Section (Umbria–Marche basin) where Jurassic pelagic sediments are well exposed. This succession contains black shales dated to the *tenuicostatum* Tethyan ammonite Zone. Abrupt negative excursions of 5–6‰ in the $\delta^{13}C_{org}$ record and of 2–3‰ in the $\delta^{13}C_{carb}$ profile are characteristic of the black-shale section. Given that similar patterns have been recorded elsewhere, these negative excursions indicate a significant perturbation to the global carbon cycle during this period, interpreted as due to an influx of isotopically light methane. Oxidation of methane to CO_2 may have suppressed deposition of skeletal calcite and led to the Toarcian 'carbonate crisis'. Inorganic geochemical proxies such as Fe-S relationships, degree of pyritization (0.20>DOP>0.65), heavy-metal enrichment (Co>Pb>Cu>V>Ni>Mo>Cr>Zn), V/(V+Ni) $>$ 0.5, throughout the black

shale-interval suggest that dysoxic to anoxic conditions prevailed during its deposition, a conclusion in accord with organic geochemical evidence for the presence of free H_2S in the water column.