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A global picture of seawater redox change and organic carbon burial during the early Toarcian oceanic anoxic event

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The early Toarcian oceanic anoxic event (T-OAE, ~183 Ma) was a severe climate perturbation linked to the release of a large volume of ^{12}C-enriched carbon, most likely from volcanism and perhaps other surficial reservoirs. During this event organic-rich sedimentary rocks and evidence for seawater deoxygenation are recorded in many, though by no means all, basins worldwide. However, the precise mechanistic links between redox and organic matter deposition are unclear. Equally, the amount of organic carbon buried during this event (and the relative importance of this burial for removing excess carbon from the Toarcian atmosphere) is unconstrained. A new compilation of data from T-OAE sections worldwide allows the pattern of redox and organic enrichment to be reconstructed. Most of the sections yet studied are in Europe and comprise shallow marine facies deposited in epicontinental seas. We find that redox was a major control on organic enrichment and burial rates, but rates of organic carbon burial during the T-OAE were low relative to shallow margins at the present day. Importantly, we also find that the very high TOC (>5 weight%) observed in hydrographically restricted euxinic basins in northern Europe and elsewhere were largely a consequence of limited dilution by low clastic fluxes. A majority of sites around the world show an increase in TOC at the T-OAE relative to pre-event values, and TOC increases were highest in sections where seawater deoxygenation was most severe. In particular, we find that in anoxic-euxinic basins organic carbon burial rates may have increased by around 500% during the T-OAE. In contrast, sites that remained relatively well oxygenated or were dominated by terrestrial organic matter show only minor, and potentially negligible, increases in organic enrichment across the T-OAE. Quantitative analysis suggests that an extra ~10,000 Gt of carbon may have been buried in shallow seas during the T-OAE relative to the preceding time interval. Although this estimate is poorly constrained, it is likely that organic carbon burial played a key role in sequestering excess carbon released to the biosphere during the T-OAE.