Positive sulfate sulfur isotope excursion indicates large-scale pyrite burial and marine anoxia during the end–Triassic mass extinction

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The late Rhaetian–early Hettangian transition is characterised by the emplacement of Central Atlantic magmatic province and associated climatic effects, coincident with a severe biotic crisis (~201.5 Ma). The oxygen deficiency in the ocean realm is possibly linked to this significant loss in marine biodiversity. However, direct evidence of contemporaneous development of marine anoxia on a global scale has been lacking and the relationship between oxygen and extinction is unclear. Here we report carbonate-associated sulfate $\delta^{34}S$ data from three sections across the Late Triassic–Early Jurassic transition. We find synchronous large positive $\delta^{34}S$ shifts with a magnitude of >10‰ in the latest Rhaetian at all three locations. The duration of the shift is estimated to take as little as ~50 Kyrs. Biogeochemical modelling suggests that this positive S-isotope excursion reflects a global increase in pyrite burial by approximately five times, consistent with broadly correlative records for development of marine anoxia on the Panthalassa margin and NW European shelf. This shift in pyrite burial and inferred ocean deoxygenation also correlate with the major phase of the extinction. Our modelling results suggest that sulfate-poor conditions (<1 mM) are established prior to the pyrite burial event in the Late Triassic, which also characterizes many other oceanic anoxic events (OAEs) during the late Permian and the rest of the Mesozoic Era. Here we also propose a conceptual model that low sulfate conditions may have been a prerequisite to enhance net benthic methane release to the water column and places an increased burden on the bottom-water oxygen levels during these OAEs