Evidence for local carbon-cycle perturbations superimposed on Toarcian carbon isotope excursion

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Though a global negative carbon isotope excursion (CIE) is well-documented during the Toarcian oceanic anoxic event (T-OAE at ~183 Ma) [1], a growing body of evidence has proposed that local paleoenvironmental variability had the potential to disturb the preexisting (bio)geochemical evolutionary trajectories [2,3]. A previous lipid-biomarker study on a stratigraphic profile at Dotternhausen, SW-Germany, representing the semirestricted basin of the Toarcian European epeiric sea, reported an increased abundance of isorenieratene, which is exclusively produced by green sulfur bacteria [4]. However, whether or not the green sulfur bacteria disturbed the coeval marine carbon-cycle perturbations has not been constrained. This study, building on the preceding biomarker work, aims to address this gap using ultra high-resolution carbonate and organic $\delta^{13}C$ chemostratigraphies coupled with major- and trace element data.

An overall $\delta^{13}C_{carb}$-$\delta^{13}C_{org}$ decoupling interval, which can be partitioned into three smaller-scale decoupled $\delta^{13}C$ patterns, superimposes the climax of the Toarcian CIE. These $\delta^{13}C_{carb}$-$\delta^{13}C_{org}$ variations do not correlate with indicators for detrital content of the shales (i.e. aluminium or thorium concentrations) and thus exclude the possible influence on our carbon-isotope records from terrestrial organic sources. Interestingly, it is noted that this decoupling interval coincides well with the abrupt isorenieratene anomaly, indicating that anoxygenic photoautotrophic bacteria may play a key role in disturbing the coeval basinal marine carbon cycles, leading to the observed fluctuation in the $\delta^{13}C_{org}$ signatures. Within the disturbed $\delta^{13}C_{carb}$-$\delta^{13}C_{org}$ interval an authigenic carbonate bed (‘Unterer Stein’), which was formed by sulfate-driven anaerobic oxidation of methane (AOM) during early diagenesis, carries light $\delta^{13}C_{carb}$ signatures and thus reinforces the decoupled $\delta^{13}C$ signals.

[1] Röhl et al. (2001), *Palaeo*, 165, 27-52. [2] Fantasia et al. (2018), *Global and Planetary Change*, 162, 53-68. [3] Them II et al. (2019), *Earth and Planetary Science Letters*, 115(26), 6596-6601. [4] Schwark and Frimmel (2004), *Chemical Geology*, 206, 231-248.