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Carbon isotope stratigraphy across the Triassic-Jurassic boundary: Building a global stack, assessing its correlation utility, and understanding carbon cycle perturbations

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The Triassic-Jurassic boundary (TJB) immediately follows the end-Triassic extinction event, which is one of the five major Phanerozoic mass extinctions. Similarly to the other four events, the TJB is also marked by one or more prominent carbon isotope excursions (CIE). Since their first recognition in three independent studies in 2001-2002, a large amount of data has been assembled in the last 15 years which prove that CIEs are recorded in both terrestrial and marine boundary sections, marine strata of different depositional settings, and in both carbonate and organic matter. However, no systematic review of these data has been attempted to date, even though controversies persist in $\delta^{13}C$-based stratigraphic correlation, and the processes and causes of the underlying carbon cycle perturbations remain debated.

Here we address these issues using a compilation of a global $\delta^{13}C$ dataset from 67 published sections which span at least parts of the Rhaetian and Hettangian stages. Our underlying age model uses a modified version of GTS 2012 [1], with a notable update concerning the age of the Norian-Rhaetian boundary [2], leading to a shorter duration of the Rhaetian. Astrochronology is used to provide additional estimates of durations of chronostratigraphic units [3]. Correlation of the sections is achieved through an integrated web of independent ammonoid, conodont, radiolarian, foraminiferan and palynological biostratigraphies and magnetostratigraphy.

A synoptic view of the global $\delta^{13}C$ stack allows a critical assessment of the reproducibility and global or regional significance of previously identified CIEs, including a Rhaetian precursor CIE, the latest Rhaetian initial negative CIE, the main negative CIE at the TJB, and one or more positive CIEs in the Hettangian. Clearly, not all of the above CIEs are recorded uniformly in different substrates, environmental settings or paleogeographic regions, warranting caution in the use of $\delta^{13}C$ in chemostratigraphic correlation.

We tested the regional validity of $\delta^{13}C$-based correlation and the potential in use of the global stack on newly obtained $\delta^{13}C_{carb}$ data from three localities in the Transdanubian Range (Hungary). All three sections record the termination of carbonate platform growth at the TJB and truncation of the Dachstein Limestone Formation, which is paraconformably overlain by lowermost Jurassic carbonates of varying facies. Excellent correlation is demonstrated among the three $\delta^{13}C$ curves, but sizing up the regional TJB gap is compromised by ambiguities of correlation with the global stack.

Overall, the new global compilation will contribute to a better understanding of the processes and causes of carbon cycle perturbations across the TJB. Features of the global stack are compared with the

predicted effects of previously proposed mechanisms of volcanogenic CO_2 degassing, methane release from gas hydrate dissociation, reduction of primary productivity, changes in shallow marine carbonate production, changes in the burial rate of organic carbon and other scenarios.

References:

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