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Long-term oceanic stability and orbital control on carbon cycle prior to the Late Triassic mass-extinction

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We established a new high-resolution carbonate isotope record from the lower Carnian to the late Rhaetian in the Northern Calcareous Alps of Austria. The new curve has an excellent biostratigraphic control based on ammonoids and conodonts. Among the six sampled sections was the proposed GSSP section (Steinbergkogel) for the Norian-Rhaetian Boundary. The Carnian has been sampled from intraplatform carbonate, whereas the middle Norian to lower Rhaetian curve is established from a sequence of different Hallstatt-type limestones. These consist of fine-grained bioclastic wackestone deposited from periplatform ooze. Hallstatt limestone deposition was ended by the Rhaetian terrigenous event of the Zlambach Formation. Its toe-of-slope to basin environment of alternating marls and subordinate micritic limestone is episodically overlain by allodapic carbonate sedimentation.

The initial Upper Triassic curve displays a gentle increase with three negative excursions of 2 to 3 per mille amplitude during the early Carnian. The two first excursions rebound to previous values, whereas the third negative excursion, at the Julian-Tuvalian boundary, is followed by a positive excursion up to plus 5 per mille. The remaining Upper Carnian shows stabile values around 2 per mille. The Carnian-Norian boundary interval is marked by a minor increase of less than 1 per mille. The carbon isotope curve display a gentle decrease from the late early Norian (3.5 per mille) to the base of the Rhaetian (1.8 per mille) with two accelerated steps, one in the middle Norian and the other one just after the Norian-Rhaetian Boundary. This last 1 per mille decrease corresponds however to a change in lithology from Hallstatt limestone to an alternation of marls and limestone. The values show then a small increase during the early Rhaetian, with a maximum in the middle Rhaetian (at 2.4 per mille). The general stability of the curve even through the Norian-Rhaetian boundary crisis event describes a stable oceanic structure prior to the end-Triassic mass extinction. From an isotopic point of view, only the two Lower Carnian excursions, the Lower Upper Carnian Boundary and the Triassic-Jurassic Boundary can be interpreted as events, whereas other biotic crises of the Late Triassic seem to have occurred during periods of gradual changes in the carbon isotopic composition of seawater.

Superimposed to this long-term trend, the delta^{13}C isotopic curve in the Zlambach Formation records distinctive cycles. First results of the spectral analyses reveal a prominent 400 kyr. cyclicity in the curve, which correlates with Milankovitch long eccentricity changes. Cycles occurring in our record resemble those observed in several Cenozoic and Cretaceous records, suggesting that a link between orbital forcing and carbonate cycling existed also in Late Triassic time. These 400kyr cycles in the Late Triassic could have been linked to sea-level changes influencing the carbonate export from the platform or, as during the Cretaceous, may have been related to a fluctuating monsoonal regime.