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BUILDING AN UPPER TRIASSIC CARBON ISOTOPE REFERENCE CURVE

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During the Upper Triassic, it appears that despite new originations, the general decline in biodiversity was punctuated by a series of accelerated steps between the Carnian and the Rhaetian, while the T-J boundary event may have been the final strike (McROBERTS & NEWTON, 1995, HALLAM, 2002). How these changes in the biosphere were related to oceanographic and/or geochemical changes during the Late Triassic biotic crisis events is a question of primary importance. In order to solve this issue, two principal questions have to be addressed: (1) are these extinctions best explained by a gradual process of environmental change or by (a series of) abrupt or even catastrophic events? and (2) how do Late Triassic patterns of biotic turnover correlate and couple with oceanographic geochemistry? An expansion of a well-calibrated carbon isotope reference curve for the whole Upper Triassic is an important first step to address these questions.

While a comprehensive isotopic data set is available for the T-J boundary (e.g. MORANTE & HALLAM, 1996; GUEX et al., 2004; KÜRSCHNER et al., 2007; WILLIFORD et al., 2007) only a few data are available for the Upper Triassic. To establish a carbon isotope reference curve and in addition of the sparse literature (ATUDOREI, 1999; GAWLICK & BÖHM, 2000; HAUSER et al., 2001; MUTTONI et al. 2004; HORNUNG & BRANDNER 2005; KORTE et al., 2005; HORNUNG et al., 2007a,b, WARD et al., 2004; SEPHTON et al., 2002), several Tethyan and Peritethyan sections were measured in the Austrian Alps, Slovakia, Turkey, Oman and the Indian.

The Upper Ladinian samples record an increase in $d^{13}C_{carb}$ until the Lower Carnian, followed by stable values until the Upper Carnian (MIETTO et al., 2007; RICHOZ et al., 2007a). This stability is, however, disturbed by some small negative excursions in the isotopic signal near the Reingraben event (Lower Carnian-Upper Carnian boundary, ATUDOREI, 1999; HAUSER et al., 2001; HORNUNG & BRANDNER, 2005 and HORNUNG et al., 2007a,b). We present here evidence from the Spiti valley, Indian Himalaya; Mayerling, Austrian Alps and several sections in Taurus. The Carnian-Norian boundary interval in Turkey and Slovakia is marked by a minor increase in the C isotope value (less than 1‰, MUTTONI et al., 2004; GAWLICK & BÖHM, 2000; RICHOZ et al., 2007b). The isotopic values then show an increase until the

Middle Norian followed by a decrease recorded in Oman, Sicily and Austria (MUTTONI et al., 2004; RICHOZ et al., 2007b). In the Upper Norian the isotopic values are relatively stable, and show no shift across the newly proposed Norian/Rhaetian boundary (Steinbergkogel, Austria and Oman, KRYSTYN et al., 2007) before increasing again through the classical Norian/Rhaetian boundary (Oman, Turkey, Austria, this study; British Columbia, WARD et al., 2004, SEPHTON 2004) into the Lower Rhaetian. The isotopic record then remains constant until the top of the Rhaetian and the significant negative shift of approximately 2.0 to 3.0‰, identified in a number of marine sections in close proximity to the Rhaetian-Hettangian boundary (e.g. KUERSCHNER et al. 2007; GUEX et al., 2004; WARD et al., 2004, VAN de SCHOOTBRUGGE et al 2008). These excursions begin below the highest occurrence of conodonts and Triassic ammonites and the lowest occurrence of Jurassic ammonites, allowing very good correlation, and demonstrating unequivocally that the base of the shift lies below the Triassic-Jurassic boundary. The isotopic trends could be compared to the one at the PT boundary.

The Reingraben event is marked by a disturbance of the carbon cycle. The Lower to Middle Norian crisis is marked by a turning point from slowly increasing carbon isotopic values to gradually decreasing values. The Upper Norian (in the classical sense) is marked by a shift from decreasing to increasing isotope values. From an isotopic point of view, only the Reingraben event (Lower Carnian-Upper Carnian boundary) and the Triassic-Jurassic Boundary can be interpreted as event, whereas other biotic crises of the Late Triassic seem to have occurred during periods of gradual changes in the carbon isotopic composition of the marine seawater.

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