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A new chemostratigraphic marker of the Triassic-Jurassic boundary

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The Triassic-Jurassic boundary (TJB) was only recently defined by a GSSP that was ratified in 2010. The definition uses the first appearance of an ammonoid species (*Psiloceras spelae*), even though global ammonoid diversity and abundance was at a minimum after the end-Triassic mass extinction. The primary marker therefore has only limited global correlation value. Another issue is that the system boundary thus defined is not aligned with the most significant changes in the Earth system in the TJB interval, expressed as a major mass extinction and related environmental crises. These events are not only widely regarded as the true division between the two periods in Earth history, but they also offer more practical stratigraphic signals as concurrent range terminations of many fossil groups are coincident with a major negative carbon isotope excursion (CIE). Here we explore the use of trace element geochemistry in marine sedimentary sections in search of other geochemical anomalies which are also of stratigraphic value and which may offer clues to the causality of the end-Triassic events.

To test if a rare earth element (REE) anomaly near the TJB, previously recognized in the Kendlbachgraben section (eastern Eiberg basin, Northern Calcareous Alps, Austria), were present in other sections, we measured trace element abundances across the TJB in the GSSP locality of Kuhjoch (western Eieberg basin) and in another well-studied boundary section at Csővár, Hungary. Although *Psiloceras spelae* only occurs at Kuhjoch, all three sections display the most characteristic CIE in the TJB interval, known as the initial CIE.

Of the three analyzed sections, the most pronounced heavy REE enrichment is the one documented earlier from the topmost limestone layers of the uppermost Rhaetian Kössen Formation at Kendlbachgraben, coincident with the initial negative CIE. A more subdued HREE anomaly occurs in exactly the same stratigraphic position in the Kuhjoch section. At Csővár, where carbonate deposition is uninterrupted across the system boundary and the sedimentation rate is higher, the HREE anomaly is also detectable but more muted due to the dilution effect. Significantly, it also occurs in the narrow stratigraphic interval characterized by the initial negative CIE.

The most likely source of extra REE added to the otherwise low background of marine sediments is distal air-fall volcanic ash originating from the largest eruptive pulses of the Central Atlantic Magmatic Province. Prior to breakup of Pangea, the studied sections were located c. 2000–2500 km from CAMP. Our data support the synchrony of CAMP volcanism, carbon cycle perturbation and marine extinction, and strengthen the case that major pulses of CAMP volcanism triggered a cascade of environmental and biotic changes. The detected REE anomaly permits chemostratigraphic correlation within the Eiberg basin and between sections in different basins immediately below the TJB, even in the absence of the rare earliest psiloceratid ammonoids. Further studies can test the applicability of this novel chemostratigraphic marker in other TJB sections worldwide. The geochemical fingerprint of the REE anomaly might also help matching it with certain flow units in the eruptive sequence of CAMP basalts.