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What triggered the largest Early Triassic extinction? Potential causes for end-Smithian extinction inferred from a new U/Pb-CA-ID-TIMS calibration

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The Early Triassic is characterized by large and recurrent perturbations of the global carbon cycle that are associated with radiation and extinction pulses of marine nektonic organisms and ecological turnovers of terrestrial plants. The most drastic setback of the taxonomic diversity of ammonoids and conodonts occurred during the late Smithian, associated with a protracted global positive carbon isotope excursion (CIE). However, the timing and duration of the successive biotic events, the positive carbon isotope shift and the environmental responses leading into the extinction climax at the end of the late Smithian are poorly constrained and its ultimate cause remains enigmatic. A reliable U/Pb age calibration can provide valuable information on the underlying mechanisms potentially acting on different timescales. We present new high precision, chemical abrasion, isotope dilution, thermal ionization mass spectrometry (CA-ID-TIMS) single zircon U/Pb ages from volcanic ash layers recovered from three sections ranging from middle Smithian to early Spathian in the Luolou Formation within the Nanpanjiang Basin (South China). The U/Pb ages are intercalibrated with a robust biochronological scheme based on conodont Unitary Associations and preliminary ammonoid Unitary Association zones. The U/Pb ages serve as basis for a Bayesian age-depth model that allows a precise and reproducible interpolation of the age of the Smithian-Spathian boundary in the studied sections, determination of the duration of the positive CIE, and recognition of a hiatus at the Smithian-Spathian boundary.
On the basis of the inferred durations and rates of the carbon isotope record change, we can discriminate between some of the potential geological and environmental processes responsible for the positive CIE and which are known to act on specific timescales. Therefore, we propose that the late Smithian event was associated with a progressive burial of organic carbon and a drawdown of CO_2 that promoted a brief but substantial global cooling. Our U/Pb-ages do not agree with recently proposed astronomically tuned Triassic timescales. This has substantial impact on our understanding of the Early Triassic recovery dynamics which occurred on a shorter time span than previously thought and moreover argues against a prolonged recovery from the Permian mass extinction due to persisting unfavourable environmental conditions as often postulated.