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High precision dating of mass extinction events: a combined zircon geochronology, apatite tephrochronology, and Bayesian age modelling approach of the Permian-Triassic boundary extinction

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Chemical abrasion isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) U-Pb dating of single-zircon crystals is preferably applied to tephra beds intercalated in sedimentary sequences. By assuming that the zircon crystallization age closely approximate that of the volcanic eruption and ash deposition, U-Pb zircon geochronology is the preferred approach for dating mass extinction events (such as the Permian-Triassic boundary mass extinction) in the sedimentary record. As tephra from large volcanic eruptions is often transported over long distances, it additionally provide an invaluable tool for stratigraphic correlation across distant geologic sections. Therefore, the combination of high-precision zircon geochronology with apatite chemistry of the same tephra bed (so called apatite tephrochronology) provides a robust fingerprint of one particular volcanic eruption. In addition we provide coherent Bayesian model ages for the Permian-Triassic boundary (PTB) mass extinction, then compare it with PTB model ages at Meishan after Burgess et al. (2014).
We will present new high-precision U-Pb zircon dates for a series of volcanic ash beds in deep- and shallow-marine Permian-Triassic sections in the Nanpanjiang Basin, South China. In addition, apatite crystals out of the same ash beds were analysed focusing on their halogen (F, Cl) and trace-element (e.g. Fe, Mg, REE) chemistry. We also show that Bayesian age models produce reproducible results from different geologic sections. On the basis of these data, including litho- and biostratigraphic correlations, we can precisely and accurately constrain the Permian-Triassic boundary in an equatorial marine setting, and correlate tephra beds over different sections and facies in the Nanpanjiang Basin independently from litho-, bio- or chemostratigraphic criteria. The results evidence that data produced in laboratories associated to the global EARTHTIME consortium can provide age information at the 0.05% level of 206Pb/238U zircon dates.

REFERENCES

Burgess, S.D., Bowring, S., Shen, S.Z., 2014. High-precision timeline for Earth's most severe extinction. PNAS 111, 3316-3321.