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Understanding the early Mesozoic world: New geochronological data from terrestrial and marine strata

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The first ∼50 Ma of the Mesozoic (the Triassic Period) are marked by two major mass extinctions at the end-Permian and end-Triassic, extensive flood volcanic events (the Siberian Traps and the Central Atlantic Magmatic Province), perturbations of the ocean chemistry, paleoenvironmental changes in a greenhouse world and the origin of modern terrestrial ecosystems. Marine records of events leading to the end-Permian extinction as well as subsequent recovery during the Early and Middle Triassic are now well understood in terms of their relative and absolute timing, mainly due to significant advances in both the quantity and quality of geochronological data. This includes a detailed understanding of the Middle and end-Permian extinction events and their potential causes, their aftermath, and also the timing of large scale perturbations of the global carbon cycle in the Early Triassic. For the remaining ∼30 Ma of the Triassic, however, there was until recently virtually no chronostratigraphic framework, and hence there is a major lag in our understanding of major events such as the origin and early diversification of dinosaurs, major reef building episodes in marine ecosystems, paleoenvironmental changes (e.g., the Carnian Pluvial Event), and a large extraterrestrial bolide impact (the Manicouagan impact). In absence of high-resolution radioisotopic ages, assumptions about causal inference and the role of these events, remain poorly constrained.
We have therefore started to build a chronostratigraphic framework by applying U-Pb CA-TIMS analyses to zircon from primary and redeposited volcanic strata within both marine and terrestrial sequences of Late Triassic age. In particular, the potential of geochronological techniques applied to redeposited volcanic layers has long been ignored because the time lag between zircon crystallization and deposition is unknown; however, our initial results calibrating terrestrial sequences in North and South America are very promising and many of the obtained maximum ages are in agreement with stratigraphic order. Our new marine ages support the hypothesis of a long Norian Stage (∼20 Ma), and new data suggest a wholly Norian age for the fossiliferous terrestrial Chinle Formation in the southwestern US. Thus, previous correlations based on terrestrial biostratigraphy with deposits in South American sequences are now thought to be flawed, suggesting that the rise of dinosaurs was diachronous, and occurred later in North America than in South America.
Further complementary geochronological analyses from marine sequences are currently underway and are aimed at correlating and understanding key events and processes that are recorded both marine and terrestrial sedimentary archives of Late Triassic age.