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Synthesis of a multi-method chronostratigraphic framework for the Late Triassic (Chinle Formation, Colorado Plateau, USA)

Roland Mundil (1), Cornelia Rasmussen (2,6), Brenhin Keller (1,3), Dennis Kent (4,5), Christopher Lepre (4,5), Paul Olsen (5), Randall B. Irmis (6), Dominique M. Giesler (7), George Gehrels (7), John Geissman (8), and William Parker (9)

(1) Berkeley Geochronology Center, Berkeley, USA, (2) University of Texas, Austin, USA, (6) University of Utah, Salt Lake City, USA, (3) University of California, Berkeley, USA, (4) Rutgers University, New Brunswick, USA, (5) LDEO, Palisades, USA, (7) University of Arizona, Tucson, USA, (8) University of Texas, Dallas, USA, (9) Petrified Forest National Park, USA

Generating a geologic time scale often requires the integration of data from various methods, including radioisotopic dating, magnetostratigraphy, cyclostratigraphy, biostratigraphy and chemostratigraphy. In most cases, however, only a subset of data from these methods is available and in many cases the reconstruction of timing solely hinges on radioisotopic dates, the accuracy of which has not been independently tested. Likewise, in several cases, the timing of sedimentary sequences has been solely calibrated by cyclostratigraphic methods using the superposition of signals from orbital tuning.

A ∼520m core (CPCP-PFNP13-1A) through Triassic sediments of the Colorado Plateau in Petrified Forest National Park offers the unique opportunity to establishing an exportable time scale of a +15 Ma time interval (ca 210 Ma to 225 Ma) using integrated data from radioisotopic dating, magnetostratigraphy and cyclostratigraphy in this previously poorly calibrated age bracket. We present U-Pb zircon dates from fluvial sandstones of the non-marine Chinle Formation. The resulting ages must be considered maximum depositional ages because of redeposition, with the time lag between crystallization of the (youngest) zircon and deposition being a priori unknown. Our analytical strategy involves analyses of a large number of zircon crystals using LA-ICPMS methods and subsequent extraction of the youngest fraction for precise CA-TIMS analyses. In many cases age dispersion of the individual ages of a sample makes age interpretation difficult. The combination of the zircon ages with rock magnetic data, which are in turn calibrated by orbital cycles that are recorded in the age equivalent Newark Basin, results in a highly resolved (at the 100 ka level or better) exportable time scale. Events that are recorded in the Chinle Formation, such as the Adamanian-Revueltian biotic turnover, are now tightly constrained and can be globally correlated accurately for the first time. Interpretations regarding potential causes of this turnover, as well as paleoenvironmental changes recorded in the Chinle Formation, are now tied to a precisely calibrated time scale. Through internal consistency, this multi-method approach provides a mutual test for complex LA-ICPMS and CA-TIMS zircon age data and cyclostratigraphic modeling. Our efforts are aimed at developing methods and tools that can be used for a more robust data interpretation of such data sets.