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Searching for Manicouagan: astrochronological predictions and tests of alternative age models in the Late Triassic Chinle Formation [Colorado Plateau Coring Project-1 (CPCP-1), Arizona, USA]

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The age of the ~100 km Manicouagan impact structure (Quebec, Canada) is ~215.5 Ma (*1, 2*), falling roughly in the middle of the Norian (228-206 Ma) of the Late Triassic, plausibly corresponding to the mid-Norian biotic crisis in the oceans (*3*) and Adamanian-Revueltian (*4*) biotic turnover on land. The latter is the largest apparent biotic disruption in the continental Triassic of North America, as documented in the Chinle Formation of the Colorado Plateau and environs in the southwestern USA. Funded by ICDP and NSF (2013-2016), CPCP-1 cored nearly the entire Norian part of the Chinle intersecting what should be the time of the giant impact and biotic transition. Analyses of detrital CA-ID-TIMS U-Pb zircon ages and magnetostratigraphy resulted in two alternative age models for the Chinle in the core (*5, 6*). Model A emphasized the one-to-one magnetostratigraphic match of polarity zones between the Chinle (*5*) and the Newark-Hartford Astrochronostratigraphic Polarity Time Scale (N-H APTS) (*7*) and is consisent with the youngest zircon ages, whereas Model B emphasized the mean of the youngest coherent cluster of ages at a specific level (*6*). Although both age models agree for the upper stratigraphic core section of the Chinle, they differ dramatically lower down with Model B having three additional accumulation rate segments, one of which is so low as to suggest a hiatus at the Adamanian-Revueltian turnover and Manicouagan impact, similar to a previous CA-ID-TIMS outcrop study (*8*). Model A predicts no discernable change in rate or hiatus at the putative event level and only one other accumulation rate segment. Timeseries analysis using Model A reveals significant ~1.8 Myr and 405 kyr cycles in both accumulation rate segments for natural gamma radiation and the elemental XRF ratios, in phase in both segments with the chaotic Mars-Earth and metronomic Venus-Jupiter cycles in the N-H APTS (*9*). Model B, in contrast, lacks significant cycles at these periods for the lower three accumulation rate segments. Consilience between Model A and the independent astrochronological predictions suggests it is the better model. The discrepancy with Model B is parsimoniously explained by the youngest coherent age clusters tending to be dominated by recycled zircons in the lower part of the core as suggested by LA-ICP-MS data (*10*). The Adamanian-Revueltian biotic turnover and Manicouagan impact therefore should have a record in the higher accumulation rate part of the Chinle and not be cut out by a hiatus or in a condensed section. Additional coring and denser CA-ID-TIMS ages will be needed to fully test the robustness of this conclusion.

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