Age concern – testing the astronomical calibration of the early Paleogene and the K/Pg boundary

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The detailed reconstruction of Earth's history requires a very precise geological time scale. Imprints of Earth's orbital variations common in paleoclimatic records have been utilized to establish a very stable and accurate time scale for the last ~40 Ma by astronomical tuning. Astronomical tuning of geological data depends on long-term numerical solutions for insolation quantities of the Earth. Uncertainties in these computations beyond 42 Ma and uncertainties in radiometric dating limited the construction of an accurate astronomically calibrated time scale for the early Paleogene. However, attempts to construct a robust orbitally tuned time scale for this interval by integrating radioisotopic and astronomical dating are only partially consistent.

Here we present a comparison between the expression of the very long eccentricity cycle (~2.4 myr) minima of the new orbital solutions for Earth's eccentricity (La2010) and geological data which contain eccentricity modulated precession cycles. Our aim is to test how far back in time the amplitude modulation of eccentricity is stable in the La2010 solution and thus finally obtain an accurate astronomically calibrated time scale for the late Paleocene to early Eocene. We use X-ray fluorescence (XRF) core scanning iron (Fe) intensity data obtained on marine sediments drilled by the Ocean Drilling Program (ODP). These records have a robust cyclostratigraphic framework based on the stable 405-kyr cycle in the early Paleogene and show well expressed very long eccentricity cycle minima. Our results suggest a remarkable consistent pattern between geological data and the latest astronomical solution. Based on the first order calibration using the very long eccentricity minima we present a new astrochronology which indicates that the synchronisation of astronomical and radioisotopic rock clocks might be much more problematic than previously thought.