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Reconstructing Palaeozoic astronomical frequencies from geological records

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Astronomical tuning is the process of correlating geological records to an astronomical solution, allowing to establish a detailed age model and facilitating the investigation of Earth's climate response to changing boundary conditions in detail. The astronomical solutions that are needed for astronomical tuning consists of reconstructed eccentricity, obliquity and precession through time, and are computed by astronomers. Beyond ca. 12 million years, the phase of obliquity and precession cannot be calculated with confidence. For most of Earth history, the frequencies of obliquity and precession have few constraints. Astronomical models extrapolating recent observations are at least partly problematic because an extrapolation of the present tidal dissipation in the Earth-Moon system would lead to an Earth -Moon collision ca. 1500 Ma ago. Astrochronology has not yet been employed for the quantitative establishment of obliquity and precession frequency, though some qualitative analyses confirm astronomical models for the last ca. 300 Ma.

Here, we discuss a novel computation approach for the reconstruction of precession and obliquity frequencies from sedimentary units showing a clear imprint of orbital forcing. We apply this tool to determine the frequency of precession and obliquity, and also the underlying precession constant p, and astronomical g- and s- frequencies, with their uncertainty. This method allows for the reconstruction of recent astronomical properties, confirming its reliability. Using the same method and extrapolating uncertainty for the g- and s- frequencies, we investigate several Devonian datasets and present results for the precession constant as well as precession and obliquity length.