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The Geological Orrery: Using Earth's Geological Record to Map the Chaotic Evolution of the Solar System with continuous cores of Earth's climate record

Paul Olsen (1), Dennis Kent (1,2), Christopher Lepre (1,2), John Geissman (3), Roland Mundil (4), Cornelia Rasmussen (4,5), George Gehrels (6), Dominique Giesler (6), Randall Irmis (7), Jessica Whiteside (8), Yanan Fang (9), Jingeng Sha (9), and William Parker (10)

(1) Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10968 USA, (2) Earth and Planetary Sciences, Rutgers University, 610 Taylor Road, Piscataway, NJ 08854 USA, (3) Department of Geosciences, University of Texas at Dallas, Richardson, TX 75080 USA, (4) Berkeley Geochronology Center, Berkeley, USA, (5) University of Texas, Austin, USA, (6) Department of Geosciences, University of Arizona, Tucsan, AZ 85721 USA, (7) Department of Geology & Geophysics, University of Utah, Salt Lake City, UT 84112 USA, (8) National Oceanography Centre, Southampton, University of Southampton, Southampton, SO17 1BJ, UK, (9) Nanjing Institute of Geology and Paleontology, Nanjing, China, (10) Petrified Forest National Park, USA

The Geological Orrery explores the dynamic evolution and stability of the Solar System by recovering geological records of climate change on Earth to empirically constrain solutions for the gravitational system of the Sun, planets, and smaller bodies. Because of limitations imposed by the n-body problem, precision of measurements, and the inherently chaotic behavior of the Solar System, it is presently impossible to constrain solutions beyond ~50 million years ago. However, as the system's history is embedded in cyclical climate records extending billions of years into the past, theoretical solutions can be tested for historical conformity.
A Geological Orrery proof-of-concept has three parts, two of which are largely completed.
1) The US NSF-funded Triassic-Jurassic Newark Basin Coring Project and Hartford Basin lacustrine tropical climate records reveal modulations of climatic precession inconsistent with favored numerical solutions in period and phase, but not inconsistent with what chaotic drift allows(1), with the Mars-Earth eccentricity cycle having a 1.6 - 1.8 Myr period, outside the 2.4 - 2.0 Myr predicted range(2). Despite corroboration from contemporaneous pelagic cherts(3), validity of these data rests on the accuracy of the time scale, hitherto based on the astrochronology itself.
2) Testing of the Triassic part of the astrochronology and the Mars-Earth eccentricity cycle has been accomplished by the ICDP/US NSF-funded Colorado Plateau Coring Project- Phase 1(4,5) that recovered over 850 m of core from two sites and three boreholes from low-latitude Triassic age strata in Petrified Forest National Park in Arizona, USA. These cores have many levels providing precise U-Pb, CA-ID-TIMS dates. In concert with magnetic polarity stratigraphy, these dates validate the Newark-Hartford astrochronology, corroborating not only the Triassic period of the Mars-Earth cycle, but also the theoretical metronomic nature of the 405 kyr Jupiter-Venus cycle.
3) Future recovery of the mode of the obliquity-eccentricity Mars-Earth secular resonance for the Triassic-Jurassic depends on exploiting a high-latitude section, such as the 60°N Junggar Basin (Xinjiang, China), where obliquity pacing should be maximally expressed. Outcrop data suggest that the present-day Mars-Earth secular resonance was in effect(6), but drilling is necessary to permit paleomagnetic polarity correlation to a section with U-Pb-datable levels (as proposed in the Colorado Plateau Coring Project phase 2).
If the period and state of the Mars-Earth system for this early Mesozoic ~50 Myr interval is determined, the process can be extended to pairs of low and high latitude cores from 50 Ma to 200 Ma providing Laskar's, "...ultimate test for the gravitational model..."(7) of the Solar System. Although ambitious by Earth Science criteria, The Geological Orrery will yield fundamental insights into deep physical processes of our Earth, the Solar System, and beyond.

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