A Roadmap for Empirical Mapping of the Chaotic Behavior of the Solar System and Consequent Development of an Astronomical Time Scale for the Phanerozoic

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Date: Tuesday, June 9

Time: 3:50 pm - 4:10 pm

Location: 102/104/106

Speakers: Olsen, Paul, Kent, Dennis V., Olsen, Paul E.

Track: Cyclostratigraphy and the Astronomical Time Scale

Description: Because of the long-term chaotic evolution in planetary orbits (1) development of realistic target curves for astronomically constraining geological time scales anchored in the present is limited to about 50 m.y. This is largely because of the unpredictable behavior of the Earth-Mars system, Mercury, and insufficient constraints on the J2 of the Sun, resulting in phase and frequency shifts in the periods of all of the eccentricity and obliquity-modulating cycles (except g2-g5) cycles that could be used for tuning. However, the chaotic history of these frequencies and their phases can be empirically mapped by acquisition and analysis of continuous paleoclimate records each spanning tens of millions of years, and treating them as "geological interferometers" from which the fundamental frequencies of the inner planets, as well as transitions in the Earth-Mars resonance, can be recovered by delineation of very long-period climate cycles. To reduce the number of unknowns, these long swaths of time ideally should be represented by at least one precession-dominated record from low-latitudes and one from high-latitudes with a significant obliquity signal. In this way the periodicities of long eccentricity cycles could be potentially isolated from the obliquity modulators and the state of the Earth-Mars resonance determined. Additionally, most records should be lacustrine to enhance the effects of local isolation forcing, as opposed to global signal integration common to marine environments, and should have good magnetostratigraphies for correlation and ties to radiometric ages. We illustrate the concept of the "geological interferometer" with our analysis of ~5000 m of cored section spanning 32 million years of the Triassic-Jurassic from eastern North America (2), from which we have recovered Triassic values of the fundamental frequencies (g values) of Earth, Mars, and Mercury that in turn allow construction of a Triassic-Early Jurassic precession curve. If this can be done for the rest of the Jurassic, Cretaceous, and early Cenozoic, the "geological interferometer" will allow the development of a highly-accurate solution for the behavior of the Solar System over 235 million years, a robust test of general relativity as has been noted by Laskar (1), and high-accuracy, <20-ky-resolution target isolation curves. References: 1, Laskar, 1999, Phil. Trans. R. Soc. Lond. A, 357:1735; 2, Olsen & Kent, 1999. Phil Trans. R. Soc. Lond. A, 357:1761.

Speakers

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