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Testing the Orbital Hypothesis for Climate Variability in the Lacustrine Green River Formation

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The Eocene Green River Formation of the western United States represents one of the most often cited examples of cyclicity preserved in a continental sedimentary succession. Up to hundreds of meters of strata were deposited in a series of large, shallow lacustrine basins. Preservation of a number of organic-rich intervals has also made the Green River Formation an economically important oil shale resource. Several studies have drawn a potential link between repetitive facies indicating fluctuating lake levels, and orbital Milankovitch cyclicity. However, few attempts have been made to quantify the cyclicity, or rigorously demonstrate that orbital climate forcing had enough of a control on sediment input to imprint a signal above the noise level of autogenic variability. Among these, Machlus et al. [2008] used oil yield data from cores as a proxy to evaluate the presence of significant periodicities in the strata. Although there appears to be significant sub-Milankovitch variability in the Green River Formation, spectral peaks identified at longer wavelengths show a promising correspondence to known orbital frequencies.

We have collected a diverse array of new data sets to evaluate the presence of spatial periodicity in the Piceance and Bridger basins of Colorado and Wyoming. These include color, lithology and grain size records obtained from field work, along with analysis of cores and high-resolution multi-spectral remote sensing images. Core records allow us to directly compare physical properties with existing oil yield records, while providing higher spatial resolution and depositional context. Due to the fact that organic content controls a large fraction of the visual variability within the sediments, our continuous color record has an excellent correspondence to previously analyzed oil-yield records. Additionally, we have undertaken a wider characterization of the Green River stratigraphy from remote sensing data. Using stereographic satellite images, we have derived 2$\sim$m scale Digital Elevation Models of our field sites. From these, we are able to extract geometrically corrected multi-spectral color and slope records at meter-scale stratigraphic resolution. These data in particular allow us to document lateral variability within the sedimentary basins. Pietras et al. [2006] presented evidence of lateral impersistence among individual cycles, implying that the reconstruction of a continuous climate record would be difficult. We will present the results of our multi-scale characterization of the Green River formation, assessing both temporal and lateral variability, and their implications for both astrochronological tuning and climate cyclicity.