Astronomical Controls on Paleohydrology of the Eocene Lacustrine Green River Formation, Bridger Basin, Wyoming

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The Green River Formation (GRF) is a cyclic lacustrine deposit that formed during the Early Eocene Climatic Optimum. Lithostratigraphic, geochronologic, chemostratigraphic and astrochronologic studies have greatly contributed to understanding the GRF. However, the origins of GRF sedimentary cyclicity are still debated: what climatic processes forced the cycles; how did these processes lead to a cyclic succession of sedimentary facies? Fischer assay data from the Blacks Fork and Currant Creek cores in the Bridger Basin are analyzed to test the hypothesis that GRF cycles were forced by Milankovitch cycles. The cores are near the basin depocenter with the most complete record of Lake Gosiute sediment deposition. Astronomical (eccentricity, obliquity and precession) cycles are present as well as apparent “hemi-precession.” Climate modeling shows that orbital perihelion at northern winter solstice with warm winters and cool summers produced high precipitation/evaporation (P/E) ratios and led to the formation of profundal facies; orbital perihelion at northern summer solstice with hot summers and cold winters produced low P/E and led to the formation of littoral facies. $^{87}\text{Sr}/^{86}\text{Sr}$ ratios from the White Mountain and Blacks Fork cores are inversely correlated with Fischer assay and lake level. Less radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ occurs in hightstand facies with high oil yield; more radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ occurs in lowstand facies with low oil yield. This relationship is controlled by the provenance of atmospheric moisture delivered into Lake Gosiute. During lake expansion surplus precipitation from the Pacific Ocean contributed to annual snowpack on the western side of the basin, reacting with less radiogenic marine carbonate before entering the lake. During lake contraction precipitation from the Gulf of Mexico associated with summer monsoons reacted with highly radiogenic Precambrian rocks on the eastern side of the basin before entering the lake. The $^{87}\text{Sr}/^{86}\text{Sr}$ cycling from these alternating sources occurred at the precession scale, and supports the climate model. In sum, astronomical forcing controlled cyclic lake expansion and contraction, with climate responses to orbital perihelion that involved alternating moisture sources to the lake and preservation of strong precessional rhythms in GRF depositional cycles.