Tropical Climate Forcing and Biotic Provinciality in Triassic-Jurassic Pangea

Paul E. Olsen and Jessica H. Whiteside

We will investigate the interactions between Milankovitch variability and faunal provinciality in the equatorial rift basins of Triassic-Jurassic Pangea (235-195 Ma), where there are very long, high-resolution records, coupled with rich faunal and floral remains. The Carnian (235-228 Ma) and early Norian (228-206 Ma) tetrapod assemblages of North Carolina and Virginia record temporally persistent biotic provinces restricted to narrow swaths around the paleoequator. Because of the northward drift of central Pangea, the equatorial belt passed over progressively more southern basins, and strata that should contain younger Norian and Rhaetian (206-200 Ma) equatorial assemblages now lie buried in southeastern South Carolina Georgia and Florida. There were uniquely few barriers to continental migration in Triassic Pangea, and climate is implicated as the most likely driver of such endemism in the absence of geographic isolation. Preliminary data demostrate a distinct equatorial mode of climatic cyclicity dominated by “sub-Milankovitch” fluctuations in a very humid climatic milieu compared to contemporaneous higher but still tropical latitudes dominated by the better known ~20 ky precessional cyclicity. As a prelude to a proposed major scientific coring project that will recover very long sections in a Norian, Rhaetian, and Early Jurassic equatorial setting in Pangea (South Georgia Rift Coring Project), we will investigate the equatorial climate fluctuations and their coupling to the biotic provinciality at a smaller scale by a multi-proxy analysis of lacustrine cores and outcrops from the areas producing these distinctive vertebrate assemblages.

Preliminary data from Carnian and early Norian cyclical lacustrine deposits suggest that climatic fluctuations in the equatorial zones were dominated by “sub-Milankovitch”climate cycles of 9 to 15 ky periods in which local Milankovitch control of maximum continental summer heating drives the intensity of the equatorial monsoon, resulting in two wet intervals per climatic precession cycle. In higher tropical latitudes, the usual 20 ky precessional fluctuations dominate, as observed in coeval deposits in the Newark basin. However, these analyses have been based on semi-quantitative proxies of lake depth based on sedimentary facies such as “depth ranks” or color.

Our preliminary work has shown that δ^{13}Corg is an excellent quantitative proxy of lacustrine ecosystem state in these Triassic-Jurassic lacustrine sequences. We will examine δ^{13}Corg fluctuations in four Late Triassic age intervals from Eastern North America: 1) a core section from about 3° S paleolatitude showing little precession doubling with color as a proxy but within the traversodont province; 2) an extensive quarry exposure of an equatorial section (Solite Quarry) that shows strong indications of precessional doubling and producing a rich fauna and flora; 3) a time equivalent section (based on paleomagnetic polarity stratigraphy) in the Newark basin at 5° N paleolatitude (Nursery no. 1 core); and 4) a section known to be within the procolophonid province at 8° paleolatitude in the Newark basin. Although future work will involve separation of the vascular plant compounds from the cyanobacterial components of the δ^{13}Corg signal in order to isolate the atmospheric contribution to the δ^{13}C Milankovitch signal, this preliminary work will concentrate on bulk organic isotopic ratios to characterize the gross behavior of the lake level fluctuations. This is a necessary proof of concept for more detailed work on much longer sections, such as those that could be recovered from the proposed deep coring in the South Georgia Rift.