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QUANTITATIVE RIFT BASIN EVOLUTION: APPLICATION OF EXTENSIONAL BASIN FILLING MODEL TO EARLY MESOZOIC RIFTS, E. NORTH AMERICA

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The model is based on the observation that as extensional basins fill, their prepositional surfaces increase in area as a consequence of filling. Therefore, if all other variables were held constant, sedimentation rate should decrease through time as a predictable consequence of basin geometry. The history of changing sedimentation rates can be extracted from the sedimentary record of a basin and compared to a model based on the actual geometry of the basin fill (the inverse geometric model); the deviations from the predictions of the inverse model quantitatively constrain the change through time in the other variables. Despite gross oversimplifications, our model yields predictions actually seen in the Triassic age portions of the Newark Supergroup half graben of eastern North America.

In accord with the sedimentary record of the Newark basin, the model predicts that initial basin fill is fluvial (Stockton Fm.) with lacustrine deposition beginning 2 MY after the onset of deposition. Then comes 2 MY of rapidly exponentially increasing maximum lake depth (MLD)(lower Lockatong Fm.), followed by a slower exponential decrease in MLD through the next 16 MY (upper Lockatong and Passaic Fms.). The predicted sedimentation rate is equal to the subsidence rate (0.5 mm/yr) through the Stockton, then decreases exponentially from there to 0.15 mm/yr at the top of the Passaic. This is confirmed by use of Milankovitch-type lake-level cycles. The most striking deviation from the predictions of the model is the dramatic observed E. Jurassic increase in sedimentation rate (to 1.0 mm/yr) and apparent maximum lake depth. This is a consequence of increased basin asymmetry due to accelerated extension rate, also the probable cause of the Newark igneous event. Explanations calling for major tectonic or climatic events to explain Newark Triassic stratigraphy are not needed.