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# Unraveling the Rules of Rifts

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**The stratigraphic and sedimentological patterns seen in continental rift basins appear to follow rules based on the relationship between the basin's growth through time and the resulting change in area of the depositional surface as the basin fills. Using relatively simple models based on these rules we can separate the real tectonic, climatic, and sedimentological "events" from the unfolding of the necessary consequences of the filling of a trough.**

What are the first-order rules governing the stratigraphic sequences in continental rift basins? Are sedimentation rates or types of depositional environments controlled directly by movements along the basin's boundary faults or by climate or by regional relief? Are rates of extension relatively constant or spasmodic? These fundamental questions about the rifting process have largely remained unexplored at least partly because these basins lack the fixed reference frame provided by a sea-level datum. As presently understood, the stratigraphy of continental extensional basins is generally described in historical narrative style with each major change in depositional environment and sedimentation being interpreted as a result of some unique event. Thus the tectonic and stratigraphic histories of these rift basins read like a series of disconnected causes and effects without causal generalities. Our understanding of synrift deposits, thus, stands in rather marked contrast to the elegant models that explain post-rift passive margin stratigraphy in terms of thermally driven subsidence, sediment compaction, and global sea level change.

Changes in depositional surface area due to basin growth and filling must profoundly affect rates and modes of sedimentation. In hydrologically closed basins these epiphenomena can dominate the stratigraphic pattern. We are developing a series of models for continental extensional basins which allow these basin filling effects to be subtracted from the sedimentary record, thereby revealing a residuum of real historical changes in more fundamental underlying tectonic, climatic, and biological patterns. This process is analogous to extracting a sea level curve from a passive margin subsidence curve by removing the thermal effects. Here we show how these models can be applied to the classic rift basins of eastern North America (Fig. 1).

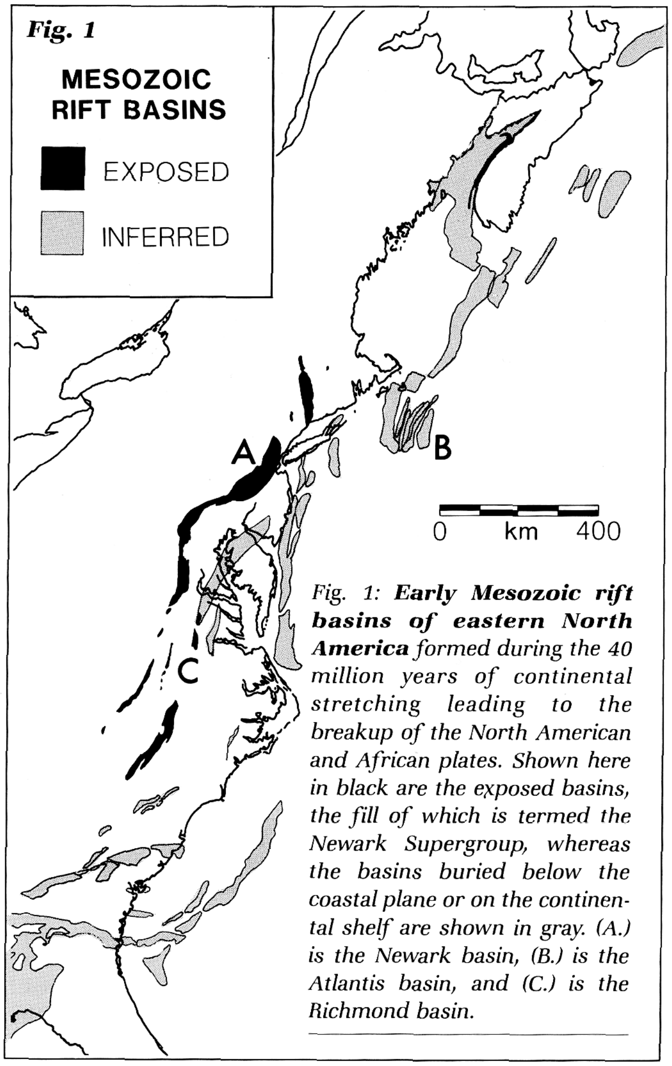


Fig. 1: ***Early Mesozoic rift basins of eastern North America*** *formed during the 40 million years of continental stretching leading to the breakup of the North American and African plates. Shown here in black are the exposed basins, the fill of which is termed the Newark Supergroup, whereas the basins buried below the coastal plane or on the continental shelf are shown in gray. (A.) is the Newark basin, (B.) is the Atlantis basin, and (C.) is the Richmond basin.*

## Geologic Background

Eastern North America includes the classic Atlantic-type passive continental margin formed by the breakup of the supercontinent of Pangea. The Triassic initiation of the breakup was marked by the formation of rifted crust all along the axis of the future Atlantic, from Greenland to Mexico. In eastern North America, 13 major rift basins, mostly half-graben, and several minor basins are exposed from Nova Scotia to South Carolina, with many more buried below the coastal plain and on the continental shelf (Fig. 1). The exposed rift basins, which closely follow the trend of the Appalachian orogen, filled with thousands of meters of continental sediments, minor mafic volcanic rocks, and diabase plutons and dikes over a period of 45 million years. The faulted, tilted, and eroded rift strata are termed the Newark Supergroup.

Based on surface geology and seismic reflection profiles, the basin fill is wedge-shaped and thickens toward the border fault side of the basins (Fig. 2). In addition, younger strata (layered sedimentary rocks) progressively onlap the basement block in the hanging wall of the border fault (the block of rock above a