g22 Newark Supergroup < continental, graben >

It is sometimes necessary to repeat what we know. All mapmakers should place the Mississippi in the same location, and avoid originality.

—Saul Bellow.[1]

The continental margin of eastern North America during the Cenozoic has been a passive margin [2] (following Seuss's classification that contrasts Pacific active margins that exhibit Andean volcanism and orogenesis and Atlantic passive margins with no such activity).[3] The passive nature of the eastern North America margin, however, was mildly interrupted during the Early Cretaceous by compressive throw-reversals of coast aligned NE-striking formerly normal faults and by emplacements of *diabase* (also called: *dolerite*, *fine-grained gabbro*, and *microgabbro*) sills fed mostly by NW-striking dikes.

The Atlantic ocean did not exist before the Late Jurassic. This is known because, for one thing, sediments older than that have not been located anywhere in it by dredge, deepsea drilling, seismic imaging, or magnetic reversal chronology. Also, excluding the Caribbean and the Scotia seas, there is no evidence of subduction within the Atlantic. So whatever has accumulated in the Atlantic ocean basin is still there.

The deep Atlantic ocean began to open in Pangea during the Late Jurassic. Prior to then (in what is now the eastern margin of North America), basaltic volcanism occurred associated with extensional continental faulting (Nova Scotia to North Carolina). Resulting graben (down-faulted basins) accumulated the Newark Supergroup (***Figure g22.1***). (A supergroup is a rock unit of great thickness that includes parts of more than one system, in this case of the Jurassic & Triassic systems).

In maritime Canada, the Newark Supergroup is comprised of postrift early Middle Jurassic upon synrift Lower Jurassic graben-filling continental sediments.

In New Jersey, the Ramapo fault gradually lowered the western side of a trapdoor graben to a depth of 9 kilometers (***Figure g22.2***). This basin was kept filled by the accumulation of nonmarine sediments. Marginally, are red-bed fluvial rudites eroded from the adjacent horsts. These contain distinctive boulders that, in inverted sequence, record unroofing of adjacent horsts. Inward from the rudites are beds of red sandstone and shale in cyclical alternation with black lake-bottom argillite. Evident is a climate that alternated between being semiarid and then wet enough for deep lakes to exist. The whole is indicative, as F. B. Van Houten in 1864 first suggested, of Milankovitch astronomical-forcing. If so, this geological record gives astronomical information, rather than vise versa.[4] (Earth's orbital and precessional motions can be reliably retraced for the last 35-50 million years but, as the evolution of the solar system has been chaotic,[5] more ancient cyclicities must be evaluated, J. Laskar in 1999 reminds, in their historical isolation.[6])

During the Early Jurassic, the southeastern United States continent-ocean rift margin accumulated a now buried—but seismically imaged—wedge of massive volcanic or volcaniclastic rock. Associated are dike intrusions parallel the trend of then opening rift basins which were also receiving graben-fill sediments. For example (in New Jersey) an intrusive event that lasted 0.58±0.1 million years in the latest Triassic (201 Ma), is recorded in the Newark series (of alternating red beds and, thinner, black lake sediments), by a 300 m thick diabase sill (strike exposure is the Palisades along the west side of the Hudson River estuary across from New York City and north for 80 km). Related plateau-basalt style volcanism is record by the three Watchung Mountains. Pipe amygdales at the base of a flow in the Third Watchung (the youngest) record puddled rain water over which the lava flowed. In the First Watchung, pillow lavas occur where locally the lava erupted into ponded water.

Regionally, Triassic diabase dikes cut through the ancient rocks of the Piedmont. Synrift deposition during the Late Triassic records the inception of Pangea's fragmentation. In some of the basin-margin rudites, the presence of boulders of these lavas indicates that they were not everywhere confined to the basins, and down-faulting of the graben did not always keep ahead of graben filling.

A Late Triassic age for the oldest exposed graben-fill Newark sediments was established from the presence of early dinosaur tracks (bones are rare because in a red-bed grave environment they dissolve in through-to-spring percolating acidic and oxygenated entering rainwater). Further back into the Triassic is now, by the Newark Basin Coring Project (1989 to 1994), known for basal Newark fossil-rich lake sediments that accumulated to 200 Ma (end Triassic) beginning 230 Ma (late Middle Triassic). Throughout is evidence in these of astronomically-driven wet/dry climate cycles. ❏

Figure g22.1 [7] (right) Location map of graben-fill of Middle and Lower Jurassic and Upper and Middle Triassic sediments in the eastern United States. These sediments, named the Newark Supergroup, are non-marine except in the northeast where early on the Tethys Sea made incursions.

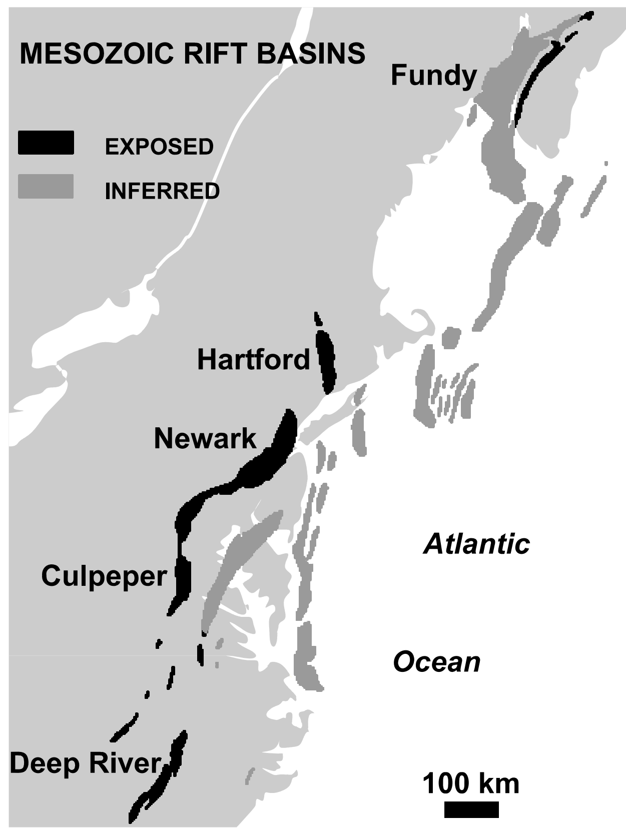

Figure g22.2 [8] (below) In the Newark basin, the three Watchung Mountains are outcrops of basalt lavas of near-end Triassic age. This is also the age of the Palisades diabase sill that intrudes the Newark Supergroup. In New Jersey lowlands, outcrops of the Newark supergroup are commonly red sandstone and shale. This and the discovery of early dinosaur footprints in some exposures, originally gave the Newark supergroup the formational name of “Triassic red beds.” The red-bed sediments are stream (fluvial) deposits. These frequently alternate with lake (lacustrine) sediments. The lacustrine sediments are fossil-rich siltstones and black shales. Many are thick and extend across the width of the graben. Near the Ramapo fault, conglomerates (rudites) with red silica cement and white vein-quartz pebbles have been quarried as “Potomac Marble.” Cut and polished, this stone paves the lower floor of the U.S. Capitol.

The Newark basin sedimentological record of an arid climate by near the end of the Triassic (202 Ma), grading from a wet tropical climate in the late Middle Triassic (232 Ma), is accounted for according to Paul E. Olsen and Emma C. Rainforth by a 7° northward drift of Pangea.