Comparing crustal type and rift processes along three transects during the Late Jurassic breakup of west Equatorial Pangea: West Texas–Colombia (western); Arkansas–Gulf of Mexico–Venezuela (central); and Mississippi–Suriname (eastern)

James Pindell, Tectonic Analysis, Ltd., Teunis Heyn, Independent, Timothy Lawton, University of Texas at Austin, and Robert N. Erlich, Cayo Energy*

Despite decades of effort, significant uncertainties remain over the Mesozoic breakup of the Americas. We compare three lithospheric cross sections depicting Late Jurassic time, for which Triassic-Jurassic extension is known from Atlantic kinematics. The sections cross West Texas–Mexico–Colombia (western), Arkansas–Gulf of Mexico (GOM)–Yucatan–Proto-Caribbean–Venezuela (central), and Mississippi–west Florida–west Bahamas–Guyana Basin–Suriname (eastern). Extension in the central section proceeded from, in the GoM, limited continental rifting, production of magmatic crust, and seafloor spreading between conjugate magmatic crusts; and, in the Proto-Caribbean, limited continental rifting and only incipient seafloor spreading, based on our reconstruction.

Similar net extensions in the western and eastern sections were achieved with less seafloor spreading, suggesting other processes. The difference in the western and central sections was not due to the commonly assumed migration of central Mexico into the section along the Mojave-Sonora megashear, because there is no marginal offset in the western GoM margin. However, the Oaxaca block, mostly Grenville basement formerly considered part of Oaxaquia, could have moved into the section along the newly defined, sinistral North Oaxaca Transfer (NOT), to its present position south of the Cuicateco belt. The NOT likely continued to the NW and merged with the Mojave–Sonora Fault of NW Mexico, allowing Oaxaca block to avoid overlap with Colombia. This intra-continental transform circumscribed northern and central continental Mexico, where, as a second means of non-oceanic extension, large-scale transtension of overthickened Alleghanian continental crust occurred in a mega-releasing bend model extending to Tamaulipas Arch. This is indicated by regional NNW-SSE and WNW-ESE extensional fault arrays, local basement uplifts resembling core complexes, Lower Jurassic–lowermost Cretaceous successions deposited on anatectites and pre-Mesozoic mid-crustal metamorphic rocks, and suspected syn-extensional sinistral rotation of crustal blocks. In addition, crustal extension in this region likely created Pacific–GoM marine connections, as revealed by Jurassic tidal and evaporitic facies. The difference in the eastern section was achieved by significant syn-rift crustal extension within the W Florida Shelf and S Florida Basin, and by SDR-type magmatism in the western Bahamas and Demerara Rise conjugates. This magmatism was not due to the Sierra Leone hotspot, but rather to a residual, focussed area of Jurassic hotspot magmatism left over from CAMP magmatism, which went on to form the Bahamas hotspot track.

Each section requires incorporation of certain processes to be drawn accurately. For example, the GoM and Suriname–Bahamas conjugate rifts were magma-rich. Using today's magma-rich Afar–Red Sea analogue where ~2 km of syn-rift dynamic elevation keeps tectonic processes shallow (e.g., seafloor spreading at <1 km, and 20 km-thick continental crust at sea level), we introduce similar dynamic control where magmatism is conspicuous in the sections. Syn-rift dynamic elevation is also evidenced by excessively rapid post-rift subsidence in Demerara Rise and the GoM, which we argue requires dynamo-thermal subsidence, a combination of thermal (isostatic) plus dynamic subsidence, the latter being the dissipation of syn-rift dynamic elevation as the basin moves off the plume responsible for the magmatism (Pindell and Heyn, 2022). Depths below sea level of pre-salt surfaces in ancient magmatic rifts were shallower than isostatic models predict, due to dynamic support. Syn-rift dynamic elevations of 1–2 km at magma-rich rifts prevent much of the expected accommodation from forming, suggesting basin depths of only hundreds of m before salt deposition began. Basins migrating off plumes during salt deposition (e.g., GoM) have long-wavelength diachronous responses to dynamic subsidence, with thinner salt toward the plume due to base-salt relief, rather than or in addition to, top-salt relief.

Some workers invoke the great water depths inferred for Messinian salt deposition in the Mediterranean oceanic basin for syn-rift settings, too (e.g., GoM). However, direct evidence for deep, syn-rift, pre-salt settings in the GoM is lacking. The differences in salt deposition in the Afar and Mediterranean demonstrate the need for an analogue with which rifts (e.g., GoM) are most similar. Both the GoM and Afar-Red Sea are magma-rich rifts. The observation that today's Afar region has >2 km of dynamic elevation should be considered for the GoM and other ancient magmatic rifts, too.