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Structural Inheritance Controls Strain Distribution During Early Continental Rifting, Rukwa Rift

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Although several studies have highlighted the general control of structural inheritance on rift basin development, very little is known about this relationship during the very earliest phases of continental extension. This knowledge gap impacts the complete understanding of the spectrum of processes that govern continental rifting in space and time. Here, we address this long-standing problem by investigating the role of structural inheritance in defining the early rift geometry and controlling strain distribution in the Rukwa Rift segment of the East African Rift. We use filtered high-resolution aeromagnetic data to delineate the geometry of the Precambrian Chisi Suture Zone (CSZ), representing the suture zone between the Tanzania and Bangweulu Cratons. We find this zone extends beneath and along the axis of the Rukwa Rift, sub-parallel to the Lupa Border Fault which itself aligns with the boundary of a Precambrian terrane (the Katuma Terrane). Using 2-D reflection seismic data, we analyze the distribution of strain across the Rukwa rift during the early phase (Permo-Triassic) of continental extension. We find that during the Permo-Triassic, the basin was defined by a narrow (5-25 km wide), NW-trending graben that was bound to the NE by the Lupa Fault, and partially on the west by an area of diffuse faulting trending sub-parallel to the CSZ magnetic anomaly. This diffuse faulting only occurs in the NW part of the basin, where the CSZ is in the proximity of the Lupa Fault, whereas in the SE, where the CSZ trend deviates away from the fault, strain is largely localized on the Lupa Fault. Also, our seismic and aeromagnetic data interpretations show that the basement-highs in the Rukwa Rift align with the CSZ. The Permo-Triassic interval thickens and tilts toward the Lupa Fault, and is thickest in the SE part of the basin; delineating a geometry that is similar to that of the present-day cumulative rift-fill. Additionally, extension on the Lupa Fault and the cumulative basin extension (beta-factor) increase to the SE where the CSZ deviates away from the Lupa Fault. We interpret that at the earliest stage of rifting, the Lupa border fault was first established along the boundary of the Katuma Terrane; after which the diffused intrabasin faults localized along the CSZ, defining the basin geometry. Further, we infer that the along-rift variation in extension, established from the onset of rifting, is controlled by the geometry and extent of the CSZ. We suggest that basement suture and terrane boundaries acted as stress concentrators, controlling strain distribution and overall basin structure during early growth of the Rukwa Rift. Our findings offer a window into the early stages of continental extension, revealing the influence of structural inheritance on early rift geometry and along-rift strain distribution.