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Linking active rifting episodes with evolution models: Lessons from the Afro-Arabian rift system

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Active and ancient continental rifts worldwide exhibit a regular tectono-magmatic segmentation along their length, but the processes that initiate and maintain these ubiquitous patterns are poorly understood. The seismically and volcanically active East African rift system affords an ideal opportunity to document the breakup of a continent because it encompasses sectors in all stages of development, including the youthful passive continental margins of the Red Sea and Gulf of Aden rifts. Earlier studies have documented the role of lithospheric strength in the dimensions of major faults and, consequently, rift basins; longer border faults develop in stronger lithosphere. Although these border faults accommodate a large percentage of strain during the initial rifting stages, magma intrusion plays a larger role as rifting proceeds to continental breakup and the formation of new oceanic crust. The aim of our comparative studies is to probe the role of magma intrusion in strain accommodation at continental breakup. Our approach is simple: we use present-day patterns of seismicity and volcanism to investigate the processes that maintain the long-lived rift segmentation. We compare patterns of deformation in episodes with and without intrusive or extrusive magmatism, drawing upon seismicity and faulting patterns in the magmatic 2005 Dabbahu (S. Red Sea) episode, the 1989 amagmatic Dobi episode. These intensive episodes of deformation affected entire rift segments, providing insights into longer-term rift evolution. We then use these insights to interpret new and existing seismic and gravity data from the southern Red Sea and Gulf of Aden passive margins.