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Rift linkage processes in areas of incipient oceanic spreading: examples from Afar

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Mid-ocean ridges are segmented and offset along their length. However, the kinematics of rift linkage and the initiation of oceanic transform faults in magmatic rifts remain debated. Crustal deformation patterns from the Afar continental rift provide evidences of how rifts grow to link in an area of incipient seafloor spreading. Here we present examples of rift linkage processes in Afar integrating seismicity and geodetic (InSAR and GPS) measurements, and explained by numerical and analytical models. We show that in central Afar overlapping spreading rifts link through zones of rift-perpendicular strike-slip faulting at the tips of the spreading rifts, demonstrating that distributed extension drives rift-perpendicular shearing. Conversely, in northern Afar we identify a linkage zone between the Erta Ale and Tat Ali segments where shear is accommodated by a conjugate set of oblique slip faults. There, InSAR modelling of a M_L 5.1 earthquake in 2007 show that overall right-lateral shear is accommodated primarily by oblique left-lateral slip along faults subparallel to the rift segments but an active conjugate fault system with right-lateral slip is also highlighted by low-to-moderate seismicity during 2011-2013. Thermomechanical models of transform fault formation are consistent with the presence of a proto-transform fault that may develop into a throughgoing transform in the future. Our results provide evidences that offset rift segments during continental breakup can be linked by a wide variety of strain types and proto-transform zones can form before the onset of seafloor spreading.