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Magmatism and plate kinematics at rift transfer-zones: the Afrera Plain transfer-zone (Afar) from a new high-resolution Pléiades-1 Digital Elevation Model

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At magma-rich extensional rift-systems, lithospheric thinning occurs through repeated injections of magma (rifting episodes) intruding the lithosphere along discrete *en-echelon* rift segments. The progression of plate divergence through rifting episodes makes adjacent rift segments grow and interact within transfer-zones that accommodate deformation and potentially evolve into transform faults. While magma is proved to be key in accommodating extension at rift segments, the role of magmatism in the plate boundary kinematics of transfer-zones remains unclear. In this study, we investigate the interplay between magmatism and tectonics at the Afrera Plain transfer-zone between the Erta Ale and the Tat Ali rift segments (Northern Afar, Ethiopia). To this aim, we used high-resolution Pléiades-1 tri-stereo imagery and produced the first 1 m DEM of the area to explore the spatial, geometrical and cross-cutting relationships between magmatic and tectonic features in the area. We mapped 4548 tectonic features and 367 previously unrecognized magmatic features including dikes and dike-related faults and fractures. We measured dikes opening with an extension oriented ~N65°E, consistent with the regional plate spreading direction while tectonic features have a strike-slip and an extensional component with the extension direction varying between ~N46°E and ~N68°E. The spatial relationships between faults and lava flows also provide evidences of co-existing magmatism and tectonics in the transfer zone. We interpret our observations with intermittent pulses of magma influencing the way the deformation is accommodated in the transfer zone leading to alternating magmatic and amagmatic phases and different strain fields. During magmatic phases, the deformation is dike-assisted with dominant extension parallel to the regional spreading direction. Conversely, the amagmatic phases are dominated by pure tectonic deformation with the interaction between the two spreading segments leading to counterclockwise rotations of the strain field and shear motions accommodated by oblique faults. Our observations suggest that magma is important not only in controlling the extension at the rift-systems but also at the rift transfer-zones and could potentially influence the formation of a future transform margin.