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Magmatic rifting recorded in the morphology of normal faults, Ethiopia.

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Magmatic extension plays an increasingly important role in divergent margins transitional from continental rifting to seafloor spreading and is recorded in the geomorphology as individual tectono-magmatic segments. Since most magmatic rifting episodes are intrusive rather than extrusive, faults and fractures prevail within the brittle cap above the level of intrusion. This raises the question as to whether the morphology of brittle structures formed during magmatic rifting is distinct from that developed consequent on amagmatic rifting. In September 2005, a magmatic rifting episode of unparalleled scale and intensity commenced within the highly-extended Afar Rift, Ethiopia, affording an opportunity to 'fingerprint' the associated brittle strain. Ground breaks developed over a width of $\sim$5km and along the entire 60km length of the Dabbahu segment above a zone of dike intrusion. Normal faults opened with horizontal displacements up to 3m and vertical displacements locally up to 5m, but commonly $\sim$ 2m. Faults are sub-vertical, opened along pre-existing cooling joints, and exhibit deep fissures between hanging wall and footwall blocks and at lateral fault tips. Reactivation of older scarps demonstrates that fault growth arises consequent on intrusive magmatic episodes. We describe the morphology of faults developed during this episode and note that similar morphology occurs within Quaternary rift segments of the Main Ethiopian Rift, spatially consistent with recent geophysical evidence for intrusion in the upper crust above magma injection zones. Border faults that bound the Miocene basins within which these segments developed have a different morphology, which we attribute to amagmatic rifting pre-2Ma. Future work includes characterisation of fault scaling relationships in the Dabbahu rift using LiDAR remote imagery to enable comparison with normal fault growth models developed for amagmatic extension.