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Magma flow direction of dikes in Eastern Iceland: Insights from field, magnetic fabric and thin section analyses

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The propagation direction of dikes and the relationships between magmatism and tectonics within rift systems are still debated. The extinct rift zones in Eastern Iceland show the deep eroded portions of a rift, largely consisting of dikes. Here we present a multidisciplinary study in the Alftafjordur volcanic system (Eastern Iceland), including a: (1) structural field analysis, to compare, at a paleodepth of 1-2 km, the crustal dilation due to dikes with that due to faulting; (2) Anisotropy of Magnetic Susceptibility (AMS) analysis, to investigate the magnetic fabric and reconstruct the flow direction of 25 dikes, assuming this may be representative of their direction of propagation; (3) Thin section analysis on selected dike samples, in order to investigate the origin of the magnetic fabric and support the AMS results in terms of flow direction.
Field data show a main NNE-SSW direction of the distal dikes (away from their dominant volcano) and a radial direction for the proximal ones. The cumulative extension due to diking is nearly one order of magnitude larger than that due to faulting. AMS data show that most of the distal dikes (14 out of 19) have an inverse fabric, conversely to the normal fabric (6 out of 6) of the proximal dikes. The petro-fabric in thin sections suggests that the inverse fabric is related to the orthogonal orientation, with respect to the dike margins, of needle-shaped magnetic minerals. The entire dataset suggests that: (1) the stress variation along the magmatic system controls the direction of the dikes; (2) the crustal dilatation in the subsurface portions of the rift system is mainly due to magmatism; (3) the normal fabric of the proximal dikes suggests both a lateral and vertical magma flow; (4) the inverse fabric is caused by the late crystallization of needle-shaped magnetic minerals, parallel to cooling fractures; (5) the dominant flow direction of the distal dikes may be sub-vertical.