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Interpreting inverse magnetic fabric in dikes from Eastern Iceland

Daniele Trippanera (1), Stefano Urbani (1), Massimiliano Porreca (2), Valerio Acocella (1), Catherine Kissel (3), Leonardo Sagnotti (4), and Aldo Winkler (4)

(1) Roma Tre, Dipartimento di Scienze, Rome, Italy (daniele.trippanera@uniroma3.it), (2) University of Perugia, Department of Physics and Geology, Perugia, Italy, (3) Laboratoire des Sciences du Climat et de l'Environnement, CEA-CNRS-UVSQ, Gif-sur-Yvette Cedex, France , (4) Istituto Nazionale di Geofisica e Vulcanologia (INGV), Rome, Italy

Since the 70's magnetic fabric analysis has been used to infer magma emplacement in dikes. However, the interpretation of magmatic flow orientation in dikes is often complicated by the occurrence of anomalous (i.e. inverse) magnetic fabric.
This latter may either reflect the presence of single-domain (SD) grains or result from peculiar orientation mechanisms of magnetic minerals in magmas of different viscosities. Tertiary dike swarms of extinct volcanic systems in Eastern Iceland represent the ideal case study to clarify the origin of anomalous magnetic fabric.
Here we present the results of a multidisciplinary study on dikes belonging to the Alftafjordur volcanic system (Eastern Iceland), including a: (1) structural field study in order to identify kinematic and thermal indicators of dikes; (2) anisotropy of low-field magnetic susceptibility (AMS) analysis, to investigate the magnetic fabric and reconstruct the flow direction of 25 dikes; (3) first order reversal curve (FORC) diagrams and thermomagnetic properties of selected dikes to define the magnetic mineralogy; (4) petrofabric and image analyses at different microscopic scales to investigate the origin of the magnetic fabric and compare the AMS results with mineral texture.
Our results show that half of the dikes show a well defined inverse magnetic fabrics (k max orthogonal to the dike margins) and anomalous high anisotropy degrees. Only 7 dikes have a normal magnetic fabric and other 6 dikes have an intermediate magnetic fabric. No clear prevalence of SD grains, which could explain the inverse magnetic fabric, was observed. On the contrary, petrofabric and thermomagnetic analysis reveal the presence of low Ti-content coarse magnetite and high Ti-content elongated magnetite grains as the main contributors to most of the observed magnetic fabrics. In particular, the orientation of the elongated high Ti-content magnetite grains, though usually scattered, is partly comparable with that of the maximum and minimum axes of the AMS ellipsoids, suggesting that the preferential orientation of these minerals represent the main source of inverse and intermediate magnetic fabrics.
The results of this study demonstrate that the interpretation of the magnetic fabric is not always straightforward and the origin of anomalous fabrics may be related to a variety of physical and chemical processes during magma emplacement.