Thick dyke emplacement and internal flow: A structural and magnetic fabric study of the deep-seated dolerite dyke of Foum Zguid (southern Morocco)

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[1] Knowledge on forced magma injection and magma flow in dykes is crucial for the understanding of how magmas migrate through the crust to the Earth's surface. Because many questions still persist, we used the long, thick, and deep-seated Foum Zguid dyke (Morocco) to investigate dyke emplacement and internal flow by means of magnetic methods, structural analysis, petrography, and scanning electron microscopy. We also investigated how the host rocks accommodated the intrusion. Regarding internal flow: 1. Important variations of the rock magnetic properties and magnetic fabric occur with distance from dyke wall; 2. anisotropy of anhysteretic remanent magnetization reveals that anisotropy of magnetic susceptibility (AMS) results mainly from the superposition of subfabrics with distinct coercivities and that the imbrication between magnetic foliation and dyke plane is more reliable to deduce flow than the orientation of the AMS maximum principal axis; and 3. a dominant upward flow near the margins can be inferred. The magnetic fabric closest to the dyke wall likely records magma flow best due to fast cooling, whereas in the core the magnetic properties have been affected by high-temperature exsolution and metasomatic effects due to slow cooling. Regarding dyke emplacement, this study shows that the thick forceful intrusion induced deformation by homogeneous flattening and/or folding of the host sedimentary strata. Dewatering related to heat, as recorded by thick quartz veins bordering the dyke in some localities, may have also helped accommodating dyke intrusion. The spatial arrangement of quartz veins and their geometrical relationship with the dyke indicate a preintrusive to synintrusive sinistral component of strike slip.

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1. Introduction

[2] Although there has been extensive work on magma flow and propagation of dykes, most works have been carried out on shallow dykes (mainly in volcanic islands) where a passive infilling of tensile fractures is expected [e.g., *Knight and Walker*, 1988; *Gudmundsson*, 2006; *Hildenbrand et al.*, 2008]. Close to the surface, magma can flow almost freely through open fractures, but deeper in the crust, magma slowly makes its way up through rocks with no open fractures. By studying dykes that cooled at different depth with different thickness, one can investigate how magma flows under different conditions, mostly because viscosity and cooling depend on depth; that is, greater depth correlates with higher temperature and lower viscosity, and thickness, whereby thicker dykes cool more slowly. Some questions still persist on how the magma forces its way up through the crust, how the magma flows within thick intrusions, and how the host rocks accommodate the mechanical, thermal and chemical processes associated with the intrusive process. In order to answer these questions we investigated the thick, deep-seated doleritic Foum Zguid dyke (FZD, southern Morocco) and its host sedimentary rocks. We carried out an extensive collection of oriented paleomagnetic samples along several cross sections perpendicular to the FZD and its host rocks, in a total of seven

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