Geophysical Research Abstracts
Vol. 16, EGU2014-5383, 2014
EGU General Assembly 2014
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A review of numerical modeling of dike propagation

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Magma transport through brittle rock occurs by diking. Understanding the dynamics of dikes is a pre-requisite to interpreting observables associated with magma propagation in volcanic areas, such as seismicity and deformation. Moreover, diking plays an important role in the mechanics of a number of tectonic processes including continental rifts and mid-ocean ridges. Existing models of propagation of dikes are still mainly two-dimensional and include only a few of the many physical processes influencing the propagation of magma-filled fractures in rock: viscous dissipation, fracturing, magma rheology and phase changes, heat exchange, interaction with rock layering, pre-existing cracks and external stress field, among other factors.

Here we review numerical models of dike propagation, focusing on the most recent developments. Current modeling approaches have been influenced by two main philosophies, one in which fluid dynamical processes are assumed to control diking, and the other which give primary control to rock fracturing. We show how integrating the two philosophies creates the highest potential for successful representation of natural systems. We present a selection of key results obtained through numerical modelling and draw on insights from the field of hydraulic fracturing, as an industrial analogue to dike propagation. Finally, we discuss promising directions for future research.