Geophysical Research Abstracts
Vol. 12, EGU2010-6121, 2010
EGU General Assembly 2010

Dike emplacement and flank instability at Mount Etna: constraints from a poro-elastic-model of flank collapse

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We investigated the potential to initiate flank failure on Mount Etna, as a result of moderate-sized magmatic intrusions. We approximate the dynamic process of a dike intrusion in a porous media using the framework of a moving volumetric dislocation, assuming a steady behavior. A vertical planar dike is assumed as most representative of the geometry of an intrusion at Mount Etna. Given the large uncertainty existing on the range of the physical and geometrical parameters describing the dynamic process, this steady state representation can be considered adequate for characterizing pore fluid pressure changes at Etna volcano. For the geometry used in this study, the analysis of the displacement of a single wedge (block) is an appropriate mode of failure. Resolution of the forces parallel and normal to the failure (shear) surface enables the total force F_R driving the outward block motion to be determined. The minimum set of coefficients that describes the stability of the isothermal system may be determined as $F_R = F_R\,(a, p_{sc}, \theta)$, where θ *is* the slope of the groundwater surface, $p_{sc}$is the depth of the detachment surface at the rear scarp, and a the depth below sea level of the toe of the block. Only two of the three parameters (a, θ) are somewhat constrained, while p_{sc} is practically unknown. Our analysis shows that when there is no dike intrusion, the block seems to be practically in stable equilibrium, especially when we consider only the existence of phreatic aquifers. When we have a dike intrusion, the block is stable in the case of phreatic aquifers but may be unstable if the block is above a confined aquifer.