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Dike deflection as constraint for magma pressure, chamber depressurizing and magma withdrawal; with application to Etna 2001 case

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We studied the stress effects of the topography load on dike propagation. Firstly, we considered the results from analogue experiments; secondly, we refined the results by applying numerical simulations using the finite element method (FEM) in order to also consider the medium rheology and the real topography.
The numerical analysis shows how the stress generated by a mountain load can affect and deflect the dike path depending on its initial position and magma excess pressure. We applied the results obtained to the real case of the Etna 2001 eruption characterized by a final deflection of the uprising dike. We cross-related the information on the position and dimension of the dike, inferred from ground deformation modelling, with the numerical simulation results in order to estimate the final excess pressure of the dike when it started to deflect, which proved to be about 4-8 MPa.
As further step, we estimated the initial overpressure accumulated at the intermediate magma chamber before its breakout. For this source we used the shape and position provided by the ground deformation pattern associated with the inflation, which inferred an ellipsoidal storage centred at 4 km below sea level. Making the assumption that the pressure decreases linearly with the volume of magma moving from the chamber into the dike, and we estimated 7-15 MPa as the initial overpressure accumulated at the intermediate magma chamber before its breakout. Despite of the previous modelling, which overestimated the chamber source overpressure, now the approach presented here lead to infer a stress compatible with the strength of the rocks.