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Stability analysis of Western flank of Cumbre Vieja volcano (La Palma) using numerical modelling

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La Palma volcanic island is one of the youngest of the Canary archipelago, being a composite volcano formed by three overlapping volcanic centers. There are clear onshore and offshore evidences of past giant landslides that have occurred during its evolution. Currently, the active Cumbre Vieja volcano is in an early development state (Carracedo et al., 2001). The study of flank instability processes aim to assess, among other hazards, catastrophic collapse and potential tsunami generation. Early studies of the potential instability of Cumbre Vieja volcano western flank have focused on the use of sparse geodetic networks (Moss et al. 1999), surface geological mapping techniques (Day et al. 1999) and offshore bathymetry (Urgeles et al. 1999). Recently, a dense GNSS network and satellite radar interferometry results indicate ground motion consistent with deep-seated creeping processes (Prieto et al. 2009, Gonzalez et al. 2010).

In this work, we present a geomechanical advanced numerical model that captures the ongoing deformation processes at Cumbre Vieja. We choose the Finite Elements Method (FEM) which is based in continuum mechanics and is the most used for geotechnical applications. FEM has the ability of using arbitrary geometry, heterogeneities, irregular boundaries and different constitutive models representative of the geotechnical units involved. Our main contribution is the introduction of an inverse approach to constrain the geomechanical parameters using satellite radar interferometry displacements. This is the first application of such approach on a large volcano flank study. We suggest that the use of surface displacements and inverse methods to rigorously constrain the geomechanical model parameter space is a powerful tool to understand volcano flank instability. A particular important result of the studied case is the estimation of displaced rock volume, which is a parameter of critical importance for simulations of Cumbre Vieja tsunamigenic hazard assessment.

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