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Mechanical stability of volcanic edifice and inflating magma chamber at Piton de la Fournaise, La Réunion hot spot

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The Piton de la Fournaise (PdF) at La Réunion Island, France, is under recurrent activity (most recent in september 2018), and the question rises as of the stability of the flanks of volcanic edifice on the relatively long term period, with regards to our current understanding of 1) modes of magma feeding at depth , and 2) mechanical heterogeneities within the volcanic rock wedge, including continuous rock weathering and pre-existing failure planes and magmatic conduits. In order to assess the stress state of the PdF related to these specific mechanical effects, we use a three-dimensional numerical code, ADELI, that is able to resolve the dynamical evolution of deformation and stresses and accounts for elasto-plastic rheologies. While ADELI usually deals with Drucker-Praeger shear failure, we implemented tensile failure in order to track the possible co-existence of these two modes of failure (I and II), and we will present basic tests validating this behavior. The meshed domain accounts for the real topography of the PdF extracted from from a DEM (reaching +2600 m height), and for an elliptic reservoir of magma located at the inferred depth of -1.5 km under the PdF's summit. The stress and deformation fields are then evaluated; when first considering the volcano's morphology alone, a deviatoric stress of more than 45 MPa is generated at the reservoir's walls due to the topographic gradient alone. Then an overpressure of 50 -100 MPa is assumed applied at these walls, and a variety of failure thresholds are investigated. The models produce deformation and failure patterns which are then compared with previous studies and available structural and seismological observations. These comparisons allow to better assess the importance of pre-existing fault zones and volcanic conduits that had been identified in previous studies, and improves our understanding of the modes of fluids transfer in relation with flank mechanical stability, and thus the potential location of future volcanic eruptions.