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High-resolution mapping of fractures and fault scarps in volcano flanks using LiDAR and Structure-from-Motion data

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Volcano flanks are associated with steep slopes, in particular, at ocean island volcanoes such as Canary Islands, Azores or Cape Verde. In general, the stability of volcanoes has been studied using multiple approaches and methodologies, e.g., using a) volcano-tectonic structural data, b) geophysical and geodetic methods, c) geomechanical laboratory experiments, and/or d) numerical mechanical models. Within the first group (volcano-tectonic structural data), the recent advances in detailed and high-resolution topography could allow us to reconstruct quantitatively the deformational history of volcano flanks, even before pre-instrumental records. Moreover, to do so, we have to make several assumptions, mainly that the volcano-tectonic structures recognized in very-high-resolution topography dataset (approx. 1 m spatial resolution and <25 cm vertical precision), record the bulk of the deformation processes e.g., fault scarps, and we neglect as minor, likely off-fault processes.

In this work, I aim to reconstruct the amount of surface deformation associated to an intrusive-effusive eruption using high-resolution topographic datasets. Here, I present a detailed mapping of fractures and fault scarps carried out at the summit area of Cumbre Vieja volcano, La Palma. I use a combination of field techniques, LiDAR and Structure-from-Motion data to estimate the location, length and amount of slip/opening on an array of fractures and faults. The collected dataset allow me to estimate the probable extend at depth of the fracture and fault system, and discuss its generation mechanisms, in the context of the volcano flank stability.

This study highlights that very-high-resolution topography could, indeed under reasonable assumptions, provide quantitate information about deformation processes at volcano flanks. This methodology will contribute to the study of the stability of volcanoes, extracting information even during any pre-instrumental monitoring period on a given volcano.