EGU2020-13651
https://doi.org/10.5194/egusphere-egu2020-13651
EGU General Assembly 2020

Drones, dykes and too much data: mapping the Taburiente dyke swarm

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Sheet-intrusions are the most common means of magma transport in basaltic volcanoes, so knowledge of their propagation paths is critical for volcanic hazard analyses. Recent advances in unmanned aerial vehicle (UAV) technology and modern photogrammetric techniques such as structure from motion have made it possible to capture and analyse exposed intrusions in unprecedented detail. Using these methods we have captured digital outcrop models of the spectacularly exposed basaltic dyke-swarm that formed the plumbing system of Volcán Taburiente on La Palma (Canary Islands, Spain), and mapped 500 dykes over a total exposed length of > 50 km. We then applied a semi-automatic method implemented in CloudCompare to extract dyke orientation and thickness measurements, as well as associated uncertainty, every ~10 cm along ~60 % of the dyke margins, resulting in more than ten million individual estimates. These highlight a broadly radial dyke swarm with a focal point in the southern section of Caldera Taburiente. The near-continuous exposure also allowed us to estimate the vertical and circumferential strain induced by the dyke swarm and show that although the dykes are radial, N-S orientations are more frequent and probably gave Volcán Taburiente an elongate geometry. A simple Maxwell visco-elastic model can account for the observed strain without requiring a basal detachment or gravitational spreading, and also replicate the observed dyke-aperture distribution.