EGU21-10709
https://doi.org/10.5194/egusphere-egu21-10709
EGU General Assembly 2021

2003-2005 intra-eruptive deformation at Soufrière Hills Volcano (Montserrat) modulated by volcano-tectonics and weak crustal rocks

Jo Gottsmann[1], Molly Flynn[1], and James Hickey[2]
[1]Univ. of Bristol, Dep. of Earth Sciences, Bristol, United Kingdom of Great Britain – England, Scotland, Wales (j.gottsmann@bristol.ac.uk)
[2]Camborne School of Mines, University of Exeter, Penryn Campus, United Kingdom of Great Britain – England, Scotland, Wales (j.hickey@exeter.ac.uk)

Identifying driving mechanisms behind volcano deformation is one the key challenges of volcanology. Many geodetic models rely on simplified assumptions on source shape and the mechanical behaviour of surrounding rocks. However, geochemical, petrological and geophysical data illustrate complex architectures of sub-volcanic plumbing systems and crustal rocks. Mechanical heterogeneities fundamentally influence the stress vs. strain relationship and therefore require detailed analysis beyond the isotropic, homogenous, and elastic (IHE) half-space approximation embodied in traditional models.
Here, we invert intra-eruptive ground displacements recorded between 2003-2005 on Montserrat to shed light on the magmatic plumbing system of Soufrière Hills Volcano. Incorporating 3-dimensional crustal mechanical and topographic data in a finite-element model we show that the recorded displacements are best explained by a southeastward dipping (plunge angle of 9.3˚) vertically extended tri-axial ellipsoidal pressure source with semi-axis lengths of 1.9 and 2.0 km horizontally, and 5.0 km vertically. The source is centred at 9.35 km depth below main sea level and embedded in independently imaged anomalously weak crustal rocks. The source orientation appears to be controlled by the local stress field at the intersection of two major WNW-ESE and NW-SE striking tectonic lineaments. We derive an average volumetric strain rate of 8.4 $x10^{-12}$ s^{-1} by transcrustal pressurisation which may have contributed to flank instability and mass wasting events in the southern and eastern sectors of the island.