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Multiscale fracture density analysis at Stromboli Volcano, Italy: implications to flank stability

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Stromboli volcano has experienced four sector collapses over the past 13 thousand years, resulting in the formation of the Sciara del Fuoco (SDF) horseshoe-shaped depression and an inferred NE / SW striking rift zone across the SDF and the western sector of the island. These events have resulted in the formation of steep depressions on the slopes on the volcano where episodes of instability are continuously being observed and recorded. This study aims to quantify the fracture density inside and outside the rift zone to identify potential damaged zones that could reduce the edifice strength and promote fracturing. In order to do so we have carried out a multiscale analysis, by integrating satellite observations, field work and seismic and electrical resistivity analyses on cm scales blocks belonging to 11 lava units from the main volcanic cycles that have built the volcano edifice, ie. Paleostromboli, Nestromboli and Vancori. 0.5 m resolution Pleiades satellite data has been first used to highlight 23635 distinct linear features across the island. Fracture density has been calculated using Fracpaq based on the Mauldon et al (2001) method to determine the average fracture density of a given area on the basis of the average length of drawn segments within a predetermined circular area. 41.8 % of total fracture density is found around intrusions and fissures, with the summit area and the slopes of SDF having the highest average fracture density of 5.279 . Density, porosity, P- wave velocity in dry and wet conditions and electrical resistivity (in wet conditions) were measured via an ultrasonic pulse generator and acquisition system (Pundit) and an on purpose built measuring quadrupole on cm scale blocks of lavas collected from both within and outside the proposed rift zone to assess the physical state and the crack damage of the different lava units. Preliminary results show that P-wave velocity between ~ 2.25 km/s < Vp < 5km/s decreases with porosity while there is high variability electrical resistivity with 21.7 < ρ < 590 Ohm * m. This is presumably due to the lavas texture and the variable content of bubble/vesicles porosity and crack damage, that is reflected by an effective overall porosity between 0 and 9 %. Higher porosity is generally mirrored by lower p-wave velocity values. Neostromboli blocks show the most variability in both P-wave velocity and electrical resistivity. Further work will assess crack density throughout optical analyses and systematically investigate the UCS and elastic moduli. This integrated approach is expected to provide a multiscale fracture density and allow to develop further laboratory testing on how slip surfaces can evolve to a flank collapse at Stromboli.