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Multiscale analysis of physical rock properties at Stromboli Volcano: what controls the frictional properties?

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Stromboli volcano, located in the north-easternmost island of the Aeolian archipelago (Southern Italy) and well known for its persistent volcanic activity, has experienced at least four sector collapses over the past 13 thousand years. The most recent activity resulted in the formation of the Sciara del Fuoco (SDF) horseshoe-shaped depression and a tectonic strain field believed to have promoted flank collapses and formed a NE / SW trending weakness zone across the SDF and the western sector of the island. The tectonic strain field interplayed with dyking and fracturing appears to control the episodes of instability and the onset of slip surfaces. This study presents new data identifying areas of damage that could promote fracturing via remote sensing and rock friction measurements taken on rocks around the SDF and the coupled “weak” zone. We have carried out a multiscale approach by integrating satellite observations with block and sample scale physical and mechanical properties and frictional tests carried out in triaxial configuration on cm scale slabs. Over 5000 individual fractures have been at first processed through the MatLab toolbox FracPaQ to determine fracture density, slip and dilatancy tendency around the collapse scarp with results showing that dilation and slip 0.6< is more common the northern side of the SDF as well as around areas of eruptive activity.

Key units have been sampled on the field (Paleostromboli, Vancori and Neostromboli) with reference to SDF and the weak zone. Physical and mechanical properties defined using elastic wave velocities, electrical resistivity, uniaxial compressive strength and elastic moduli have been assessed and inverted for comparison to field scale geophysical investigations. Finally, direct-shear tests in triaxial configuration were carried out to explore the frictional properties using rectangular basalt slabs at 5 – 15 MPa confining pressure in dry and saturated conditions. Preliminary results show a variation in the friction coefficient (μ) between 0.55 and 0.7 with a general μ decrease with increasing confining pressure and saturation. The most porous Neostromboli units show the lowest friction. This suggests that the textural and pre-existing crack damage variability due to the complex and different magmatic history and cooling rates do control the evolution of the frictional properties and evolving fracturing processes. Further work will structurally quantify the slip evolution throughout post-mortem microstructural observation in order to interpret the relations to the field scale weakness zone and the SDF.