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Analogue modelling of flank dynamics at Mount Etna, Italy: first results

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Mount Etna shows one of the most relevant case of active flank dynamics along its East and South-East sectors, with some well-known tectonic structures, such as the Pernicana fault, and evident morphologies, such as the Valle del Bove depression. Factors governing this flank dynamics are still matter of debate. Among these, the most important recognized by previous Authors are the topography, intrusion of a plutonic complex in the basement, rising of magma in the volcanic edifice, regional tectonics, low cohesion layers in the volcano basement, and pore pressure.

In this study, a first set of analogue models of the complex flank dynamics of Mount Etna was conducted, and the experiments were analyzed for deformation characteristics. Several experiments were run to account for the role of each factor or combination of factors on the flank dynamics of the volcano. The modeling apparatus consisted of a sand cone on a sand base simulating the volcanic edifice and its basement. Sand used for the experiments was a mixture of high cohesion crushed silica sand and low cohesion glass microspheres. Alternated layers with different cohesion were used to account for the crustal structure of the basement. Geometry of the experiments was designated to simulate the topographic gradient at the eastern base of the volcano. Injections of high viscosity silly putty and low viscosity vegetable oil were used to model respectively the growth of an intrusive complex below the volcano and the rising of magma inside the deformed volcanic edifice. Some experiments were conducted on a sheared basal layer to reproduce the effect of the regional tectonics on the volcano flank dynamics. Finally, injection of compressed air in the model allows to simulate the pore pressure and its capability to reduce shear strength of the analogue granular materials.

We used a high resolution laser scanner to trace surface deformation as function of the physical conditions of the models. The three-dimensional surface at each deformation stage was subtracted from the DEM of the undeformed model. Areas of uplift and subsidence that became apparent from the DEMs were measured to track the process of cone deformation. Completed experiments were sliced to reveal the structures within the cone in three dimensions. Results of analogue modelling give new insights about the combination of factors governing the flank dynamics and instability of Mount Etna. From the hazard perspective, our work provides new basis for the evaluation of the role played by flank dynamics during volcanic crises, such as that of 2002-2003.