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Modelling triggers of slope instability at Stromboli Volcano with FLAC 2D finite element method

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At Stromboli, a stratovolcano located at the easternmost end of the Aeolian Archipelago (Southern Tyrrhenian Sea, Italy) and characterized by persistent Strombolian activity from several vents within a crater terrace area, small-to-large volcano slope instability characterised the initial phases of the last four flank eruptions (1985-86, 2002-03, 2007, 2014), triggering tsunamis during the 2002-03 event. Landslides at Stromboli are frequent, mainly occurring in the Sciara del Fuoco depression, a landslide scar on the NW flank of the island formed during the last 13 ka.
Landslides triggers have been investigated by means of numerical modelling using the Fast Lagrangian Analysis of Continua (FLAC-2D) software. Firstly, detailed geotechnical characterization of the volcano edifice has been achieved, mainly based on literature data and laboratory tests. This characterization furnished main information to perform a simplified model of the volcano, finalized to the FLAC numerical modelling. Modelling results have been compared with GB-InSAR monitoring activities carried out in the last fifteen years.
The model has been carried out on three profiles, with increasing level of detail. The first profile is oriented NW-SE and regards the entire volcano edifice, from the Sciara del Fuoco flank to the opposite side of the island. The unbalanced factor is here represented by the dyke intrusion which develops from the volcano basement up to the Sciara del Fuoco. The numerical model has been performed taking into account an increasing magma pressure within the dyke, with the aim to understand the effects of this increasing pressure on the Sciara del Fuoco deformation.
The second profile is still oriented NW-SE but it is more detailed than the previous one, and focuses on the effect of the dyke lateral propagation and the consequent formation of a sill within the Sciara del Fuoco, reproducing the condition occurred during the 2007 flank eruption. Also in this case, the effects of increasing magma pressure on the volcano structure have been investigated, with the final aim of evaluating the pressure value which could trigger mass-wasting in the Sciara del Fuoco.
The third and the last profile is a detail of the upper part of the Sciara del Fuoco, also involving the talus located below the North East crater (NEC), that partially collapsed during the onset of the 2014 flank eruption. Here, the numerical modelling has been performed with the aim of understand the effect of magma-filled fractures propagation on the NEC talus stability. The modelling results suggested that the emplacement of a lateral dyke propagating from the crater terrace is not sufficient to produce the observed collapse, whereas a horizontal sill propagating from the base of the lateral dyke could produce the NEC talus collapse.