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Identifying submarine slope instability from lava delta deformation: the COSMO-SKYMED and SENTINEL-1 contribution

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Interferometric Synthetic Aperture Radar (InSAR) is an incomparable technique to forecast the collapses of newly emplaced lava delta. We demonstrated that Multi-Temporal InSAR displacement measurements of lava delta can be used to detect submarine slope instability at Stromboli volcano (Italy). The Stromboli lava delta formed as consequence of the recent flank eruptions (2002-03, 2007 and 2014), overlying a pre-existing scar produced by a submarine-subaerial tsunamigenic landslide that occurred on 30 December 2002 in the Stromboli NW unstable flank (Sciara del Fuoco depression). Displacement data derived from space-borne X-band COSMO-SkyMED (CSK) and C-band SENTINEL-1A (SNT) SAR imagery, collected between February 2010 and October 2016, and processed using the SqueeSAR algorithm. Ground displacement revealed the differential ground motion of the lava delta in both the datasets, identifying a stable area within the northern sector of the SdF and an unstable area (characterized by velocity fields on the order of 30 mm/y and 160 mm/y in the CSK and SNT datasets, respectively). The slope stability of the offshore part of the Sciara del Fuoco, evaluated using a 3D Limit Equilibrium Method, highlighted a greater propensity to mass-wasting the sector already involved in the 30 December 2002 landslide, which involved the lava delta and its surrounding areas. Therefore, while MT-InSAR data provided the post-effusive deformation field after the 2007 and 2014 flank eruptions, stability analysis highlighted that the accumulation of lava flows on the prone-to-failure Sciara del Fuoco submarine slope is the main cause of the detected lava delta deformation. Therefore, the displacement recorded by the InSAR data at the Stromboli lava delta can be considered as a proxy for the deformation of submarine slides within the Sciara del Fuoco.