How do volcanic rift zones relate to flank instability? Evidence from collapsing rift at Etna and its relationship with the nearby Pernicana Fault System

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Rift zones, characterized by repeated dike emplacement, are expected to delimit the upper portion of unstable flanks at basaltic volcanoes. We use nearly two decades of InSAR observations excluding wintertime acquisitions, to analyze the relationships between rift zones, dike emplacement and flank instability at Etna. The results highlight a general eastward shift of the volcano summit, including the NE and S rifts. This steady-state eastward movement is interrupted or even reversed during transient dike injections. Detailed analysis of the NE Rift shows that only during phases of dike injection, as in 2002, does the rift transiently becomes the upper border of the unstable flank. The flank's steady-state eastward movement is inferred to result from the interplay between magmatic activity, asymmetric topographic unbuttressing, and east-dipping detachment geometry at its base. This study documents the first evidence of steady-state volcano rift instability interrupted by transient dike injection at basaltic volcanoes. We further use three decades of available geodetic data (leveling, InSAR with ERS-ENVISAT and CosmoSkyMed data) and seismic data, from 1981 to 2012, to analyze the E flank motion in the area of the Pernicana Fault System (PFS), structurally connected to the NE Rift and marking the lateral boundary of the unstable flank. We observe an overall temporal and spatial relationship between dike intrusion along the NE Rift, seismic activity and surface fracturing along the PFS.

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