New insight into the microfracturing dynamics of Etna's edifice during the 1994-2001 period

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Between 1994 and 2001, systematic gravity fluctuations were observed, due to mass redistributions in a volume located below the SE sector of Mt. Etna, at a depth range of 2 to 4 km b.s.l. The phases of gravity decrease coincide with increases in the rate of strain release, with many hypocenters clustered in the volume containing the gravity source. The joint gravity/strain release anomalies may reflect changes in the rate of microfracturing along the NNW−SSE fracture zone that cuts the SE slope of the volcano. Increases in the rate of microfracturing imply a local density (gravity) decrease, and an increase in the release of seismic energy, thus explaining the observed coupling in time and space. A phase of gravity decrease/strain release increase culminated in the breakout of the 2001 flank eruption. Previous studies suggested that the magma in a pressurized deeper reservoir used the inferred zone of increasing microfracturing as a path to the surface. The process proposed to explain the coupling between gravity and seismic data is mirrored in the mechanical behavior of rocks under deformation, with cracks that form, link up and grow, determining increasing damage and dilatant processes during the pre−failure stages. Under the hypothesized scenario, there are two main issues that need to be addressed. The first one concerns the mechanism that induces the inferred changes in the rate of microfracturing along the NNW−SSE fracture zone. The second one concerns the strain effect at the surface associated to the inferred changes in fracturing rate at depth. Indeed, the ground deformation, expected to be induced by the inferred volume changes at depth, was not observed. In order to address the above issues, we use a finite−element modeling approach and we assume for the NNW−SSE shear/damage zone a lower Young's modulus than the rest of the domain. Preliminary results suggest that tensile stresses across the fracture zone may be induced by a pressure source below the Western flank of Etna, a location of known magma storage that was active during the studied period. We also find that, if a different Young's modulus is assumed for the NNW−SSE shear/damage zone, a considerable extension across it may correspond to a relatively small deformation effect at the surface. The latter would be swamped by the effect of the pressure source below the Western flank of the volcano.