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Continuous strain, gravity, magnetic and thermal-satellite data for tracking the dynamics of a lava fountain eruption : application to Etna 15 November 2011 case

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We present a multidisciplinary set of recent and new data that allowed to make a step forward in studying the internal mechanisms of a powerful lava fountain occurred at Etna volcano.
In particular, the negative change in the signals recorded at two borehole strainmeters, installed just two weeks before the explosive event, gives clear evidence of a deep depressurizing source (depth of ca. 6-8 km below summit craters). The decompression was well recorded at both the two stations located at a radial distance from summit craters of 6 and 10 km, respectively. Due to the exceptional accuracy of the strainmeters (the nominal resolution is of about 10E-12 in strain), this episode represents the first time that strain field changes are observed at Etna with such precision during a lava fountain.
As for other previous episodes, during the lava fountain the gravity signals of the two continuous stations showed a different reversal trend that inferred a shallower (ca. 1.5 km below summit craters) source, where the low density rich-gas magma (foam) accumulated and then was released during the lava fountain. Therefore, this set of data (strain and gravity) allowed to infer the positions of two intermediate storages involved in the shallow-intermediate plumbing system.
Also magnetic data recorded a significant permanent piezomagnetic variation of about 3 nT providing useful constraints on the stress field. The piezomagnetic effect depends directly on the deviatoric stress and, hence, gave insights into the internal overpressure within the volcano edifice.
During this event, satellite data acquired by MSG-SEVIRI (3 km of spatial resolution, 15 minutes of sample time) were elaborated to detect thermal anomalies, to compute a radiant heat flux and to provide an estimation of the emitted volume. Both strain signals and SEVIRI-derived radiant heat flux started to show a first significant change few hours before the lava fountain beginning, when also a lava flow was emitted from SE crater anticipating the paroxysmal event. The estimate of the emitted volume allowed to infer the overpressure released during the explosive episode, thus also providing constraints on pressure change associated with the depressurizing sources.