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Recent Eruptive Activity at Etna Volcano Inferred by Borehole Strainmeters : Source Modeling and Magma Volume Balance

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After the end of the last effusive flank 2008–2009 eruption, in January 2011 the eruptive activity resumed at Etna producing a new phase with 44 lava fountain episodes through December 2013.
Almost all the lava fountains had similar characteristics. The intensity of the initial strombolian explosions increased rapidly and the activity soon shifted to lava fountains. The paroxysmal phase was accompanied by increasing tephra emission with lava fountain reaching up to ∼0.5–0.8 km above the crater and an eruption column rising several kilometers above the volcano summit before being dispersed by wind to the distal volcano flanks and by lava flow output. The paroxysmal episodes lasted a few hours and fed lava flows that expanded in the Valle del Bove depression with maximum lengths of 4–6 km. These eruptive episodes emitted much more magma than in the phases occurred in the previous decades.

In November 2011, the first two borehole strainmeters, dilatometers type with nominal precision of $\sim 10^{-10} - 10^{-11}$, were installed at Etna at ∼180 m depth below the ground surface with distances from the summit central crater of 6 (DEGI) and 10 km (DRUV), respectively. During the paroxysmal events these high precision instruments detected negative strain changes indicating medium expansion at both sites. For each fountain episode the amplitude of the stain changes were almost similar with ∼0.2 and ∼1 μstrain at DRUV and DEGI, respectively.

A Finite Element Model was set up to estimate accurately the tilt and volumetric strain, taking into account the real profile of the volcano and the elastic medium heterogeneity.
The numerical computations indicated an elongated depressurizing source located at 0 km b.s.l., which underwent a volume change of $\sim 2 \times 10^{6}$ m^{3} which is the most of the magma volume erupted, while a smaller remaining part ($\sim 0.5 \times 10^{6}$ m^{3}) is accommodated by the magma compressibility. This allowed to infer a representative average erupted volume of $\sim 2.5 \times 10^{6}$ m^{3} for each lava fountain event, that independently confirmed the estimation of the mean total volume emitted such as separately calculated from field measurements for the pyroclastic deposit and thermal satellite data for the lava flows.

This shallow source cannot accumulate large magma volumes but is able to favor frequent short-term periodic eruptive events with a fairly constant balance between the refilling and the erupted magma. The study also allows to make a step forward in interpreting the recent lava fountain activity and estimating the expected volume that will erupted to reach equilibrium again.