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Cyclic magma recharge pulses detected by high-precision strainmeter data at Etna volcano during the 2017 explosive-effusive activity

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High precision borehole strain-meters data at Etna revealed cyclic small volumetric strain changes, associated to the 2017 recurrent explosive-effusive eruptive events. No pre- neither co-eruptive deformation have been detected by the GPS measurements, that often fail to detect ground deformation engendered by short-term small volcanic events due to the limit in their accuracy (millimeters to few centimeters). Through the analysis and detection of small strain changes (few tens of nanostrain), hidden in the raw data, a significant time correspondence with the eruptive activity is observed. Particularly, fast exponential strain changes, preceding the eruptive events, with timescale of about 2-7 days are observed for the first time. These variations are attributable to the expansion of the magma chamber which during the inter-eruptive period is replenished with new magma from depth. Interpretation of the strain changes in terms of pressurization/depressurization of the chamber due to the cyclic influx and withdrawal of magma allows to place some constraints into the magma recharge volume rate. A Finite Element model has been developed to simulate the temporal evolution of the strain changes generated by the re-pressurization of a spheroidal magma source using a dynamical approach. An average total mass budget of about 1-2$\times 10^9$ kg, which is in the range of the successive erupted mass, is estimated to be accumulated within a shallow vertically elongated magma chamber during each inflation periods.
These evidences demonstrate that the near-real time analysis and interpretation of strainmeter records are remarkable for their capability to record small transients, that would otherwise go undetected with other current methodologies, and allow to unravel recharging phases preceding eruptive activity. Under these conditions, the ability to simulate inter-eruptive periods offers the opportunity to estimate the magma recharge rate with important implication for volcano hazard assessment.